Introduction to the Implementation Study

SETTING THE CONTEXT FOR THE IMPLEMENTATION STUDY

The 7 April 2009 Government announcement of the National Broadband Network (NBN) project stated that it would deliver:

- Superfast broadband for all Australians, at affordable prices with an objective of providing broadband via fibre to 90 percent of premises, and via next-generation wireless and satellite technology for the remaining areas; and
- Structural reform of the telecommunications industry by requiring NBN Co to operate as a wholesale-only, open-access network provider; and a commitment to improve the telecommunications regulatory framework in the transition to the NBN.

At the heart of the NBN policy is an objective to deliver a step-change improvement in broadband service quality to all Australians. The ambition of this objective is matched by the scale and complexity of the implementation task. At stake are billions of dollars of Government investment, the continuity and availability of services for millions of end users and the opportunity to establish new competition settings around a network infrastructure that will last for at least 40 years.

This report advises the Department of Broadband, Communications and the Digital Economy (DBCDE) on how the Government's policy objectives can be implemented over time, as set out in the Terms of Reference.

The report is written for those in Government who will make and implement decisions regarding the NBN, including drafting and enacting legislation, supporting negotiation of potential agreements with existing operators, modifying NBN Co's constitution and playing a role in the ongoing oversight of NBN Co. It is not to be used or relied on by any other persons.

SCOPE OF THE IMPLEMENTATION STUDY

The purpose of the Implementation Study is to advise Government on how best to implement its stated policy objectives, not to evaluate those objectives, given that the policies have already been agreed by Government. This report therefore focuses on translating high-level policy objectives into tangible actions for both Government and NBN Co to implement. Explicitly, it does not:

- Evaluate Government's policy objectives;
- Evaluate the decision to implement the NBN via the establishment of NBN Co;

- Undertake a cost-benefit analysis of the macro-economic and social benefits that would result from the implementation of a superfast broadband network.

The Implementation Study complements rather than duplicates NBN Co's activities in a number of areas. Our report focuses on how to translate the policy objectives into a mandate for NBN Co, including supporting legislation and regulation. Where the Implementation Study examines issues such as network design and pricing, it is with a focus on how these impact the commerciality, coverage and competition objectives of the NBN. Details of implementation planning, engineering analysis, technology evaluation and roll-out planning remain the responsibility of NBN Co.

The priority roll-out in Tasmania and the Regional Backbone Blackspots Program did not form part of the Implementation Study's scope, except to incorporate the cost of these initiatives in our modelling, given they were included in Government's initial $43 billion estimate of the capital costs for implementing the overall NBN policy.

IMPLEMENTATION STUDY METHODOLOGY

The methodology employed in the Implementation Study is summarised as follows:

We have taken a conservative and detailed, fact-based approach. The Implementation Study's geospatial modelling maps every address in Australia and constructs a bottom-up reference fibre network including access network equipment (e.g., feeder, distribution, drop), exchange locations and equipment and backhaul links, using conservative assumptions about the cost to build. For wireless, the model identifies indicative tower locations (either existing or new) sufficient to meet Government's objective of providing end users at least 12 Mbps and calculates the cost of tower construction or strengthening, additional radios, backhaul and customer premises equipment (CPE). For satellite, we calculate the full systems costs required to serve premises outside the fibre and wireless footprints, including premises that could be in a wireless blackspot. We also approach revenue modelling in a conservative manner, relying on existing revenue pools and current levels of industry pricing; we have not assumed NBN Co will capture additional revenue from the innovation that the NBN will enable.

We sought extensive input from relevant experts and stakeholders:

- We consulted with a range of experts, in addition to completing our own primary analysis and research. These experts include technical experts, vendors, regulatory experts and industry insiders from Australia and overseas. This input has helped inform our analysis; however the views expressed in this report are those of the Implementation Study, not those of others we have consulted.
- We benefitted from extensive industry and stakeholder consultation. Given the magnitude of the industry transition that the NBN will initiate, our findings are

grounded in an understanding of the potential impact this will have on the industry and on stakeholders, and the roles they could play in this transition.

- We undertook regular and extensive consultation with Government to understand policy issues, implementation considerations and to build alignment. Input was received from the Department of Broadband, Communications and the Digital Economy, the Department of Prime Minister & Cabinet, the Department of Finance and Deregulation, Treasury, the Attorney General's Department, the Australian Competition & Consumer Commission, the Australian Communications and Media Authority, the Australian Bureau of Statistics, the Australian Local Government Association and a range of other state and federal government departments concerned with aspects of the implementation of the NBN.
- We worked closely with NBN Co to share perspectives on various aspects of implementing the NBN and to understand NBN Co's work on the technical and commercial aspects of the network design. This engagement helped inform the Implementation Study's views on how Government can best achieve its policy objectives; however this report contains our independent perspectives and recommendations on how to implement the NBN policy through NBN Co and supporting mechanisms.

We present an integrated set of recommendations that can be implemented in a practical way. Our recommendations and the analysis that supports them aim to be internally consistent—the recommendations form a coherent package, rather than a menu of options. We recognise uncertainty where it exists, the ability (and need) to adapt implementation approaches over time, and the need to navigate a practical path rather than trying to solve all details upfront.

Finally, we recognise that negotiations have been proceeding with Telstra under the Terms of Engagement announced in December 2009. While we have considered the potential impact of a range of possible agreements in our analysis and recommendations, Government policy is to build the NBN—unilaterally if required—and that has been taken as our reference case.

STRUCTURE OF THE IMPLEMENTATION STUDY REPORT

This report is structured into an executive summary, and four parts.

Executive Summary

Chapter 1 contains a stand-alone overview of our findings and recommendations.

Part A: Achieving the national broadband objectives

Sets out a recommended approach to implementing Government's objectives. It is organised in five chapters. Chapter 2 proposes a mandate for NBN Co. Chapter 3 describes how this mandate will enable a new generation of services for end users. Chapters 4, 5 and 6 provide detailed recommendations for constructing each part of the network. Chapter 4 describes the fibre access network to meet Government's 100 Mbps objective to 90 percent. Chapter 5 describes the solution for the final 10 percent. Chapter 6 describes how to ensure nationwide backhaul availability.

Part B: Creating sustainable commercial arrangements

Describes the overall business case elements under different scenarios, and how these translate into funding considerations. It is organised in two chapters. Chapter 7 examines the overall returns for the NBN project under various scenarios. Chapter 8 presents recommendations on funding given the nature of the NBN project and how that funding model should be adapted over time.

Part C: Ensuring a competitive telecommunications industry

Explores how to achieve Government's competition objectives through the NBN, both in the transition to the new network, and once NBN Co becomes the monopoly privately-owned fibre access infrastructure provider. It is organised in two chapters. Chapter 9 identifies the risks to competition that need to be addressed during and subsequent to the industry transitioning to the NBN. Chapter 10 describes the suite of actions required to deliver on Government's near-term competition objectives while also safeguarding competition once the network is built and privatisation is being considered.

Part D: Maintaining momentum

Chapter 11 sets out the implications of implementing the NBN for Government's roles in oversight and support of NBN Co, and identifies practical considerations around implementing each of the recommendations. It includes a full listing of the recommendations contained in the report.

NAVIGATING THE IMPLEMENTATION STUDY REPORT

Three similarly formatted inserts draw attention to the principal recommendations, advice and highlighted points throughout the report:

> **Recommendation.** Significant counsel to Government on what should be done to implement the NBN.

> **Advice.** Significant counsel to the NBN Co Board on matters expected to be at the discretion of the Board and by extension, NBN Co management. This is also intended to serve as a guide for Government in its role as shareholder providing oversight to NBN Co.

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Contents

Glossary of acronyms used

2G	Second Generation mobile communications technology
3DTV	Three-Dimensional Television
3G	Third Generation mobile communications technology
3GPP	Third Generation Partnership Project
4G	Fourth Generation mobile communications technology
AAS	Australian Academy of Science
ABC	Australian Broadcasting Corporation
ABG	Australian Broadband Guarantee
ABN	Australian Business Number
ABS	Australian Bureau of Statistics
ACCC	Australian Competition and Consumer Commission
ACMA	Australian Communications and Media Authority
ACTU	Australian Council of Trade Unions
ADSL	Asymmetric Digital Subscriber Line
AEC	Australian Electoral Commission
APON	ATM (Asynchronous Transfer Mode) Passive Optical Network
ARPU	Average Revenue Per Unit
ASP	Application Service Provider
ASX	Australian Stock Exchange
ATA	Analogue Telephone Adapter
ATUG	Australian Telecommunications Users Group
AUSFTA	Australia-United States Free Trade Agreement
BBSW	Bank Bill Swap Reference Rate
BOT	Build-Operate-Transfer
BPON	Broadband Passive Optical Network
BSS	Business Support System
BT	BT Group (formerly British Telecommunications)
CAGR	Compound Annual Growth Rate

CAN	Customer Access Network
CAPM	Capital Asset Pricing Model
CaSP	Carriage Service Provider
CAT 5	Category 5 (a type of cable used for in-home wiring)
CAT 6	Category 6 (a type of cable used for in-home wiring)
CATV	Cable Television
CDMA	Code Division Multiple Access
CIR	Committed Information Rate
COAG	Council of Australian Governments
CoSP	Content Service Provider
CPE	Customer Premises Equipment
CSG	Customer Service Guarantee
CTO	Chief Technical Officer
Dark fibre	Optical fibre with no active electronics attached
DBCDE	Department of Broadband, Communications and the Digital Economy
DCF	Discounted Cash Flow
DEEWR	Department of Education, Employment and Workplace Relations
DEIWG	Digital Economy Industry Working Group
Digital dividend	The radiofrequency spectrum from 694 MHz to 820 MHz
DOCSIS	Data Over Cable Service Interface Specification
DOFD	Department of Finance and Deregulation
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
DTV	Digital Television
DVR	Digital Video Recorder
EAS	Ethernet Aggregation Switch
EBIT	Earnings Before Interest and Taxes
EBITDA	Earnings Before Interest, Taxes, Depreciation and Amortisation
ECA	Export Credit Agency
EFTPOS	Electronic Funds Transfer at Point of Sale

EoI	Expression of Interest
EP2P	Ethernet Point-to-Point system
EPON	Ethernet Passive Optical Network
EV	Enterprise Value
FAN	Fibre Access Node (i.e. fibre exchange)
FATA	Foreign Acquisitions and Takeovers Act
FCC	Federal Communications Commission (U.S.)
FDD	Frequency Division Duplex
FDT	Fibre Distribution Terminal
FiOS	Fibre Optic Service
FIRB	Foreign Investment Review Board
FTTB	Fibre-to-the-Building
FTTC	Fibre-to-the-Curb
FTTH	Fibre-to-the-Home
FTTN	Fibre-to-the-Node
FTTP	Fibre-to-the-Premises
GB	Gigabyte
GBE	Government Business Enterprise
Gbps	Gigabits per second
GEO	Geostationary Earth Orbit satellite
GFS	Government Finance Statistics
GHz	Gigahertz
G-NAF	Geocoded National Address File
GPO	General Purpose Outlet
GPON	Gigabit-capable Passive Optical Network
GSM	Global System for Mobile Communications
HD	High Definition
HDTV	High Definition Television
HFC	Hybrid Fibre Coaxial
HSPA	High Speed Packet Access

ICT	Information and Communications Technology
IDA	Infocomm Development Authority
IEEE	Institute of Electrical and Electronics Engineers
IGMP	Internet Group Management Protocol
IOG	Independent Oversight Group
IP	Internet Protocol
IPND	Integrated Public Number Database
IPO	Initial Public Offering
IPTV	Internet Protocol Television
IRR	Internal Rate of Return
ISDN	Integrated Services Digital Network
ISP	Internet Service Provider
IT	Information Technology
ITU	International Telecommunications Union
IX	Internet Exchange
Ka-band	The radiofrequency spectrum from 27 GHz - 40 GHz
kbps	Kilobits per second
KEIC	Korea Export Insurance Corporation
KT	Korea Telecom
Ku-band	The radiofrequency spectrum from 15 GHz - 17 GHz
L2	Layer 2
L3	Layer 3
LAN	Local Area Network
LEO	Low Earth Orbit satellite
LFC	Local Fibre Company
LRIC	Long Run Incremental Cost
LSS	Line Sharing Service
LTE	Long Term Evolution
MB	Megabytes
Mbps	Megabits per second

MDF	Main Distribution Frame
MDU	Multi-dwelling Unit
MEO	Medium Earth Orbit satellite
MHz	Megahertz
MIMO	Multiple Input, Multiple Output
MIRR	Modified Internal Rate of Return
MLPA	Multi-Lateral Peering Agreement
MUX	Multiplexer
MVNO	Mobile Virtual Network Operator
NBN	National Broadband Network
NBN Co	NBN Company
NGN	Next Generation Network
NID	Network Interface Device
NTD	Network Termination Device
NTT	Nippon Telegraph and Telephone Corporation
ODF	Optical Distribution Frame
OECD	Organisation for Economic Co-operation and Development
OLT	Optical Line Terminal
ONT	Optical Network Termination
OPEL	An Optus and Elders joint venture
OPTA	Independent Post and Telecommunications Authority of the Netherlands
OSI	Open System Interconnection
OSS	Operational Support Systems
OTT	Over-the-top
P2P	Point-to-point
PAPL	Permitted Attachment Private Lines
PC	Personal Computer
PNFC	Public Non-Financial Corporation
POI	Point of Interconnect
PON	Passive Optical Network

PoP	Point of Presence
POTS	Plain Old Telephone Service
PSMA	Public Sector Mapping Agencies
PSTN	Public Switched Telephone Network
PSU	Power Supply Unit
PT	Portugal Telecom
RF	Radio Frequency
RFoG	Radio Frequency over Glass
RG	Residential Gateway
RIM	Remote Integrated Multiplexer
RLC	Remote Line Concentrator
RSP	Retail Service Provider
SLA	Service Level Agreement
SME	Small and Medium Enterprise
STB	Set-top Box
STS	Standard Telephone Service
TDD	Time Division Duplex
TER	Telecommunication Equipment Room
TPA	*Trade Practices Act 1974*
TPON	Telephony over Passive Optical Network
UBA	Unbundled Bitstream Access
ULL	Unconditioned Local Loop
UN	United Nations
USO	Universal Service Obligation
VDSL	Very high speed Digital Subscriber Line
VHA	Vodafone Hutchison Australia
VHF	Very High Frequency
VoD	Video-on-demand
VoIP	Voice over Internet Protocol
VSAT	Very Small Aperture Terminal

WACC	Weighted Average Cost of Capital
WAIX	Western Australian Internet Exchange
WARPU	Wholesale Average Revenue Per User
WDM	Wavelength Division Multiplexing
WDM-PON	Wavelength-Division-Multiplexed Passive Optical Network
WiMAX	Worldwide Interoperability for Microwave Access
xDSL	Any form of Digital Subscriber Line technology (e.g. ADSL, VDSL)

1 Executive Summary

SUMMARY OF IMPLEMENTATION STUDY FINDINGS

- Government's objectives for the National Broadband Network can be implemented within the $43 billion estimate of capital expenditure by deploying fibre to 93 percent, fixed-wireless from the 94th to 97th percentiles and satellite to the final 3 percent of premises.
- The NBN should be deployed efficiently by setting practical coverage objectives, being willing to make use of existing infrastructure, providing appropriate legislative support and leveraging the capabilities of commercial wireless operators.
- Retail competition should be improved through mandating NBN Co's wholesale-only, open-access role and by ensuring NBN Co eliminates network bottlenecks and operates at the lowest appropriate layer in the OSI stack.
- The fibre access network should be expected to become the predominant fixed-line telecommunications infrastructure over time by pricing for affordability and take-up and providing continuity for existing services.
- Full Government ownership should be maintained until after the roll-out is complete requiring temporary peak funding in the vicinity of $26 billion by year 6—which can be paid down quickly from then with investment-grade debt prior to privatisation. Government should expect to cover its cost of funds under most plausible business case scenarios.
- Future competition and innovation potential should be safeguarded by preferring a network design that preserves options for active-layer competition and shifts in technology, and by ensuring a healthy industry structure and appropriate regulatory regime are in place prior to privatisation

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The conclusion of the Implementation Study is that Government's objectives for the NBN can be implemented within the original $43 billion estimate of capital expenditure, by deploying a mix of fibre, wireless and satellite technologies. Once implemented, the NBN will deliver Australia a world-class broadband infrastructure.

Along the way, there will be many risks to manage and many challenges to overcome. Successful implementation will require sustained, focused and accurate execution over many years by NBN Co, Government, and the ecosystem of vendors, carriers and end users involved.

The new fibre infrastructure covering 90+ percent of premises will be long-lived and will redefine the current industry structure, superseding the copper network that has been in place for over 50 years in many places. The fibre laid over the next decade will be in place for possibly as long again. Today the Australian telecommunications industry is shaped by a highly profitable vertically-integrated and horizontally-integrated incumbent with a monopoly position in most fixed-line access and many backhaul routes. With the advent of the NBN, a fundamentally different industry structure will emerge around NBN Co, a new wholesale-only infrastructure provider. This change will accelerate the evolution of the industry. At times this may be smooth; at other times it will be uneven. New business models and companies will emerge. Existing participants will need to adapt to succeed.

In this context, three mutually supporting principles have shaped the approach recommended by the Implementation Study: pragmatism; flexibility; and foresight.

First, recognising that the implementation task is enormous, a pragmatic approach is needed. Up to 250,000 kilometres of access network and backhaul fibre must be buried or strung overhead, along most roads across the country. Up to 5,000 customer visits per workday could be required over the 8-year roll-out. Since much of this work is repetitive however, lessons learned in early deployments can be applied quickly, allowing the NBN to evolve over time.

Second, acknowledging the pace of change and the uncertainty of markets and technology, flexibility is required—in commercial arrangements, in technology choices and in the translation of broad policy goals into practice. Any approaches developed early in the process should be grounded in an appropriate level of confidence in the ability to predict accurately how technology and markets will develop over time.

Third, recognising that today's decisions about the design of the NBN will shape the structure, conduct and performance of Australia's telecommunications industry for decades—and address many conflicting interests—foresight is called for in making recommendations that will withstand the test of time and serve the country's interests beyond short-term pressures.

The challenge for Government is to balance these three principles of pragmatism, flexibility and foresight successfully over the next decade as the network is deployed and the industry progressively evolves.

This executive summary provides a stand-alone overview of the most important findings and recommendations of the Implementation Study. The remainder of the report contains detailed recommendations and supporting analysis.

1.1 Set coverage objective as fibre to 93 percent, fixed-wireless and satellite from 94 to 97 percent and satellite-only from 98 percent—achievable within estimated expenditure of $43 billion

Government's initial policy announcement set an objective of providing fibre to 90 percent of premises and using wireless and satellite technologies to deliver at least 12 Mbps to those 10 percent of premises expected to be beyond the reach of fibre.

Based on detailed geospatial modelling of every address in Australia, the Implementation Study recommends that the NBN coverage objective be adjusted to take fibre to 93 percent of premises by the end of the 8-year roll-out. Another 4 percent of premises should be covered by a commercially-tendered fixed-wireless service delivering at least 12 Mpbs—and much greater speeds for many premises in the coverage area. NBN Co should provide a wholesale Ka-band satellite service to ensure at least 12 Mbps is delivered to the remaining 3 percent of premises, and also to provide a coverage option to the 4 percent of premises within the fixed-wireless footprint.

1.1.1 RECOGNISE THE GEOGRAPHIC, ECONOMIC AND TECHNOLOGICAL CONSTRAINTS TO PROVIDING FAST BROADBAND NATIONALLY

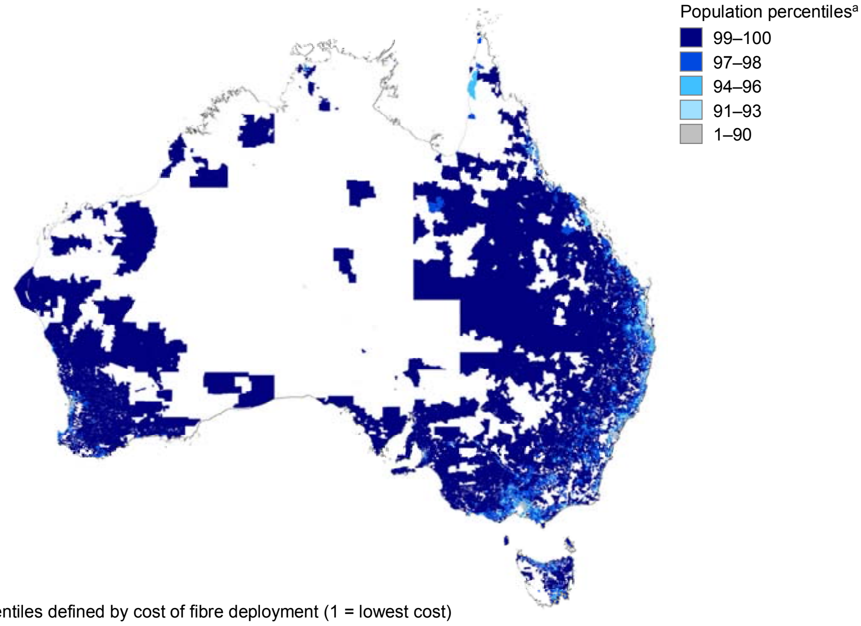
The most significant driver of total cost for a fixed-line or wireless access network is the density of premises it serves. For a fibre network, civil works are approximately 70 percent of deployment costs and those costs vary with the distance that fibre needs to be trenched or strung along electricity poles. For a wireless network, density determines how many towers and radio transmitters are needed: in highly-populated areas denser networks of base stations are required for a given amount of spectrum and at low densities there may be few premises per tower, making the economics challenging. Satellite is an exception—geostationary satellites can cover all of Australia, so density determines provisioning of bandwidth, but relative to the fixed costs of launching a satellite, is not a substantial cost driver.

The importance of density means that to set the coverage objective for the NBN accurately, detailed geospatial data is required to calculate distances on a premises-by-premises basis, as is granular data about deployment techniques and costs by geo-type, to translate these distances into network deployment costs. The geospatial modelling undertaken by the Implementation Study maps all addresses and roads in Australia in order to design a plausible network to deliver Government's policy, estimates costs of deployment and determines appropriate coverage objectives. These costs will be refined as deployment proceeds: the evolution of NBN Co's network will be informed by the experience of on-the-ground implementation (including NBN Co's first release sites), and hence will not match our reference network model precisely. Nevertheless, within the constraints of pre-roll-out analysis the modelling undertaken by the Implementation Study provides as accurate an estimate of deployment costs as is practical to develop, and should be used for setting upfront coverage objectives that can then be revised over time.

Most Australians live in relatively dense areas. Only around 9 percent of Australia is inhabited, and 90 percent of the population occupies just 0.2 percent of the land mass, as shown in Exhibit 1–1. This leaves 10 percent of premises distributed across 98 percent of the populated land mass, with significant variability in density within this final 10 percent.

As well as truly-remote premises, the final 10 percent includes premises in rural towns, at the edges of regional towns and urban fringes. This is illustrated in Exhibit 1–2 which shows the extent of the proposed fibre coverage to 93 percent of premises on the urban fringes of a metropolitan city. As the exhibit demonstrates, many premises near metro areas will fall outside the economically-feasible fibre footprint, and the boundary between the fibre and non-fibre areas will be complex.

Exhibit 1–1. Coverage area for final 10 percent



a. Population percentiles defined by cost of fibre deployment (1 = lowest cost)
SOURCE: Implementation Study

Exhibit 1–2. Example of potential boundary between fibre and non-fibre areas

SOURCE: Implementation Study

Today, an estimated 92 percent of premises have access to broadband via a digital subscriber line (DSL) connection over a dedicated copper pair, including the estimated 20 percent who also have access to high-speed broadband over hybrid fibre coaxial (HFC) networks. Beyond this 92 percent, mobile data services are, in principle, available to 99 percent of the population according to reported coverage statistics. In reality however, service quality and experienced data rates can be poor, particularly if the user is indoors —and often well below advertised peak rates—unless in close proximity to a wireless tower and in an area with relatively few concurrent users.

In very remote areas it is not economical for service providers to install DSL equipment in small exchanges or for wireless operators to upgrade radios or increase tower density for a relatively small number of customers.

With the advent of 4th generation (4G) wireless technologies (both the LTE and WiMAX families), peak data rates and spectral efficiency (bits per Hertz) will improve substantially. However, guaranteeing peak data rates of at least 12 Mbps to comply with Government's coverage objectives will require the number of premises served by any given tower to be capped at a significantly lower number than in today's networks, which were designed for mobile voice. In addition, in a scenario where 2.3 GHz spectrum is used, premises would also need to fall within approximately 7 km of the nearest 4G wireless tower—even with the use of a fixed, professionally-installed external antenna.

In the least densely populated parts of Australia, the only economically-feasible way to deliver broadband is via satellite. Fortunately, next-generation Ka-band satellites will have vastly improved throughput rates compared with today's Ku-band satellites, and will enable substantial increases in broadband speeds at lower prices.

The technology characteristics of wireless and satellite, in combination with the highly fragmented location of the final 10 percent of premises, have important implications for the NBN. They mean that a wireless network covering the 94th to 97th percentile, as recommended by the Implementation Study, would need to cover most populated parts of Australia, and a satellite service would need to be configured to cover effectively the whole of Australia's land mass.

1.1.2 SET COVERAGE OBJECTIVES BASED ON EXPECTED COST PER PREMISES AND A PREFERENCE FOR SUPERIOR TECHNOLOGIES

Government has selected fibre as the preferred access network technology to meet Australia's future telecommunications needs. As a physical medium, fibre can far exceed Government's stated objective of 100 Mbps—already, single fibres can carry 1,000 times this traffic. Fibre is widely accepted as the optimal medium for data transmission, and with a lifespan of 40 years or more, is clearly the preferred technology for future-proofing a network. The Implementation Study recommends that Government set NBN Co an objective to deploy fibre to 93 percent of premises by the end of the 8-year network roll-out, rather than the 90 percent objective of the original policy statement.

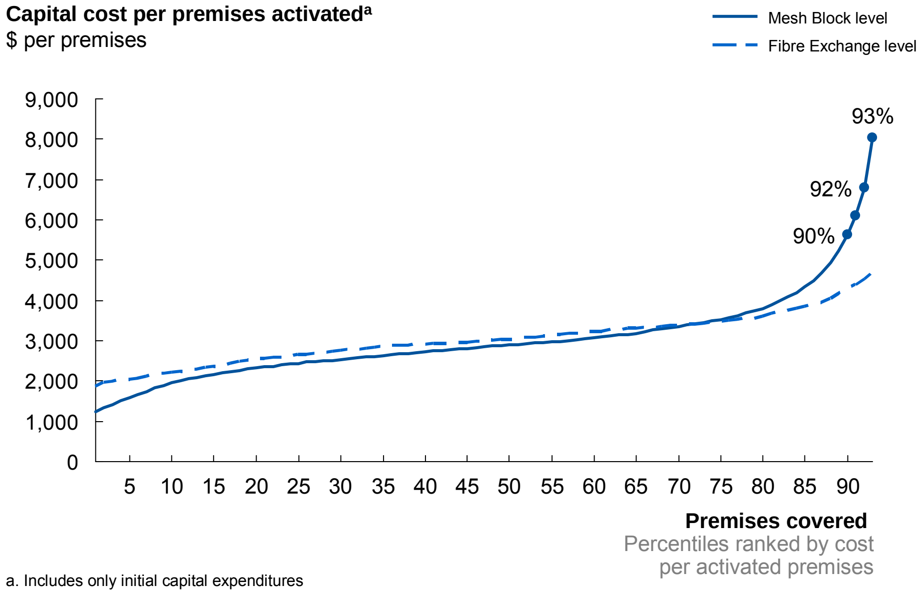
Over time, we expect that Government would aspire to extend fibre even further, however, we recommend that 93 percent be the objective for the initial network build for three reasons.

First, the cost of deploying fibre to 93 percent is not prohibitive. Our geospatial modelling shows—as expected—that the cost to deploy fibre rises as the distance between premises increases. As shown in Exhibit 1–3, the rate of increase begins to accelerate starting at around the 80th percentile, then starts to rise more sharply as it nears the 90th percentile at which point it is 1.9 times more expensive per premises to deploy fibre than at the 50th percentile. By the 93rd percentile, it costs 2.8 times the 50th percentile cost.

This cost curve is obtained by analysing the cost to deploy fibre in incremental units of aggregation—ABS Mesh Blocks—each of which account for an average of 30 premises. In a practical network roll-out however, the decision of whether to expand the fibre footprint incrementally would be made on an exchange-by-exchange basis.

Since exchanges aggregate many more premises than mesh blocks, this means that premises at the 93rd percentile would be aggregated with premises at lower points on the cost curve to form exchange groupings. This means that the sharp increase as the curve

Exhibit 1–3. FTTP cost curve (93 percent coverage)



a. Includes only initial capital expenditures

SOURCE: Implementation Study

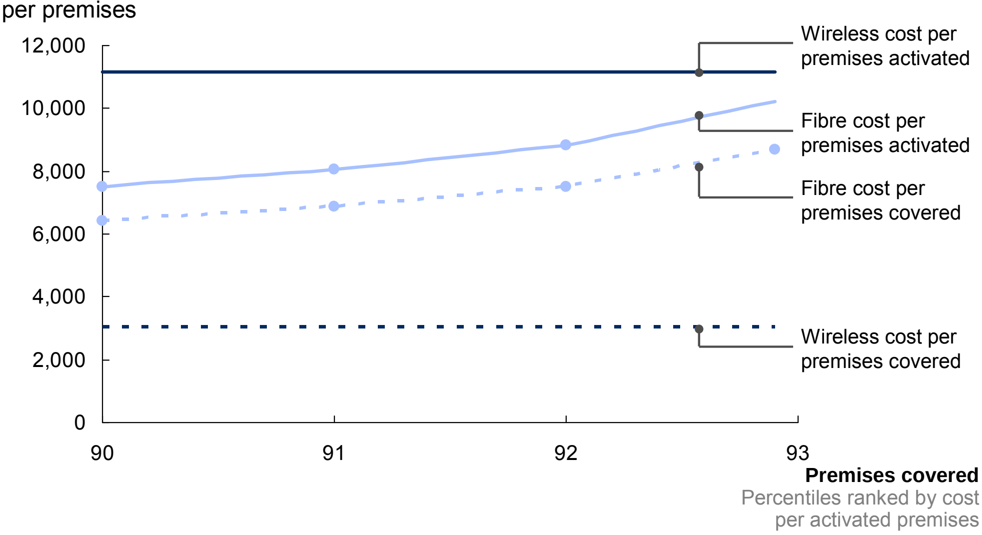
approaches the 93rd percentile is smoothed when represented as the average cost per premises by fibre exchange as shown by the dashed line on Exhibit 1–3. While the total cost (represented by the areas under the curves) remains the same, the additional incremental cost per premises to push fibre beyond 90 percent to 93 percent, is more modest when considered in these terms.

Second, stopping at 90 percent would mean fewer premises would receive fibre than currently can receive DSL broadband connections. Most premises out to 93 percent have access to DSL today, which is likely to provide a superior service to wireless or satellite solutions due to low latency and fast data rates.

Third, the cost per premises *activated* for an NBN fixed-wireless service is potentially higher than for fibre in the 90th to 93rd percentile range. While the cost of *covering* a premises in this range is much cheaper with wireless, applying a realistic take-up rate to a fixed-wireless service in competition with both established mobile broadband and DSL services raises the average cost per premises *activated* substantially, as shown in Exhibit 1–4. Even if the take-up rates for a fixed-wireless solution were higher and average costs proportionally lower (e.g. if the copper network was deactivated so that DSL was no longer an alternative), the Implementation Study considers that Government should be willing to pay a premium to extend the fibre footprint further given its superior performance.

Exhibit 1–4. Cost comparison of alternative technologies from 90–93 percent

Capital cost per premises—covered and activated
Includes capitalised opex and the discounted value of replacement capex[a]
$ per premises

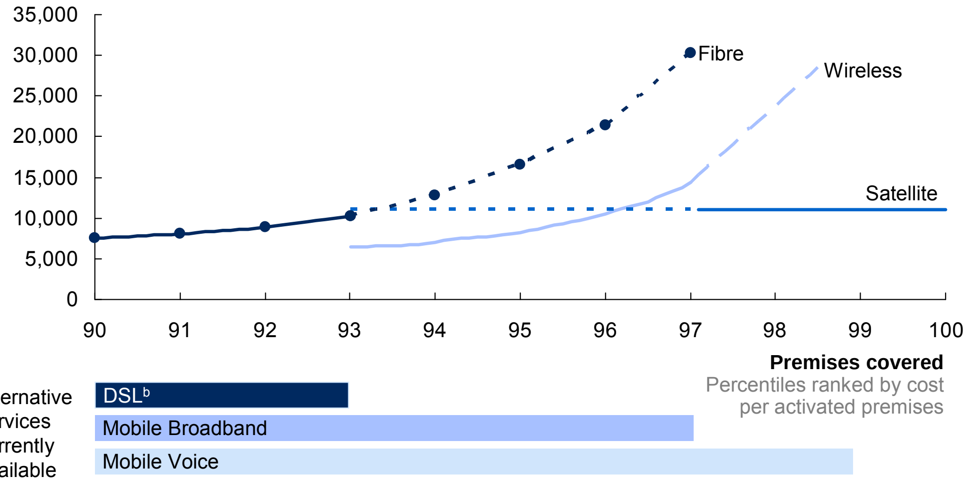


a. Network specific operating expenditure (including maintenance, leases and power) capitalised at 9% discount rate; replacement capital expenditure modelled based on useful life of active and passive infrastructure and discounted at 9%

SOURCE: Implementation Study

Exhibit 1–5. Cost comparison of alternative technologies in the final 10 percent

Capital cost per premises activated
Includes capitalised opex and the discounted value of replacement capex[a]
$ per premises



a. Network specific operating expenditure (including maintenance, leases and power) capitalised at 9% discount rate; replacement capital expenditure modelled based on useful life of active and passive infrastructure and discounted at 9%

b. Fixed-line broadband currently covers 92% of premises. Future greenfields adjacent to the fibre access network mean the percentage of premises with access to fixed-line broadband is expected to rise to ~93% in 2018–19

SOURCE: Implementation Study

Extending the fibre footprint beyond the 93rd percentile becomes too expensive based on Implementation Study cost modelling applying current deployment techniques. By the 95th percentile for example, the cost accelerates to almost 5 times the 50th percentile cost.

Exhibit 1–5 shows a cost comparison of the proposed technology deployments across the final 10 percent of premises. This exhibit shows the cost per premises activated, where the fibre curve matches that shown in Exhibit 1–4. To the right of the fibre curve, the cost curve for the fixed-wireless solution begins at the 94th percentile. The trajectory of this curve is lower than that shown for fixed-wireless in Exhibit 1–4 since beyond the 93rd percentile DSL is not a viable alternative, so take-up of the fixed-wireless solution is expected to be higher.

Under any solution a satellite service is required since guaranteeing 12 Mbps data rates via a fixed-wireless solution becomes extremely expensive in the most remote areas, as each tower is shared by very few premises. As shown in Exhibit 1–5, the fixed-wireless solution becomes prohibitively expensive to deploy beyond approximately the 97th percentile.

Once a commitment is made to satellite, any practical solution will require at least two satellites for redundancy, given the possible (albeit unlikely) scenario of a catastrophic satellite failure followed by a 3-4 year design and launch cycle to restore service. While such a satellite service could be configured as the sole solution to deliver Government's objective of at least 12 Mbps peak data rates to all 7 percent of premises outside the fibre footprint, this would be a sub-optimal solution for those premises that could otherwise receive a fixed-wireless service.

The Implementation Study therefore recommends that NBN Co deploy two Ka-band satellites with the ability to cover the 7 percent of premises outside the fibre footprint and provisioned for up to 350,000 activated premises with sufficient throughput to enable a substantial increase in average data rates from today (e.g. an increase in average data rates by more than a factor of 20). This will result in a satellite service which is vastly superior to that possible on today's technology.

Even though a Ka-band satellite service will be able to deliver impressive data rates to end users, the use of geostationary satellites causes unavoidable latency in the signal, making real-time interactive services such as videoconferencing and video gaming impractical. This fact, combined with the 4-year delay before Ka-band satellite services could be in operation, leads the Implementation Study to recommend that fixed-wireless technologies be deployed beyond the fibre footprint out to 97 percent of premises.

While the satellite service would be the sole NBN solution offered beyond the 97th percentile, it should be offered to all premises outside the fibre footprint. While take-up in areas covered by fixed-wireless is likely to be low, offering satellite service will ensure coverage for premises in wireless blackspots. It will also fulfil Government's commitment to provide a wholesale-only service in all areas, given that the commercial fixed-wireless provider is expected to offer both wholesale and retail services, as discussed in Chapter 5.

In the near-term, the performance of the existing Ku-satellite solution for remote areas could be improved by upgrading the satellite modems deployed in end-user premises to provide greater throughput. These modems should be capable of supporting both today's Ku-band services and a future Ka-band service. In addition, by requiring NBN Co to aggregate demand for today's Ku-band satellite capacity, savings in the cost of satellite bandwidth should be possible, allowing retailers to provision greater throughput to end users at equivalent prices.

1.1.3 EXPECT TOTAL CAPITAL EXPENDITURE TO BE WITHIN INITIAL ESTIMATE OF $43 BILLION

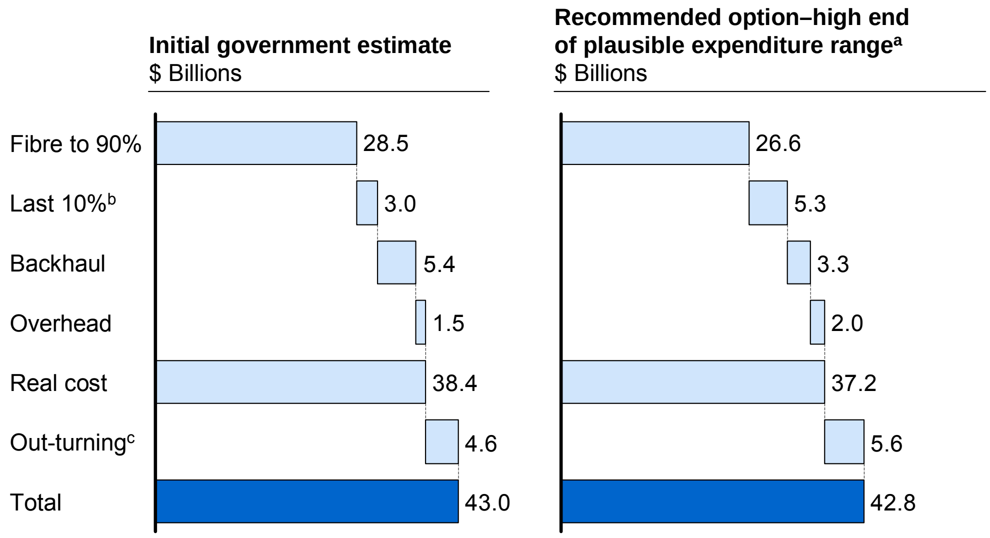
The recommended solution to deploy fibre to 93 percent, a fixed-wireless network to the next 4 percent, and satellites capable of serving all premises beyond the fibre footprint, is affordable within Government's initial cost estimate of $43 billion. This cost estimate encompasses the capital expenditure to build the network and to activate services.

Exhibit 1–6 shows a comparison between Government's initial cost estimates and the estimates resulting from the detailed cost modelling conducted by the Implementation Study. The figures are shown as the total of actual expenditure incurred in real dollars, 'out-turning' adjustment (commonly applied in Government costings) which calculates the cumulative nominal total that would be reported at the end of the roll-out. The out-turning adjustment in the Implementation Study's analysis is higher than in Government's initial estimate due to differences in the timing of costs being incurred, based on the Implementation Study's granular analysis of expected network roll-out.

The costs shown in Exhibit 1–6 show the high end of the plausible range of costs modelled by the Implementation Study. Informed by the detailed geospatial model, the cost of the fibre access network to the first 90 percent of premises is slightly less than estimated by Government. By contrast, the last 10 percent solution is more expensive, primarily due to the recommendation to extend fibre to 93 percent of premises. A fixed-wireless solution for premises in the 91st to 93rd percentiles would be less expensive to deploy in total, but more expensive per premises activated due to low expected take-up, as illustrated in Exhibit 1–4.

Backhaul costs are projected to be lower than initially estimated, with shorter total distance required and a lower expected unit cost. Overheads are higher, and have been estimated conservatively in the Implementation Study model.

Exhibit 1–6. Estimated cost to build the NBN



a. Cost assumptions are for the 'High-end of the plausible range' scenario.
Technology assumptions: 50% of the Fibre Access Network uses a Home Run topology; 50% uses a shared feeder with distributed splitter cabinets; Wireless network uses 2.3GHz spectrum and LTE technology; Satellite transitions to Ka Band.
b. Fibre from 90 to 93% is included in last 10%.
c. Conversion from real to nominal expenditure, using a nominal inflation rate of 2.5%
SOURCE: Implementation Study

These costs reflect the assumption of a unilateral build—i.e. without assuming an agreement is reached with Telstra to share infrastructure such as ducts, pits, exchanges and unused backhaul fibres, as contemplated in the Terms of Engagement between Telstra and NBN Co announced on 18 December, 2009. Such an agreement could lower the overall cost. This approach also means that any consideration paid to Telstra for an agreement to use Telstra's infrastructure is implicitly included in the cost estimates—an agreement would only make commercial sense if it reduces NBN Co's total cost to build relative to not using Telstra's infrastructure.

If an agreement to migrate traffic onto the NBN is struck with Telstra or any other service provider (a 'migration agreement'), any consideration paid should be treated as an incentive payment netted against the revenue that is brought forward from early migration of the traffic concerned, and hence would not be relevant to an analysis of the $43 billion capital expenditure estimate.

1.2 Deploy the NBN efficiently: set practical obligations, leverage existing infrastructure and provide legislative support to NBN Co

The nature of the physical NBN roll-out across millions of premises over 8 years will be highly repetitive, notwithstanding tailoring for local conditions. Decisions taken around the design of components or the techniques to lay fibre will be replicated across millions of sites around the country. Therefore, seemingly small decisions have a substantial impact on the business case. For example, a decision that would add or subtract $100 to the cost of deploying to each premises scales to close to $1 billion in additional costs or savings nationally. At the same time, in most cases, the NBN will represent long-lasting infrastructure so that potential short cuts or infrastructure-sharing agreements to save money need to be evaluated in this context.

1.2.1 SET CLEAR, TRANSPARENT AND PRAGMATIC COVERAGE REQUIREMENTS FOR THE NBN

By 2018, Australia will have approximately 12 million premises, growing from 10.7 million today. This forecast growth should form the basis of NBN Co's coverage objectives to ensure that open-access, wholesale services are available to all premises. In most cases, within the fibre footprint, this requires NBN Co to provide wholesale services directly. In the few places where fibre exists and retail competition is already vibrant, or where retailers can already obtain NBN-like speeds and prices on a wholesale basis over fibre, NBN Co should not be required to duplicate infrastructure.

For the purposes of practical implementation and to be consistent with industry terminology, Government's objectives around the provision of superfast broadband should be interpreted as coverage—rather than activation—objectives.

There are three steps in activating service to a premises. First, NBN Co lays fibre down the street. Next, the fibre is brought to the side of the building—this final cable run is known as the drop. Finally, the company (or a contractor on its behalf), installs an ONT (Optical Network Terminal), either on the side of, or inside, the building. Service can then be activated by a retailer once the ONT is live, by connecting a residential gateway to the ONT to allow computers, telephones, gaming consoles or other end-user devices to receive retail services.

The Implementation Study recommends that a premises should be considered 'covered' by the superfast broadband network if NBN Co is able to provide a wholesale service to that premises within a reasonable time (i.e. measured in days for metro areas) over a customer access network that enables retailers to deliver superfast broadband services to that premises. Premises should be considered to have been 'activated' once a service is being delivered via a retailer. The Implementation Study uses the terms ‘covered’ and ‘activated’ with these specific meanings to avoid ambiguity.

Some commentators also use the term ‘connected’, which is ambiguous: for a new network it does not refer to actual service activation, and could be misinterpreted as NBN Co being required to extend the network to the actual premises prior to services being ordered. Installing the ONT upfront in this way implies purchasing and installing ONTs for premises that may not ever take a fibre service during the network build period. Moreover, this could force deployment of a more expensive ONT configuration with more external components due to lack of access to the home.

Modelling by the Implementation Study suggests these changes could add substantially to the initial deployment cost, and therefore should be avoided. There are some scenarios, for example under a potential migration agreement with Telstra, where—with the appropriate powers and immunities—NBN Co may decide to do more than pass the house at the time of first deployment. However, this should be left to management’s commercial judgment.

Similarly, in the satellite and fixed-wireless footprints, premises should be considered covered by the NBN when the wireless or satellite service is available at that location. No installation of wireless antennas or satellite dishes should be required until a service is ordered.

The roughly 1.3 million new premises to be built over the next 8 years will comprise 11 percent of the projected total premises in 2018. The majority of these new premises will be constructed within the eventual fibre footprint; hence NBN Co must plan to cover them in order for the coverage objective to be met by the end of the roll-out.

Government has proposed a requirement for all new developments to allow for fibre from 1 July 2010. The most practical way for this to be implemented is for NBN Co to provide fibre when it has fibre infrastructure sufficiently close to be able to deploy fibre to the new development economically. If NBN Co has not yet deployed close enough, then Government should encourage the most efficient transition path to those developments having fibre by the end of the roll-out. The preference for these areas should be to encourage fibre to be deployed, but in a way that makes integration with NBN Co’s network simple. This requires setting specifications for a fibre provider to comply with so that the network can be integrated as is or so that the underlying fibre can be used with NBN Co electronics. In some cases, it may not be practical for fibre to be deployed—either backhaul is not available or the estate is too small to attract a service provider. In such a case, the objective should be to ensure that costs for NBN Co to deploy fibre subsequently are minimised. This requires insisting that all new premises are built with duct, pit and pipe infrastructure that NBN Co can use to deploy fibre to each of the premises in the new development.

Another category of premises requiring special consideration is multi-dwelling units (MDUs). They represent a significant portion of the market—up to one third of Australian premises form part of an MDU. These include small residential units, mixed use 2- to 3-story premises on suburban main streets, and CBD towers. MDUs can present unique challenges for rolling out fibre infrastructure because installation typically requires access to common areas or areas owned by other parties. In addition, the cost and method of installation can vary substantially based on the age and layout of the building.

While Government's intent is to connect premises receiving a fixed-line connection with fibre, the body corporate at some MDUs may choose not to permit NBN Co sufficient access rights to install a fibre solution to individual premises. In these cases a compromise solution could be pursued in which NBN Co connects fibre to the basement and then re-uses the in-building copper wiring to deliver fast VDSL services to the individual premises.

This technology can deliver speeds of above 50 Mbps and in some cases, could be cost-efficient. However, this approach would forego a one-time opportunity to fibre up as much of the country as possible. Therefore, the Implementation Study recommends that bodies corporate be compelled to facilitate access to deploy fibre. VDSL should be considered as a fallback only if in a few years' time NBN Co finds access to a substantial number of MDUs has been frustrated.

Today, HFC networks owned by Telstra or Optus (primarily in Melbourne and Sydney) pass about one fifth of Australian premises. These networks comprise fibre cables as far as nodes located close to premises, with a 'last mile' connection via coaxial cable from the node to the premises.

With an upgrade to the network software (e.g. to DOCSIS 3.0), HFC networks may be capable of delivering speeds to meet Government's objective of 100 Mbps for downloads, although they would deliver much slower upload speeds. However, HFC has a less certain upgrade path than does a solution taking fibre all the way to the premises. In addition, not all premises within the HFC footprint are capable of being activated on the HFC network.

Having designated fibre as the access technology of choice and being able to meet its coverage goals within its capital expenditure estimate by deploying fibre, Government should set NBN Co an objective to cover at least 93 percent of premises with fibre, notwithstanding existing HFC connections. This will involve NBN Co overbuilding existing HFC networks and migrating traffic either through competition or commercial agreement. As long as NBN Co meets its fibre coverage objective over the specified 8-year window, in the near term, it should have the flexibility to acquire and upgrade the HFC networks and offer a wholesale open-access service over HFC if this is commercially attractive and proves technically feasible.

In addition to the premises where Australians live and work, there are a significant number of non-premises sites that are connected to telecommunications networks. Examples include traffic lights, mobile base stations, and remote telemetry services at dams. NBN Co should negotiate commercial terms to provide connections to service providers who want to deliver services to these sites, with prices set through competition with existing Telstra services or wireless alternatives.

One exception to this principle is mobile base stations, where NBN Co should be required to offer a commercially-priced service to a base station within a fibre exchange area, and should have the option to offer a commercially-priced service outside a fibre exchange area. Even though mobile broadband will compete with NBN Co’s service across the fibre footprint, ensuring a thriving mobile industry will be a healthy check on NBN Co’s monopoly power in the fibre access network and will be in the long-term interests of end users.

To ensure transparency, NBN Co should maintain a register that details its progress in making high-speed broadband available to all Australians. This should contain an up-to-date record of all premises, and keep track of premises covered by fibre and by satellite. It should detail where coverage has been frustrated by lack of MDU access or where NBN-compliant coverage was already provided by other parties. This register should be available via a publicly-accessible website with maps showing existing and planned coverage at a regional level, subject to privacy restrictions.

1.2.2 COMMIT TO BUILDING UNILATERALLY, BUT MAINTAIN WILLINGNESS TO SHARE INFRASTRUCTURE

The Implementation Study, consistent with Government’s stated policy, assumes the intention to build the NBN unilaterally. Nevertheless, there is existing infrastructure that could be used to build the network more quickly and cheaply.

Most obviously, Telstra has an estimated 100,000 to 140,000 km of underground ducts that NBN Co could potentially use to deploy its fibre. Where there is room in those ducts (estimates range from 50 to 80 percent) it is a win-win for NBN Co to pay a reasonable charge to use them. This creates value for NBN Co as long as it is cheaper than the alternative of stringing aerial cable or digging its own trenches to install ducts; and value for Telstra given there are few alternative ways of earning money from these ducts.

Similarly for backhaul, Telstra likely has unused backhaul fibres in many places where NBN Co will need them. It would be costly for NBN Co to construct new backhaul where it is required for the NBN, but for Telstra the cost of providing access to its unused backhaul fibre is minimal. In a potential agreement, NBN Co might, for example, acquire indefeasible rights of use over sufficient fibres and install its own optical and electronic equipment to meet its capacity requirements over time.

For both ducts and backhaul, this provides incentives for both parties to obtain value from use of existing assets. This implies an agreement is likely over time, but given the value at stake and the long time period of the NBN roll-out, it may not be reached quickly. In the absence of an agreement, NBN Co should proceed to build both its access network and its backhaul unilaterally.

1.2.3 PROVIDE SUPPORT TO NBN CO TO BE ABLE TO DEPLOY EFFICIENTLY

Government can reduce the risk of cost over-runs by enhancing existing powers and immunities commensurate with the scale and aspiration of the NBN. Otherwise, costs are likely to increase due to potential delays in gaining planning approvals from the many relevant authorities and NBN Co not being able to choose the most efficient deployment technique by area.

These powers and immunities should ensure that the key components of the NBN deployment are deemed low-impact facilities and that access rights to ducts and power poles are available at reasonable cost. In addition, NBN Co will be able to make much more efficient build-versus-buy tradeoffs if it is able to obtain detailed information about existing network infrastructure. This requires legislative support.

The work to construct the NBN will employ thousands of people over an 8-year period. It has the potential to lead to the development of innovative fibre deployment techniques and innovations in the business models of NBN Co and its sub-contractors. At the same time, two workforce transitions must be managed during the implementation of the NBN. The first depends on the nature and timing of migration from Telstra’s copper network to the NBN and the potential re-skilling and employment of the existing copper network workforce for fibre deployment (both employees of carriers and of contractor organisations, many of which will be small and medium enterprises). The second will be the transition of NBN Co from extensive construction-related activities to operating the network, with new deployment confined to new premises or extensions of the network beyond 93 percent.

To address these challenges it is important that NBN Co retains the independence and flexibility to pursue the approach that will lead to the most efficient network build.

1.2.4 LEVERAGE COMMERCIAL OPERATORS TO DEPLOY FIXED-WIRELESS SOLUTION

Wireless technologies have a substantial role to play in delivering broadband services to the final 10 percent of premises, and this role is likely to expand over time.

Unlike fibre, the wireless market has multiple existing infrastructure-based providers offering broad coverage. Currently however, the business case to provide wireless broadband outside the fibre footprint at the guaranteed minimum speeds Government envisages is not viable for these operators. This is due to the high cost of backhaul, the need to install additional radio transmitters and towers and the lower overall revenue pool available relative to metropolitan areas.

To deliver a wireless solution that meets its coverage objectives, Government should run a public tender process for a provider to build and operate a fixed-wireless network to deliver at least 12 Mbps peak data rate broadband services to all premises within the designated coverage footprint. This network should cover 4 percent of premises beyond the fibre footprint (essentially the 94^{th} to 97^{th} percentiles), with the precise locations covered to be specified by the tenderer with reference to NBN Co's geospatial modelling to define the 93 percent coverage area.

This tender should be preceded by an EoI process to assess interest from the market and inform the detailed tender design, particularly in light of previous experience tendering for the provision of a fixed-wireless network. NBN Co should not participate in this tender process, but Government should ask NBN Co to provide an initial estimate of its costs to provide such a network. This will serve as a valuable reference point when evaluating the tenders received, and in the unlikely event of a lack of commercial interest, Government should reserve the right to instruct NBN Co to build the network.

While the emergence of acceptable commercial bids through such a tender process is not guaranteed, the Implementation Study believes it is likely as there are several participants in the market who have the necessary expertise and who would benefit from either monetising existing assets or protecting against loss of existing revenues. Further, current participants would be able to construct and operate the network at a significant discount to NBN Co by making use of existing assets (e.g. towers, backhaul and spectrum) and expertise (e.g. existing wireless network engineers and technicians).

Experience shows it is difficult to design a successful tender process for provision of fixed-wireless services. To maximise the likelihood of success, the tender should be designed with four features:

First, allow the tenderer(s) to identify the 4 percent of total premises they would cover beyond NBN Co's fibre footprint, using the same geospatial data set as NBN Co. Once the tender is concluded, NBN Co can configure its satellite to serve the remaining 3 percent. This approach permits maximum re-use of existing infrastructure and alignment with retail interests.

Second, define specifications of the 12 Mbps peak speed service offering in detail, including minimum average data rates and busy-hour usage assumptions for inclusion in the network design.

Third, build in flexibility for inevitable adjustments in coverage boundaries. As NBN Co deploys its network, it will not be exactly as modelled. The tender needs to contemplate fibre being deployed to wireless areas, and also gaps in the fibre network where additional fixed-wireless services may be required.

Fourth, have NBN Co deploy additional transit backhaul to wireless tower locations where required by the successful tenderer. This will reduce the cost of building the wireless network and remove backhaul bottlenecks. This backhaul would be offered to other operators on an equivalent, open-access basis.

The successful tenderer(s) would be required to offer an open-access wholesale service as well as to offer retail services. In the unlikely event that no acceptable tender is received and NBN Co is instructed to build a wholesale-only, fixed-wireless network, retailer incentives may be required to guard against retail market failure—without them, retailers may simply not offer services given the geographic dispersion.

Where fixed external antennas must be provided to premises as part of the service, the type and cost of this customer premises equipment (CPE) should be specified as part of the tender. Spectrum is expected to be commercially available, but Government should be open to further action to free up suitable spectrum if required.

Affordability should be ensured by mandating inclusion of an entry-level offer with minimum performance (e.g. at least 4 Mbps peak speeds) and at a price that Government specifies in the tender. This price would be broadly consistent with entry-level pricing for fibre and satellite offerings. A mechanism for adjusting the price over time would also be required, and could take the form of a cap on the annual price increase permitted or an alternate mechanism regulated by the ACCC. The exact specifications of the entry-level offer would be proposed as part of the competitive bid submitted by each tenderer. In addition, the wholesale offer should be priced at a level that encourages entry by other retail providers.

Over time, Government should facilitate infrastructure-based competition in the wireless broadband market, by encouraging expansion of the footprint served adequately via mobile technologies. In particular, the upcoming availability of 700 MHz digital dividend spectrum affords an opportunity to improve mobile broadband coverage in regional and rural areas. As part of any auction of digital dividend spectrum, Government should require successful purchasers to deploy next-generation technologies in rural areas concurrently with metropolitan area upgrades. As today, wireless pricing is likely to be uniform nationally.

1.3 Improve retail competition by eliminating bottlenecks, operating at the lowest appropriate layer in the stack and through NBN Co's wholesale-only, open-access mandate

Broadband end users in Australia face very different retail offers depending on where they live. This is due to variability in the cost of access to Telstra's copper access network by geography, limited competition in HFC infrastructure, and whether there is competitive backhaul from exchanges.

In densely populated areas, competition is vigorous among Internet service providers (ISPs) who frequently have their own DSL equipment installed in Telstra's exchanges and use Telstra's Unconditioned Local Loop (ULL) or Line Sharing Service (LSS) services. These ISPs offer consumers attractive prices, speeds and download allowances. As a result, service providers other than Telstra now have over 60 percent share in many of these exchanges.

In other areas, ISPs resell Telstra's wholesale broadband or do not participate at all due to high regulated prices or no access to competitive backhaul. Telstra's retail market share in these exchanges remains high.

NBN Co can level the competitive playing field in three ways. First, it will deploy infrastructure where bottlenecks exist in access and backhaul. Second, it will operate on a wholesale-only, open-access basis with equivalent service for all access seekers (construed as the provision of like services on like terms to access seekers in like circumstances), removing the problems of vertical integration. Third, it will offer Layer 2 services over fibre and Layer 3 services elsewhere to strike a balance between lowering barriers to entry and preserving the ability of access seekers to differentiate their retail offers. These measures strike a balance between intervention and permitting markets to function where possible. However, each part of the market will need to be monitored to determine whether further interventions are required.

1.3.1 DEPLOY WHERE BOTTLENECKS EXIST IN ACCESS AND BACKHAUL

The NBN will enhance retail competition by creating alternatives to existing bottlenecks in the access network and in backhaul. The NBN will create new bottlenecks, but will be restricted to providing services on a wholesale-only, open-access, equivalent basis.

An access network is a network that links end-user premises to a point of aggregation such as a local exchange. Today, these links are mostly copper pairs extending from Telstra exchanges and mostly represent a Telstra monopoly. The NBN will transform broadband data rates and resolve the copper bottleneck by replacing it with a superfast wholesale-only, open-access infrastructure.

Access networks are not the only infrastructure bottlenecks that constrain retail competition today. Beyond the access network, transmission links—backhaul—carry data between exchanges and hubs which tend to be in capital cities. Many of these already have fibre, but with the exception of links between capital cities, few are competitive.

If the access network is analogous to local roads, backhaul represents the arterial roads and highways. For many parts of the country, these backhaul links are only served by Telstra. While Telstra permits access to these links, this access is provided on a managed basis, as opposed to allowing access seekers direct access to the passive or 'dark' fibres, on which they can provide their own electronics. Further, access seekers have frequently struggled to make the economics work due to the cumbersome nature of the negotiate/arbitrate model of access regulation (amendments to which are before the Parliament) and the need to negotiate each backhaul link separately.

As a result of the lack of competitive backhaul, there are around 300 Telstra exchanges (serving a total of approximately 2 million premises) that are capable of supporting competitive DSL based on the number of customer premises they each serve, but in which no competitive DSL equipment has been installed.

In addition to building an access network, NBN Co must therefore enable access seekers to connect to this network at points where it is economic to do so—which in many regional areas will not be at the local exchange. This requires NBN Co either to build or acquire transit backhaul links to connect local exchanges to points where there is competitive backhaul, or where there is a reasonable incentive for the market to supply competitive backhaul.

As described in Section 1.2, NBN Co's operations should be confined to those areas where the market has not delivered a competitive outcome on its own—this principle should also apply to NBN Co's participation in backhaul. Commercial operators like Optus, Nextgen Networks, Pipe Networks and Telstra have created competitive backhaul markets on high-traffic routes. NBN Co should not overbuild these links for the purpose of creating a contiguous national network. In the absence of market failure, there is no commercial rationale for NBN Co to duplicate this investment, and duplication would be harmful to competition and industry investment incentives.

Restricting new backhaul to only non-competitive routes would require deploying approximately 60–70,000 kms of backhaul, including the approximately 6,000 kms as part of the Regional Backbone Blackspots Program.

For a non-contiguous NBN to serve the needs of access seekers adequately, Layer 3 wholesale access providers will need to emerge (as discussed in Section 1.3.3), and industry will need to adopt consistent protocols and service configurations to enable high QoS traffic (e.g. IPTV) to move readily across network boundaries. While this is technically achievable, NBN Co will need to define its network interfaces thoughtfully and Government will need to monitor the development of the Layer 3 market.

1.3.2 DEFINE NBN CO'S MANDATE AS WHOLESALE-ONLY, OPEN-ACCESS WITH EQUIVALENCE

NBN Co's wholesale-only, open-access mandate is crucial to achieving Government's competition objectives. Vibrant competition is held back in telecommunications industries in many markets around the world by a monopoly wholesaler offering better wholesale services to its own retail arm than to the retail businesses of competitors.

Regulators frequently try to combat this incentive by imposing an equivalence obligation—that is, vertically-integrated companies are required to provide the same wholesale services, terms and prices to external customers as to their own retail arms. In practice, this has been difficult to enforce and expensive for operators to implement, given their business processes, IT systems and commercial frameworks are simply not designed to operate at arm's length between wholesale and retail.

By contrast, NBN Co will offer the same wholesale services to access on equivalent basis from Day 1 as it rolls out its network and brings across traffic from legacy networks.

Defining wholesale-only is simple in theory but complex in practice. For residential users, it is straightforward to restrict NBN Co from any direct relationship. The situation for sophisticated businesses is more complex. Consider an entity, such as a bank, that uses telecommunications services as an input to delivering banking services to end users. This could be classified as either a wholesale or a retail service depending on the strictness of the definition. The risk is that relaxing the wholesale definition in this or other similar ways could provide an opportunity for NBN Co to expand its scope beyond what was originally intended by Government.

The Implementation Study recommends a narrow starting definition for the wholesale-only restriction, but with practical flexibility. NBN Co should only be permitted to offer services to a carrier or service provider as defined by the Telecommunications Act, unless specific exceptions for classes of customer are made by the Minister. Of course, obtaining a carrier licence is not difficult, so an alternative for a sophisticated enterprise seeking a direct relationship with NBN Co would be to set up a wholly-owned carrier to serve its own needs. In practice, the impact of either a Ministerial exception or a business developing an in-house carrier capability in this way, is limited by the sophistication required from a customer to take a Layer 2 bitstream service. This problem would be more acute were NBN Co to offer Layer 3 services.

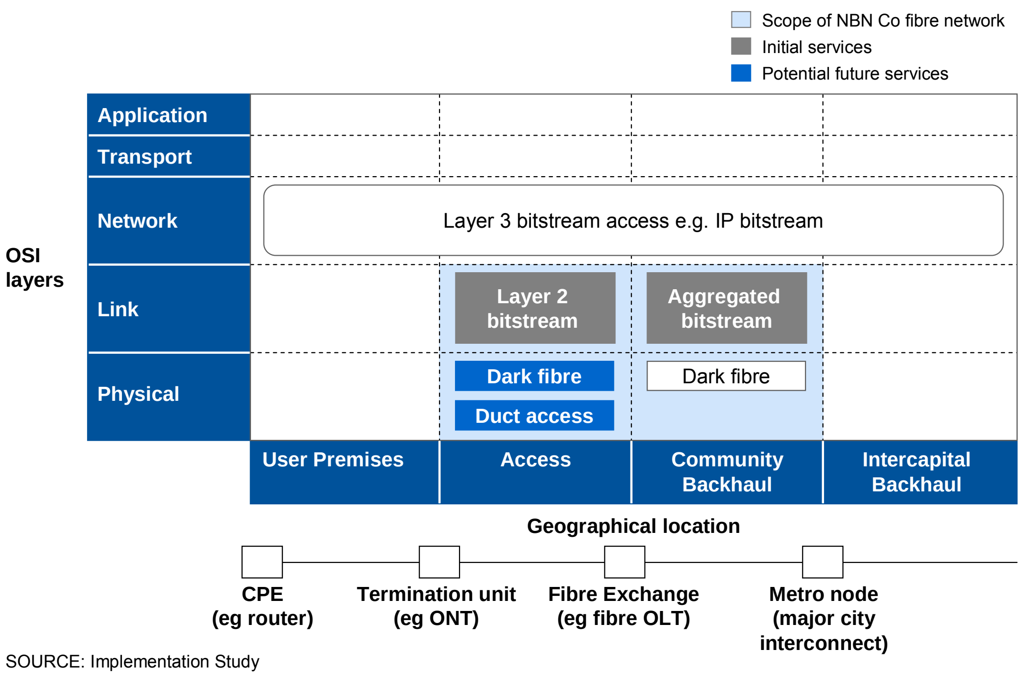
1.3.3 OFFER LAYER 2 SERVICES ON FIBRE, AND LAYER 3 ON WIRELESS AND SATELLITE

Initially, NBN Co should offer only a Layer 2 bitstream service on its fibre network. This means NBN Co will own active equipment in all fibre exchanges and at the customer premises served, to 'light' the fibre. However, retailers will also need to install some equipment to move data around the network and translate the Layer 2 bitstream service into meaningful end-user applications such as broadband Internet, voice and video. In terms of the analogy to today's DSL environment, this level of service from NBN Co lies in between a ULL service and a resale service, lowering barriers to entry across the market, yet still providing scope for product innovation and differentiation. Exhibit 1–7 shows where NBN Co is expected to participate, both initially (the Link or Layer 2 level) and potentially over time with the fibre access network (e.g. providing dark fibre and duct access in the physical layer of the access network as described in Section 1.6.4).

For satellite, wholesale services should be delivered at Layer 3 to enable effective management of the access link. Similarly for wireless, the wholesale service should be at Layer 3 although Layer 2 tunnelling, may be investigated.

With NBN Co providing only a Layer 2 service, ISPs will need to negotiate commercial terms with backhaul owners to ensure national access. However, in doing so, they will have a choice on all routes given NBN Co's commitment to provide transit services from local exchanges to a point of interconnect at which competitive backhaul is available.

Exhibit 1–7. Options for NBN products/services in stack layers and network locations



SOURCE: Implementation Study

Some service providers—for example, those who want to sell standalone applications such as in-home health monitoring solutions—may find negotiating terms with multiple backhaul providers and ensuring end-to-end quality of service guarantees too onerous. To cater to these types of applications, a Layer 3 wholesale market is likely to emerge, with existing telecom operators and system integrators expected to be interested to enter.

1.3.4 MONITOR HEALTH OF RETAIL COMPETITION TO DETERMINE WHETHER FURTHER INTERVENTIONS REQUIRED

The intervention of NBN Co in removing bottlenecks, being required to operate on an open-access and wholesale-only basis, and in offering Layer 2 services promises to level the retail playing field and hence improve the ability for service providers to compete. Nevertheless, Government needs to be aware of future adverse competition scenarios and monitor the health of retail competition to determine if further intervention is required.

There are five potentially adverse scenarios that the Implementation Study has identified. First, limiting NBN Co to offering backhaul only on monopoly links creates a risk of duopoly conduct on some of the remaining links. Second, smaller ISPs may remain structurally disadvantaged by peering arrangements that favour scale operators. Third, some stakeholders argue that NBN Co should go further than Layer 2 and also offer Layer 3 services—concerned that the Layer 3 wholesale market will not emerge, or if it does, it will take too long. Fourth, if bandwidth becomes commoditised and content becomes the basis for differentiation, concentration in content arrangements could entrench incumbent operators. Fifth, if the levelling of the playing field triggers intense, price-based competition without much differentiation in services, then incentives to invest in new services will be limited.

Each of these scenarios needs to be monitored and Government should be prepared to act to mitigate their impact. For example, the risk of backhaul duopolies stifling retail competition can be mitigated through ACCC action, and/or by NBN Co moving its POIs higher in the network to strand duopoly links.

For Layer 3, potential failure of the market is a legitimate concern, but the solution is not for NBN Co to ‘move up the stack’ and become more vertically integrated. To do so would pose risks to innovation and diminish prospects for competition at Layer 3. Commercial operators will enter the market if there is demand certainty, and Government can use its own needs for delivery of services such as e-health and e-education and its purchasing scale to stimulate entry into the Layer 3 market. In the unlikely event of persistent market failure Government can revisit the decision to preclude NBN Co from Layer 3 participation.

1.4 Expect the fibre network to become the predominant fixed-line telecommunications infrastructure by pricing for affordability and take-up and providing continuity for existing services

Over time, the Implementation Study expects the fibre network to become a mass-market essential service. Wireless networks will continue to be important, but as bandwidth-hungry applications and content become more prevalent, they are expected to become complementary to fibre, rather than a substitute.

If NBN Co prices for affordability and take-up and given the expected deterioration in the quality and economics of copper, NBN Co's fibre network is likely to emerge over time as the predominant fixed-line access network. This will require careful planning for the transition of legacy services and obligations that are technology-dependent.

1.4.1 EXPECT MASS-MARKET ADOPTION OF FIBRE-BASED SERVICES OVER TIME

Government should expect strong take-up of NBN services in the long-term if NBN Co sets prices to enable retailers to offer superior value to end users currently served by the copper network. Driving take-up should be the main priority for NBN Co over the coming decade.

The Australian broadband market has future growth potential above population growth. There are numerous countries with higher fixed-line broadband penetration, and current offers in Australia have dampened growth—services are slower, more expensive and subject to lower download caps than elsewhere. The NBN will unlock a new wave of fixed broadband growth by providing superior services.

Mobile broadband will continue to be popular, but will not replace fibre for most households in the long run. As end-user bandwidth demand continues to grow, fibre will become the fixed-line network of choice, and while some households will permanently abandon fixed-line broadband services, most will not. For these households, wireless will be viewed as complementary to, rather than a substitute for, fibre.

The growth of mobile broadband in Australia in recent years has been rapid. This rapid growth relative to fixed-line broadband can be attributed to several factors, including aggressive pricing, strong marketing, take-up by business users and today's typical web-use patterns. Experience in overseas markets and historical growth rates for bandwidth demand however, suggest that over time wireless broadband will not be able to keep pace with richer broadband applications. As rich content becomes mainstream, the

Implementation Study believes that fixed broadband over fibre is likely to emerge as a mass-market essential service.

The most immediate consumer application for high-speed IP networks in other markets is video, whether delivered as an IPTV service or ‘over the top’ (OTT) on a best efforts Internet connection (e.g. YouTube). Video can also be broadcast via an RF overlay employing a dedicated wavelength on the fibre—but this is not well-suited to an open-access platform given that current RF functionality only permits one provider per exchange area. Nor is it commercially compelling—the presence of satellite as a cheap alternative broadcast platform caps potential revenue to around \$2 per subscriber per month.

In other markets, such as the United States, a step-change in potential speeds on cable and phone networks has led to the development of ‘triple play’ offers where voice, broadband and video are bundled together by retailers. New offers and new business models will emerge for video in the Australian market, but these models may struggle to achieve mass-market adoption in the near term given the content arrangements in place with the free-to-air TV networks and with the PayTV operators. Given the current industry structure, Australians have not yet benefited from strong competition for triple plays. Therefore, Government should not assume that the Australian market will develop on a similar triple-play path as other markets without changes to media and content market structure and regulation. Detailed analysis of the nature of the changes that might be required is beyond the scope of the Implementation Study.

1.4.2 SET PRICES TO DRIVE AFFORDABILITY AND TAKE-UP, ACHIEVING COMMERCIAL VIABILITY OVER TIME

Wholesale prices for NBN services should be set to meet the goals of affordability and take-up. As a wholesale-only provider, NBN Co cannot set the retail prices that end users will ultimately pay. However, the wholesale price that NBN Co charges will be the largest input cost for a retailer. This price will therefore have a substantial influence on retail price levels.

NBN Co’s immediate priority should be take-up of services, which will require wholesale pricing that provides retailers with a better business case on fibre than they currently enjoy on copper, for a significant portion of their customer base. Over time, it is likely end users will see additional value in high data rates as more bandwidth-hungry applications and content become common. New services such as IPTV and innovative applications will also emerge. However, the timing and nature of these future services are uncertain, hence the Implementation Study has taken a conservative approach to innovation-driven take-up in the revenue modelling.

For some time, NBN Co will co-exist with legacy copper and HFC networks, either in competition, or during a transition period in which retailers are migrating their traffic onto the NBN.

NBN Co should set prices to deliver a superior offer to service providers compared with such legacy networks. Based on the Implementation Study's modelling, this implies pricing entry-level wholesale fibre services at between $30 and $40 per month—depending on the level of the competing copper ULL price—with uniform prices across the fibre access network.

Given the advantages that fibre has over copper in operating costs, set-up costs and expected churn, this will enable retailers to offer consumers much faster broadband speeds without increasing the prices they charge end users. Over time, end users will attribute greater value to fibre capabilities, particularly as rich services continue to become more prevalent. As this happens, NBN Co should be permitted to increase real prices gradually under ACCC supervision to earn a reasonable return on its assets over its lifetime—but must not be permitted to extract monopoly rents.

NBN Co should have wide discretion to set migration incentives to encourage take-up in the most efficient way. Different incentive levels will be appropriate in different situations based on variations in legacy service availability and plans, local competition, local demographics, the stage of roll-out and available applications and services. Without discretion in migration incentive levels, NBN Co would need to set prices uniformly to meet the cheapest current retail offers in the market—which would substantially harm its commerciality. Further, allowing flexibility in migration incentives should not be interpreted as a relaxation of the principles of equivalence and fair treatment of all service providers. These incentives should be disclosed transparently and subject to ACCC review to ensure consistency with NBN Co's broader equivalence obligations.

Transit services from remote fibre exchanges to points of interconnect with competitive backhaul should be priced to be consistent with Government's affordability objective. This requires capping the cost to a reasonable level relative to retail prices. Depending on the price charged and the cost of these links (which in turn depends on construction costs or the outcome of negotiations with Telstra), this may require a cross-subsidy within NBN Co.

Prices for NBN services should be set uniformly across the fibre footprint to deliver affordability across the country, with a price architecture that encourages take-up of high data rate services and usage. Setting a uniform price provides an implicit cross-subsidy from lower-cost (denser) areas to higher-cost (less dense) areas. If the higher-cost areas have very substantially elevated costs, then the uniform price must be set high so there is sufficient cross-subsidy from the prices charged to lower-cost areas. This can result in a uniform price that is too high to drive take-up.

In actuality, the shape of the fibre deployment cost curve shown in Exhibit 1–3 has a relatively gradual slope, with fibre deployment costs equal to 1.9 times the 50th percentile costs at the 90th percentile, and 2.8 times by the 93rd percentile using the Mesh Block methodology. The more realistic exchange-level aggregation shows a less pronounced difference. As a result, the magnitude of the cross-subsidy required is manageable, and a uniform price can be set at a level that is expected to attract retailers to migrate their traffic from the copper network.

Prices should be differentiated by service features and tailored for end users—for example, by offering wholesale business services with faster fault rectification and superior committed data rates than for consumer services. Higher prices should also be charged for higher data rates, but with an entry-level offer of at least 20 Mbps. A unique feature of the Australian market is that broadband plans typically offer limited, or ‘capped’ usage. While usage caps are increasing—that is, usage is getting cheaper—with retail competition, retailers will continue to charge for usage where they can. For NBN Co, usage patterns have limited impact on cost in the fibre access network (except in driving active equipment cost on transit backhaul links) and the actual usage for a given premises could prove difficult to measure. Thus while some usage-based pricing by NBN Co could improve its commerciality, Government should encourage NBN Co to keep wholesale usage charges to a minimum.

Finally, uniformity of wholesale access pricing should apply only within access technology platforms and not universally across fibre, wireless and satellite. The capabilities of these platforms are too different for any uniformity across platform to be practical. Nevertheless, prices for wireless and satellite services should be set so that entry-level wholesale services are similarly priced to entry-level services on fibre, although they need not be identical.

Within the wireless and satellite footprints, just as NBN Co will pay for the ONT for fibre services, allowance for the cost of expensive CPE has been made to provide incentives for retailers to offer service. The details of providing the CPE should be designed in consultation with NBN Co in the case of satellite and the successful tenderer(s) in the case of fixed-wireless, and should be linked to a requirement to provide services at appropriate peak and average data rates to guarantee service quality.

1.4.3 CONTINUE WITH UNILATERAL BUILD TO FACILITATE MIGRATION

NBN Co should price to offer a compelling proposition to existing retail service providers, Telstra included. Under the Terms of Engagement announced by Telstra and NBN Co on 18 December, 2009, NBN Co and Telstra are negotiating a potential agreement for migrating traffic and/or deactivating the copper network. An agreement between NBN Co and Telstra to migrate traffic would allow an orderly migration of customers and an efficient transition to the new national fibre platform. However, such an agreement could also accelerate Telstra's revenue loss and so Telstra would likely seek compensation.

A key consideration in determining the level of compensation that is appropriate is to understand the likely outcome if there were to be no agreement. In this 'no-deal' scenario, Telstra's retail operation, if operating at arm's length from the copper network, would be expected to migrate much of its traffic to the NBN over time. Specifically, if NBN Co offers a wholesale fibre access service which is preferable to the wholesale copper service for some portion of customers (e.g. based on cost and operational complexity), all retailers—including Telstra's retail operation—would be expected to migrate those customers onto fibre. Further, the NBN fibre service will enable retailers operating on it to offer end users a variety of innovative offers, helping them win further share over time.

As more traffic migrates from copper to fibre over time, assuming some portion of the cost of supporting the copper access network is fixed, the cost of supporting the remaining customers on copper will increase. Faced with deteriorating copper economics (and deteriorating condition of the copper) over time, in any given exchange area, Telstra would face the task of stripping out costs or migrating the remaining traffic to fibre and shutting down the exchange. A decision to deactivate an exchange would need to be accompanied by sufficient notice to various end users and an agreed migration of network obligations that are attached to the copper network to NBN Co or an alternative network such as wireless.

Reaching a migration agreement with Telstra could be attractive to remove uncertainty for the industry. However, such an agreement would depend on reaching a common view of the likely level of take-up for fibre and the cost structure of the copper network. In practice, these are not simple issues to agree upon, especially given the potentially large amount of value at stake. A further complication is that as of the time of writing, Government's *Telecommunications Legislation Amendment (Competition and Consumer Safeguards) Bill 2009* is still under consideration by Parliament. Given this uncertainty, if Government's goal is to maximise the likelihood of its objectives for the NBN being met, the imperative for Government is to maintain its resolve to continue to proceed unilaterally.

1.4.4 MANAGE TRANSITION OF USO AND SUPPORT FOR LEGACY AND EMERGENCY SERVICES

Although detailed consideration of voice services is outside the scope of the Implementation Study, it will be important to address migration of voice services as part of the industry transition, particularly in non-fibre areas. In addition, if fibre becomes the universal fixed-line infrastructure, Government needs to plan carefully for if and how legacy services and obligations transition to fibre.

As the USO provider, Telstra faces the prospect of continuing to be obliged to provide standard telephone services. Within the fibre footprint, providing an analogue telephone emulation service on the ONT will facilitate this. In non-fibre areas, the issue is more complex, particularly given the relatively high cost of maintaining copper lines beyond densely-populated areas. If it retains the voice USO, Telstra will need to choose whether to continue to supply voice services by means of its copper network or by some other means, such as via wireless. Telstra has over 99 percent mobile voice coverage today, and with the advent of 4G technologies such as LTE, the quality and reach of its coverage is expected to improve further, to reach 70 km or more from a tower location. The large and increasing share of total voice usage captured by mobile telephones demonstrates that for many users wireless is already an acceptable substitute for fixed-line voice services.

Even with an expanded footprint enabled by 4G radios, a small number of premises will remain that cannot be served by a wireless network. Providing voice to these premises remains challenging for the industry. Telstra fulfils its USO obligation for many of these premises today with long copper loops, except for around 20,000 premises where fixed radio solutions are deployed, and an even smaller number where voice is delivered via satellite.

As the industry transitions to the NBN, either Telstra will retain its USO for these premises or Government will need to find an alternative USO bearer. In either case, a mix of technologies such as those described above will continue to need to be deployed for the foreseeable future.

Over time, the NBN is likely to become the only fixed-line infrastructure for the country, replacing the copper as Telstra deactivates it. Government must develop a plan to transition the services offered on, and regulatory obligations associated with, copper to a new industry structure underpinned by a wholesale-only NBN Co and national commercial wireless networks. Some services, most obviously broadband, will transition easily. Others, such as fax lines and conventional phone services, can relatively easily be delivered via emulation of an analogue telephone service over fibre. Some, such as payphones will not easily move onto fibre and sufficient notice will be required for application providers and end users to find alternatives or innovate to make the transition.

The copper network also plays a critical role in supporting emergency services that will need to be supported on the NBN to meet social policy imperatives. For example, non-cordless telephones are powered over the copper lines and hence can operate if the mains electricity to a premises is cut. To offer similar capability over the fibre network, NBN Co should design its ONT to provide end users with the option of a self-supplied, self-maintained battery backup to maintain telephone access in the event of a power failure. There are customers who will need assistance with maintaining the battery backup—principally designated priority assistance customers who qualify for lifeline services and currently receive special assistance from telecommunications providers. Government should pay to provide and maintain battery backup for these priority assistance customers, and NBN Co should enable such features as required via contractual arrangements.

Finally, NBN Co should coordinate with Commonwealth security and law enforcement agencies to understand their requirements around providing support for emergency services, as well as to ensure the network design provides reliable and secure services with appropriate levels of redundancy and resilience. In particular, the copper network today has a capability to send the caller's number to 000 emergency services. For emergency calls, Telstra maintains an Integrated Public Number Database (IPND) that emergency service operators use, along with the calling number, to locate a fixed-line caller dialling 000. NBN Co should coordinate with law enforcement agencies to determine what capabilities are needed on the new NBN network to support similar functionality.

1.5 Fund NBN Co with Government equity and introduce investment-grade debt over time; expect to cover Government's cost of funds under most plausible business case scenarios

Under a range of plausible business case scenarios modelled by the Implementation Study, Government can expect to cover its cost of funds for the equity investment required in NBN Co to implement the NBN policy objectives.

Government policy is to establish NBN Co as a commercial entity, operating with commercial incentives and funded, to the extent possible, with private capital. This policy is achievable over the life of the NBN. Initially however, Government should fund NBN Co solely with Government equity until NBN Co can raise its own investment-grade debt and pay interest from its own earnings. This will allow Government to preserve policy flexibility and avoid diluting the returns it could earn over time.

NBN Co has been established as a wholly-owned Government Business Enterprise (GBE). Given its intention to operate commercially, it has been classified as a Public Non-financial Corporation (PNFC), and should be able to maintain this status based on current Australian Bureau of Statistics (ABS) guidelines.

1.5.1 ANTICIPATE PROJECT RETURNS TO EXCEED GOVERNMENT COST OF FUNDS UNDER REASONABLE ASSUMPTIONS

The projected internal rate of return (IRR) for NBN Co exceeds the Government bond rate of 6 percent based on reasonable assumptions for cost and revenue (Exhibit 1–8). In other words, project returns are sufficient to cover the cost of interest on the Government debt that would be raised to fund the equity investments in NBN Co. Once the network is built and the business is mature, NBN Co is expected to generate substantial free cash flows and margins, with an EBITDA margin in the vicinity of 75 percent.

Exhibit 1–8. Sensitivity analysis

- Project IRR above Government borrowing rate
- Project IRR below Government borrowing rate
- Theoretical corner case without changing plans

Revenue Scenarios[a]	Fibre deployment cost blowout	Build cost at higher end of plausible range	Reasonable infrastructure sharing	Build cost at lower end of plausible range
Higher demand • $35 basic service	5.0%	6.7%	7.5%	8.3%
Mid-case demand • $35 basic service	4.5%	6.3%	7.0%	7.9%
Mid-case demand • $30 basic service	4.2%	6.1%	6.8%	7.7%
Lower demand • $30 basic service	3.6%	5.6%	6.3%	7.2%

Build cost scenarios

a. Fixed-line broadband penetration (ie the total of fibre, copper and HFC) ranges from 70% (Lower demand) to 80% (Mid-case demand) to 90% (Higher demand). Prices are entry-level prices at the start of roll-out. Real growth (including a glide path for the $30 entry price scenario) is applied thereafter

SOURCE: Implementation Study

These returns are achievable under a conservative set of assumptions, taking costs at the higher end of the plausible range calculated by the Implementation Study. This assumes a unilateral build and no productivity improvements in labour or deployment techniques.

Further upside exists depending on the nature of any agreement reached on sharing infrastructure. For revenue, a steady, but conservative, take-up of fibre services has been modelled based on analysing fibre deployments in international markets and previous technology transitions in Australia. Wholesale prices are assumed to be set based on competing with the economics of existing copper services to a retail service provider, whilst delivering the superior offers possible with fibre. Conservative assumptions have also been made about the price premium NBN Co will be able to extract for selling services at higher data rates than the entry level offer, and about the revenue from new services such as IPTV. While substantial innovation is expected as a result of the NBN, the Implementation Study's approach is to assume that NBN Co will not capture much additional revenue from these innovations.

In the most pessimistic scenario shown in Exhibit 1–8, costs increase and the market demand for fibre is much lower than expected, with pricing at the most conservative end of our range. However, deploying a large-scale fibre network is different to other large capital projects such as new mines, ports or plants. These assets tend to be one-off projects with complex interdependencies and can be challenging to stage. By contrast, the NBN roll-out is a highly incremental and repetitive project, albeit with local tailoring.

The work required to deploy fibre to a given premises, or to build a given wireless tower, is very similar as the roll-out progresses street by street and town by town. This repetition has real benefits for managing project costs, in comparison with one-off projects. There are significant opportunities to trial and improve deployment techniques to improve performance over time. In addition, a large number of civil work contractors and equipment vendors will want to participate in a project of this scale. This helps create competitive tension between suppliers to drive productivity improvements and bring costs down. Furthermore, the repetitive nature of the work is conducive to benchmarking contractor performance to improve price and performance over time and encourage innovative techniques.

Thus NBN Co has the ability to manage the risk of cost over-runs during roll-out. If costs blow out in early deployments, steps can be taken to find more efficient ways to deploy. If technical problems emerge, they can be addressed early in the process for the remainder of the roll-out. Outside the fibre footprint, deploying a satellite solution is quite different, with the financial impact of a failure at launch very difficult to mitigate other than through insurance contracts.

NBN Co and the Government can also take more fundamental steps to improve the returns over time if costs prove higher or take-up lower than expected. While each of these steps relax some element of Government's stated objectives, they are consistent with the overall objective of dramatically improving the speed and affordability of broadband services.

First, the roll-out schedule could be tailored to improve returns. The reference case models a uniform roll-out, where fibre is deployed uniformly to higher and lower density areas, and areas with different competitive environments—for example ranging from where there is competition from HFC, to exchanges housing multiple competitors' Digital Subscriber Line Access Multiplexers (DSLAMs), to those with no DSLAMs (and hence no DSL service). NBN Co could adapt this roll-out instead to focus first on areas where the rate of take-up will be greatest or where the cost of deployment is least.

Second, the roll-out could be slowed. If new broadband applications do not emerge rapidly enough to stimulate demand for superfast fixed-line services, the rapid rate of roll-out over 8 years could be slowed down. In reality, the number of FTTP trials and deployments being announced in other nations suggest that a host of innovative content and applications will emerge and that the demand for high-speed broadband will increase each year.

Third, Government could allow HFC and VDSL to be sufficient to meet the coverage objectives. If deployment were significantly delayed or over budget, then there is scope to alter some of the Government's policy settings to speed up roll-out or improve NBN Co's economics. These include using VDSL in apartment blocks and/or reusing HFC infrastructure as an interim solution beyond the 8-year roll-out timeline.

By contrast, take-up could be stronger and the cost estimates could prove to be more conservative than allowed for, for example, based on productivity improvements or a satisfactory agreement being reached with Telstra. Government could choose to accelerate roll-out, or reinvest the higher returns to take fibre beyond the 93 percent of premises recommended by the Implementation Study.

1.5.2 EXPECT LARGE CAPACITY FOR INVESTMENT-GRADE DEBT, BUT MAINTAIN FULL GOVERNMENT OWNERSHIP UNTIL AT LEAST AFTER ROLL-OUT COMPLETE

Government should fund NBN Co solely with Government equity until NBN Co can raise its own investment-grade debt and pay interest from its own earnings. Private equity should not be introduced at least until the network roll-out is complete. To do so any earlier would be too expensive, in terms of the returns required by investors, and would constrain Government's ability to establish the right policy and regulatory settings. It will also lead to a substantial distraction for management around the equity transactions concerned. This applies to both cash injections and any proposals to vend in assets in return for equity.

Private investors value certainty and demand high risk premiums to compensate for perceived uncertainty in an investment business case. In the case of the NBN, this is expected to translate into private sector investors demanding returns in the early phases of NBN Co's network roll-out in the vicinity of 15 to 25 percent—well above expected project returns. To accommodate such financing, Government would need to accept a lower return on its equity, while implicitly bearing most of the risk given its commitment to the success of the NBN.

Beyond its high cost, private sector equity has other drawbacks during roll-out, including the restrictions it places on Government's flexibility. The certainty demanded by private investors to lower their investment risk premiums would require Government to provide certainty upfront around the regulatory and policy safeguards it intends to implement—a requirement with which it would be difficult, if not impossible for Government to comply.

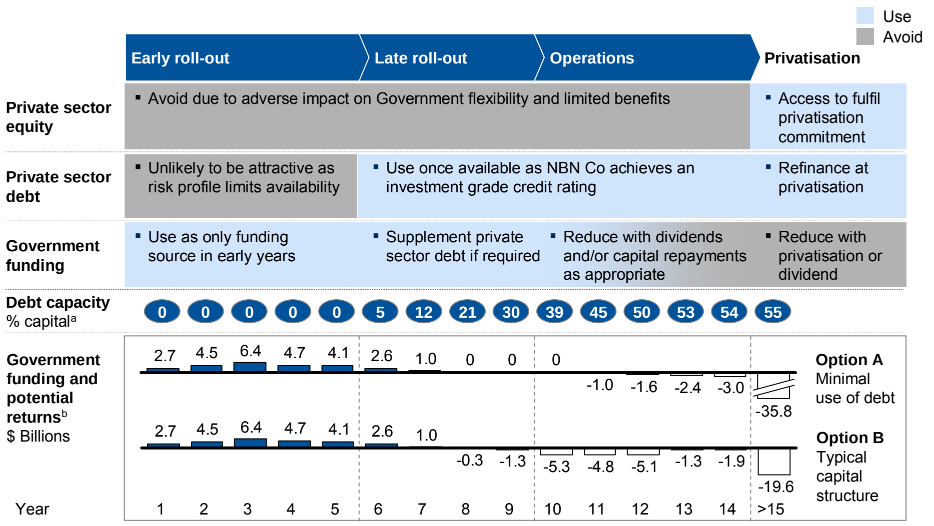
With the implementation of the NBN, the industry will go through a substantial and uncertain transition. Both Government and NBN Co need flexibility to adapt and learn through the various stages of the network roll-out, customer migration and delivery of new wholesale services. Similarly, the regulatory framework must expand from primarily addressing a vertically-integrated paradigm to embrace a wholesale-only paradigm as well. To attempt to design and lock in upfront the safeguards required against the potential downsides of a natural, national monopoly in private ownership would place at risk the success of the NBN by being restrictive and inflexible. More simply, the chances of getting all these settings right at the outset would be slim.

From a purely commercial standpoint, Government is the most natural owner of the risk versus return trade-off before NBN Co reaches steady-state operations. In its start-up phase, NBN Co faces uncertainty on multiple dimensions: competitive, technical, regulatory and political. Its financial profile requires large upfront investment with revenue generated over a 40+ year period. The Implementation Study's detailed cost modelling and conservative revenue modelling shows that over this long asset life, returns are likely to exceed Government's cost of funding. However, this requires government funding of the upfront capital costs until investment-grade debt can be raised.

Government must be prepared to adapt the amount and nature of funding for market conditions and project uncertainty. Policy preferences will also be important—for example, the impact on total government net debt and the willingness, or not, of Government to provide a guarantee to investors. Investment-grade commercial debt is likely to be available around 6 years into roll-out, when NBN Co is generating a positive EBITDA. Until that time, Government will need to invest up to $26 billion as a temporary peak investment. After that, if NBN Co maximises investment-grade debt, it is likely to be able to gear up to 50 percent debt and pay out dividends and/or capital repayments to Government totalling around $20 billion by Year 15.

The recent economic downturn and the effective closure of debt markets show how volatile capital markets can be. Debt spreads on BBB bonds are still around 300 bps at the time of writing, approximately 3-4 times their through-cycle average. If debt remains expensive, then the amount of commercial debt that NBN Co can sustain will be lower.

Exhibit 1–9. Recommended funding approach



a. Proportion of debt capacity to total capital (debt and equity)
b. Privatisation occurs at year 15 based on DCF of future cash flows (equivalent to 7.7x EBITDA). Option A—debt maximised to meet funding requirement only. Option B—debt maximised to meet a debt to total capital ratio of 50% by year 15
Note. Based on funding reference scenario
SOURCE: Implementation Study

Furthermore, Government will face a sharper trade-off between preserving returns on its own equity and maximising commercial debt.

The timing and nature of a potential agreement with Telstra will influence Government's peak funding requirement. For example, if an agreement is structured with upfront cash payments for infrastructure and revenue rebates for migration, this will likely need to be funded entirely with Government equity. Alternatively, these payments could be spread over time as the infrastructure is used and traffic is migrated, thus reducing the short-term funding requirement. Any agreement that brings forward revenue will also bring forward EBITDA and therefore the ability to support commercial debt. Consequently, such an agreement, if structured with an upfront payment, could increase the peak funding requirement but make debt available earlier.

Although it is plausible that NBN Co could be ready for privatisation within 5 years from completion of roll-out (expected to take 8 years), this timing is aggressive. While it is not possible to anticipate the behaviour of capital markets so far into the future, it is possible there may not be enough regulatory or policy certainty within 5 years of roll-out completion to avoid a valuation discount. As 2008 and 2009 showed, the IPO market can effectively close at times. Therefore the timing of privatisation should be subject to market conditions and Government should preserve flexibility.

NBN Co could be attractive to a wide range of potential investors, but will be a large and complicated business to privatise. With an enterprise value of around $40 billion expected in Year 15, it would be an ASX top 20 company and hence difficult to sell in one tranche. Specific elements of the business would be very attractive to different investor segments, but an integrated business of this expected size may not be easy to sell. This suggests considering the sale of the business in parts.

The passive elements of the business are likely to appeal to infrastructure investors as a typical regulated utility with stable cash flows, low capital expenditure and a long asset life. These characteristics are attractive to investors, such as superannuation funds, trying to match long-duration liabilities and are also conducive to taking on high levels of debt. However, many infrastructure funds prefer unlisted assets and have no mandate for listed assets. This suggests that Government will want the flexibility to privatise the passive assets separately in an unlisted vehicle. If listed, the passive assets would need to find a place in equity portfolio allocations but may lack the growth profile required to achieve an attractive valuation.

The active part of the business resembles a typical telecommunications business more closely, with greater risk and uncertainty. It could also have a much more compelling growth profile if separated from the regulated monopoly at the passive layer. As such, it would be more appealing to equity investors and potentially easier to privatise, for example via an Initial Public Offering (IPO).

As discussed in Section 1.6.5, backhaul is expected to remain a bottleneck asset that is difficult to regulate, and as such would be problematic in private hands. The Implementation Study recommends that Government have a bias not to privatise NBN Co's backhaul assets.

Government should preserve flexibility in both the timing and nature of privatisation to avoid diluting returns and to stay true to its coverage and competition policy objectives. Full privatisation 5 years after roll-out could dilute Government's returns over the life of the project, with returns sensitive to the size of the exit multiple and the timing of privatisation. Attractive earlier alternatives to privatisation may also emerge such as taking on higher levels of commercial debt to effectively reduce Government's equity investment through special dividends.

1.5.3 TAKE ACTION NOW TO SECURE FUNDING AND CLARIFY COMMITMENT

NBN Co requires certainty of funding to engage confidently with suppliers and customers. With a peak funding requirement substantially higher than currently set aside, clarity on funding availability is even more important. Government can provide this certainty with a formal funding agreement. This type of agreement has been used to fund major projects in the past and would suit the context of the NBN in several ways. It would enable Government to match funding to NBN Co's needs and performance and adapt it over time. In the longer-term it would also be positive for funding transparency.

1.6 Safeguard future competition and innovation through a network design that enables active-layer competition, and by requiring a healthy industry structure and appropriate regulatory regime prior to privatisation

While much of the focus of NBN Co management and Government—rightly—will be on ensuring the network is built and customers and services are transitioned, foresight is important given this is a once-in-a-generation opportunity to restructure the telecommunications industry in Australia.

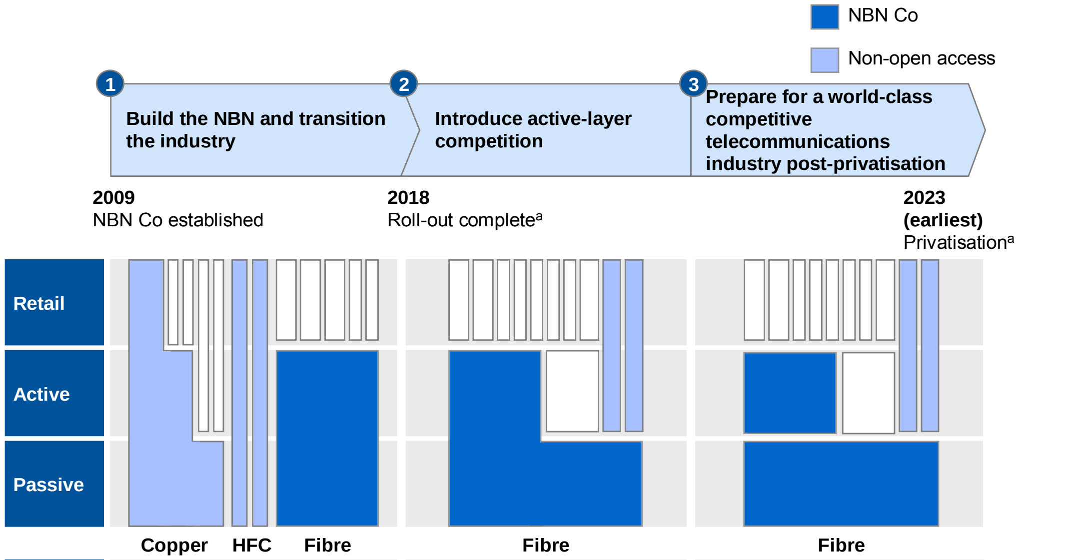
As NBN Co emerges with a new wholesale access infrastructure monopoly, Government must make privatisation conditional on a healthy industry structure outcome and ensure that decisions are not made today that are short-sighted relative to long-term competition goals.

In most developed markets, governments and regulators endeavour to create competition in telecommunications either through competing networks, or through competition on a single network between different owners of active equipment. This has also been the case in Australia historically. Wireless competition is strongest in areas where multiple operators have competing radio equipment—sometimes with shared passive infrastructure such as wireless towers. Similarly, broadband competition is strongest where ISPs (Internet Service Providers) have installed their own active DSLAMs (equipment installed in local exchanges to provide fast Internet over copper) in Telstra exchanges to use the underlying copper assets.

In building the NBN, Government will create a new monopoly passive access network for most of the country; moreover, through NBN Co being the sole provider of Layer 2 services, this will also create a monopoly at the active layer. This departs from the collective experience in most other markets, where competition has been encouraged at the active layer. While the danger of undesirable monopoly behaviour is mitigated to an extent by the requirement that NBN Co operate as a wholesale-only, open-access provider, as discussed in Section 9.4 significant risks will remain.

To ensure healthy competition in Australian telecommunications in the long term, NBN Co's monopoly at the active layer should be for a limited period only (e.g. 8–10 years), with the duration to be determined by the rate of industry transition to the NBN and to subsequent market stability. Exhibit 1–10 illustrates how this industry transition could unfold from a build phase during which NBN Co operates as a monopoly on the passive and active fibre infrastructure; through a phase in which active-layer competition is introduced; to a final phase of preparation for privatisation in which NBN Co might be structurally separated into Passive and Active elements.

Exhibit 1–10. Fixed-line industry structure evolution to fibre



Competition	▪ Copper migration ▪ New FTTP subject to open access wholesale obligation and industry levy ▪ HFC consolidation/acquisition/ migration	▪ Emergence of active layer wholesalers or vertically integrated retailers ▪ Equivalence between 'NBN Co active' and passive access seekers	▪ Potential separation of Passive Co (enduring monopoly) and Active Co (competitive market)
Services	▪ Layer 2 bitstream only for access network ▪ Transit backhaul	▪ Layer 2 bitstream (or similar) ▪ Physical/ wavelength unbundling ▪ Transit backhaul	▪ Layer 2 bitstream (or similar) ▪ Physical/ wavelength unbundling ▪ Transit backhaul
Pricing	▪ Pricing for affordability and take-up ▪ Uniformity within access technologies ▪ No restrictions on migration incentives ▪ Cross subsidies OK between active, passive and backhaul	▪ Uniformity within access technologies ▪ No cross-subsidies between active, passive and backhaul ▪ Regulated real price increases	▪ Uniformity possibly only required for passive access ▪ Separation or regulation ensures no cross subsidies between lines of business
Regulation	▪ Wide ministerial and ACCC discretion to implement policy goals ▪ Approval of NBN Co topology for unbundling at earliest of 2013 or 15% premises covered	▪ Narrower ministerial and ACCC discretion ▪ Definition of active layer industry structure	▪ Stable, predictable and comprehensive regulatory regime
Funding	▪ Government funded for all equity ▪ Commercial investment-grade debt as appropriate	▪ Increased levels of debt once cashflows are established	▪ Passive assets likely to be privatised separate to active layer business ▪ Backhaul likely to remain under Government ownership

a. Copper and HFC networks still likely to be in service
Note: Layer 2 and layer 3 have been simplified here into 'Active' and 'Retail' layers
SOURCE: Implementation Study

1.6.1 BUILD IN FLEXIBILITY FOR FUTURE GROWTH AND UPGRADES

The fibre access network will have at least a 40-year life. Approximately 70 percent of the construction cost of the access network is driven by civil works, with relatively low ongoing costs. Therefore, where NBN Co digs trenches or strings cables aerially, the decisions around how much fibre it deploys, and in what configuration, must be considered carefully. In particular, they must anticipate the future evolution of the market and make sense not just for today, but for at least a generation.

Exhibit 1–11 provides an overview of the characteristics of the various elements of the fibre network to be deployed. While the active components have a lifecycle of roughly 3-7 years, with a dynamic upgrade path, the passive infrastructure has a very long life and large associated costs, hence decisions regarding passive-layer architectures must be considered particularly carefully.

In particular, when constructing the passive elements of the network, additional fibre should be laid and additional duct space provided to allow for future growth in premises. For example, in 1960, the Community Telephone Plan for Australia allowed for a population in 2010 of 33 million people. Similarly, NBN Co should provision for at least a 40-year fibre asset life and account for increasing population density and changes in end-user needs.

The network design should be consistent with Government's decision to prefer fibre as the access technology of choice. Fibre offers almost unlimited future upgrade potential, so NBN Co should deploy the network in the most future-proof way possible, not limiting the upgrade paths that could emerge to those seen today.

Exhibit 1–11. Brief overview of network elements and principal characteristics

Network layer	Description	Lifetime (years)	Principal characteristics
Service (Layer 3+)	Retail services provided to end users (NBN does not specify, but must be cognisant of demand)	n/a	■ Retail demand ■ Innovation of applications and services
Active (Layer 1/2)	Wholesale services offered to service providers	n/a	■ Wholesale inputs required for service providers to meet end-user needs
	Active equipment installed on the network (OLT and FAN switch)	7–10	■ Operational efficiency ■ Upgrade path ■ Cost
Passive (Layer 0/1)	Fibre topology	20–50	■ Desired competitive outcomes ■ Network performance ■ Cost
	Physical deployment: Poles, ducts and trenches	30–60	■ Open access ■ Security ■ Cost

Source: Implementation Study

The most effective way to accomplish this is to deploy a single fibre per home, described as a ‘home-run’ topology. As discussed later, where possible a dedicated fibre for each home is also preferable for competition outcomes. This approach may not be affordable across the entire network, and on-the-ground deployment experience by NBN Co should be used to determine the exact cost of a home-run topology and hence the optimal mix of shared and home-run topologies to deploy.

The data rates delivered to end users over the access network will depend on the active components installed to ‘light’ the fibre. For mass-market services, Gigabit Passive Optical Network (GPON) technology is sufficient to meet Government’s 100 Mbps objective. GPON is an efficient technology in its use of exchange space and power consumption, and can be deployed over both shared and home-run fibre topologies.

For schools, hospitals and businesses however, Ethernet point-to-point (EP2P) technology offers a more appropriate range of speeds and symmetrical services. EP2P service can only be delivered over a dedicated fibre from the exchange to the premises—a home-run topology. NBN Co will need to estimate the demand for EP2P services and provision accordingly. For example, NBN Co should consider the likelihood of EP2P-enabled services being adopted by SMEs and some premium consumer end users in addition to enterprise users.

1.6.2 ACCEPT AN ENDURING MONOPOLY ON PASSIVE INFRASTRUCTURE

Government policy in building the NBN is likely to create an industry structure with no significant competition between fixed networks, since the existing copper and HFC networks are likely to be deactivated over time. The trade-off is that NBN Co will offer wholesale-only equivalent access to service providers. The rationale for this is that—given the high cost of laying the fibre, the long asset life, and the limited ability to differentiate—fibre has the characteristics of a natural, stable infrastructure monopoly analogous to an electricity grid or gas pipes.

NBN Co will be subject to various obligations on its network. It must provide coverage to all premises, not only the most profitable ones. It must price uniformly within access technologies, not discriminate by cost-to-build or ability-to-pay. It may not vertically integrate to capture retail margins. However, these obligations could put it at a disadvantage relative to other infrastructure owners if they are not required to compete on a level playing field. For example, a vertically-integrated company could ‘cherry pick’ the most attractive geographic areas and deploy its own network, reducing the overall economic viability of the NBN while delivering minimal competition benefits to the population taken as a whole.

Therefore, it is desirable that alternative high-speed fixed broadband networks are subject to the same open-access requirements as the NBN, with strict equivalence standards if they are not wholesale-only. If they do not meet the requirements of an NBN-like network, then the premises covered will remain under NBN Co's coverage obligation and NBN Co will need to overbuild them. This would apply to new Greenfield networks, new fibre deployments to existing premises and any future FTTN roll-out.

1.6.3 ALLOW A TEMPORARY MONOPOLY AT THE ACTIVE LAYER

In addition to anticipating that NBN Co will create a Layer 1 fibre monopoly, it makes sense in the near term to allow NBN Co to create a monopoly in providing the electronic equipment to send information across the network (a Layer 2 bitstream service).This active layer monopoly is appropriate, in the near term, for four reasons.

First, allowing Layer 2 competition from the outset would be counter-productive for overall competition objectives. Once fibre is laid, only Telstra, and perhaps Optus, would have the scale to deploy active electronics widely and would be advantaged by their legacy customer bases. Although the roll-out will start at relatively small scale, the investment and risk of deploying electronics in any given area will still be significant, particularly if the operator is not confident of gaining a large market share.

Second, allowing multiple active layer wholesalers from day 1 would be inefficient and commercially difficult for both NBN Co or a private investor. Active electronics are still a significant percentage of the cost, and significant on a per-household basis—particularly if duplicated by multiple operators.

Third, an NBN Co integrated across Layer 1 and Layer 2 will be better able to manage the complexity of the build and migration task. Trying to co-ordinate across a wholesaler and a retailer to migrate traffic is challenging. Trying to co-ordinate a Layer 1 wholesaler, a separate Layer 2 wholesaler and a separate retailer, would simply not be practical in many instances.

Fourth, prices for passive services would need to be higher or non-uniform. The Layer 2 monopoly allows NBN Co to generate revenue from differentiated services and cross-subsidise the cost of Layer 1 during network roll-out. Open access to Layer 1 is likely to lead to active services offered close to marginal cost, with little scope for premiums for higher data rates.

While an active layer monopoly is appropriate in the short-term, Government should not permit Layer 2 services to be an enduring monopoly. This is because active layer economics are different to Layer 1, more innovation is possible, and effective regulation is difficult.

Costs per customer at Layer 2 are around one fifth of Layer 1, and the investments have a 5–7 year life rather than a 40+ year life. More importantly, Australian consumers and businesses will benefit from innovation through competition in active equipment where technology is improving and changing rapidly. While regulation is an appropriate solution for Layer 1 given most of the investment is upfront and the infrastructure is similar to a classic utility, regulating Layer 2 effectively to achieve innovation will be difficult at best, given the complex technology choices involved.

1.6.4 TAKE STEPS TO PRESERVE OPTIONS FOR ACTIVE-LAYER COMPETITION

Government should require NBN Co to anticipate Layer 2 competition after the network roll-out is complete. There are two feasible ways for this active-layer competition to emerge. The first is through wavelength unbundling, which works by multiplexing several wavelengths down a single fibre with each wavelength allocated to a different competitor. That competitor can then specify the types of services it wants to provide to the end user.

The second approach is through providing access to dedicated unlit (dark) fibres, thus allowing competitors to install their own active equipment in the fibre exchange. This is called physical unbundling and is analogous to the successful DSL competition today over ULL. Physical unbundling allows greater service differentiation, as all active layer equipment is then subject to competition.

The availability of wavelength unbundling as a scalable commercial technology is not guaranteed. The underlying technology of wave-division multiplexing (WDM) is proven and is used on backhaul links. It is reasonable to expect that it will continue to evolve and be deployed in an access network. However, there are two caveats. First, as with any technology, there are uncertainties as to whether an alternative will emerge that is better and cheaper requiring infrastructure to be retrofitted to take advantage of it. Second, there is commercial uncertainty as to whether an ecosystem of customers, vendors, researchers and component suppliers will emerge to support wavelength unbundling specifically. The challenge with wavelength unbundling is that current GPON deployments around the world are typically incumbent-led, where those incumbents are not subject to obligations to unbundle. Incumbents will no doubt resist being unbundled as they did on copper, so the incentive for vendors to develop solutions that their largest customers may not want will be low.

Thus while the technology may work in the lab and on expensive backhaul links, without a broader ecosystem there may not be enough scale and economic viability to deploy it as an access technology. Nevertheless, to keep the option open for wavelength unbundling, NBN Co needs to anticipate physical space requirements for competing equipment at its fibre exchanges and the requirement for future upgrades to ONTs, but does not need to take further action until it deploys its next generation of optical equipment in 5–7 years.

Unlike wavelength unbundling, steps are required today to preserve the option for physical unbundling. For its early roll-out, NBN Co is planning to deploy a distributed point-to-multi-point topology. This means a single feeder fibre runs from the exchange to a splitter in the field, where the signal is split to run on dedicated distribution fibres to individual premises. The shared nature of the feeder fibre makes physical unbundling on a premises-by-premises basis impractical unless additional fibres are provisioned in the feeder network and other design modifications are made.

The rationale for NBN Co's proposed topology is that it is typically more efficient to deploy than a home-run topology where a single dedicated fibre runs from the exchange to each premises (and which is suitable for physical unbundling). In particular, there may sometimes be enough space in existing ducts to run shared feeder fibres running out of an exchange, but not enough to run separate fibres for each premises. In addition, less space is needed in exchanges with a shared configuration than if every fibre runs to the exchange as with copper today.

However, these efficiency differences become marginal where new trenching is required or where there is plenty of space in ducts. Furthermore, some level of cost premium is justifiable given the value of preserving the option for technological uncertainty and physical unbundling for competition—but not where this premium is excessive.

Under any deployment scenario, NBN Co should expect to implement wavelength unbundling across its network. Ideally, NBN Co would go further and deploy its entire network in such a way as to preserve the option for physical unbundling. This is not likely to be practical however, as in some areas a home-run topology is likely to incur significant additional cost.

Until the network roll-out is underway and pre-roll-out estimates of deployment costs and duct availability and cost are refined by in-field experience, it is difficult for Government to mandate how much of the network should be designed to be physically unbundled. A pragmatic solution is for NBN Co to develop an efficient topology (such as home run) to permit physical unbundling after it has reasonable experience in deploying its fibre network. By the earliest of: the end of 2013; and the time fibre covers 15 percent of premises, NBN Co should develop a plan in consultation with the ACCC as to what the appropriate topology is to enable physical unbundling and the appropriate extent of its deployment, and secure Government's approval for the plan.

By this stage of network development, there will also be more experience to draw on from regulators in other markets such as the UK and Switzerland. Modelling conducted by the Implementation Study indicates Government should expect unbundling to be feasible for less than a 10 percent cost premium to the fibre access network costs where deployed. Further, Government should expect this to apply to a substantial proportion of the network (i.e. in the range of 30–60 percent of the network). Implementation Study modelling of capital expenditure assumes a home-run topology will be implemented across 50 percent of the fibre network, adding an average of 8 percent for those areas or 4 percent to the total fibre access network cost.

One consequence of anticipating unbundling to dark fibre or wavelength services is that NBN Co would be in a position to compete on a wholesale basis with its customers at Layer 2. To safeguard competition, NBN Co would need to offer equivalence of inputs. In other words, the same systems and processes used to serve itself would also be used to serve other access seekers and NBN Co would be required to deal at arm's length with its downstream business.

To avoid expensive rebuilding of IT systems and redesign of business processes, it may make commercial sense for NBN Co to anticipate some of the requirements of equivalence in today's product definitions as well as in its IT and business process architecture. This requires tradeoffs to be made, and should be left to the commercial judgment of NBN Co, subject to Government's endorsement as shareholder.

In any event, through either a Ministerial determination or declaration by the ACCC, NBN Co should expect to be required to offer dark fibre and/or wavelength services some time after network roll-out is complete. NBN Co would need reasonable lead time to be operationally ready from the decision to unbundle to the time it offers services.

1.6.5 ENSURE PRIVATISATION TIMING AND STRUCTURE SAFEGUARD COMPETITION

Government's intention to privatise NBN Co sets a high bar to ensure the market structure and regulatory framework are appropriate prior to privatisation. The unsuccessful series of negotiations between Government, the ACCC and Telstra around new broadband investments from 2004 to 2009 are a recent and vivid reminder of the difficulty of aligning incentives with a privately-owned monopoly infrastructure owner in the complex telecommunications industry. Implementation of the NBN provides a unique opportunity to get the structure of the market right.

Fears raised by some stakeholders around 'creating a new Telstra' by forming a new monopoly and then privatising it are overstated, given that NBN Co will be wholesale-only, but are not without foundation. More generally, given the high increasing returns to scale, capital intensity, technical complexity and pace of change in the telecommunications industry, regulators have struggled to achieve coverage and competition goals when dealing with commercial owners and managers. Commercial owners have a fiduciary duty to maximise shareholder value, including finding and exploiting loopholes in regulation. Around complex technology issues, regulators tend to be at an information and expertise disadvantage.

The underlying fibre asset is easier to regulate as most of the investment is upfront and no decisions are required about new technologies. It can be operated and regulated in much the same way as a traditional utility. Layer 2 is challenging, and barring substantial advances in regulation, should not be a monopoly if not in Government hands. Therefore, privatisation should be deferred until a competitive market exists, or is highly likely to emerge, at Layer 2. In other words, until NBN Co has successfully implemented either wavelength unbundling or physical unbundling, Government should defer privatisation or only privatise the Layer 1 business.

In the lead-up to privatisation, Government should seek independent advice about the competition safeguards that need to be in place to privatise NBN Co, and what form that privatisation should take from a competition perspective. The independent advice could reasonably be that strict equivalence is insufficient to safeguard competition once NBN Co is in private hands, and that the Layer 1 business (the ducts, poles and physical fibre) should be privatised separately to the Layer 2 business (the active equipment that lights the fibre). However, telecommunications is a dynamic industry and committing to an inquiry by an independent agency such as the Productivity Commission prior to privatisation would avoid locking in a particular solution today.

The situation for backhaul assets is different—uncontested backhaul will remain a bottleneck asset that is very difficult to regulate. Volume will be constantly increasing thus requiring upgrades in active equipment to increase data throughput, without being able to raise prices sufficiently to achieve economic returns. Stand-alone commerciality of backhaul will always be challenging while ensuring affordability, so a commercial owner will rationally under-invest. Government should therefore have a bias not to privatise NBN Co's backhaul assets, although it could allow private operators (including a privatised NBN Co) to tender for their operations. The independent review into competition prior to privatisation should start with a rebuttable presumption to keep backhaul under public ownership.

Other safeguards are also required once NBN Co has private investors seeking to maximise returns. Through a strong regulatory regime, Government needs to safeguard against monopoly incentives to minimise reinvestment and to keep prices higher and volume lower than in a competitive market. A more aggressive NBN Co in private hands could seek to increase the scope of its operations by trying to move into Layer 3 services or serve end users directly by exploiting exceptions in the customer restrictions. Explicit restrictions will be essential, removing the flexibility that is appropriate under Government ownership.

Finally, customers must not be able to exert influence on NBN Co beyond what is commercially reasonable, so consistent with most precedents, customers should be restricted from owning more than 15 percent of NBN Co.

These privatisation safeguards should be set today in the NBN legislation. This will make it more difficult to undermine competition outcomes in the future by seeking to maximise privatisation proceeds—and therefore will be an important component in safeguarding the NBN's competition legacy.

A Achieving the national broadband objective

The coverage objective of the National Broadband Network is to ensure all Australian homes, schools and workplaces have access to affordable, high-speed broadband services. Government has set an objective that 90 percent of premises will receive superfast fibre-to-the-premises (FTTP) connections providing data rates of 100 Mbps. All other premises will be able to access high-speed broadband services providing at least 12 Mbps peak data rates, through a combination of next-generation wireless and satellite technologies.

While NBN Co will be responsible for ensuring coverage to all premises, the network it builds need not be ubiquitous or contiguous. Government's investment in creating an open-access platform for the country will have the greatest value if NBN Co intervenes only where markets have not provided the necessary infrastructure to enable superfast broadband or where the infrastructure that does exist cannot be accessed on affordable terms.

In practice, this means NBN Co should focus on two key bottleneck assets: the customer access network and uncompetitive backhaul routes. Through investments in the construction of—or the acquisition of enduring rights-of-use to—these bottleneck assets, NBN Co can enable retailers to offer superfast products to end users at affordable prices, and deliver against Government's objectives within the initial capital expenditure estimate.

NBN services should be aimed at enhancing competition and innovation amongst service providers. Services should therefore be provided at the level in the Open System Interconnection (OSI) stack that lowers barriers to entry while permitting differentiation and innovation for service providers, large and small. These services should also be modular, so that households are not limited to a single retail service provider, and so that there is flexibility to construct offerings that combine transit capacity with a variety of access services.

Optical fibre is the most future-proof fixed network technology. NBN Co's network design should assume a preference for FTTP technology where consistent with commercial constraints. Detailed cost modelling by the Implementation Study indicates FTTP coverage should be extended beyond Government's initial target of 90 percent, to reach 93 percent of premises by the end of roll-out. NBN Co should endeavour to build a passive network topology which anticipates future services, plausible evolutions of market structure and regulatory developments. In particular, this topology should anticipate the need to provide competition at the active layer over a significant portion of the fibre footprint. NBN Co should also ensure that its initial basic service offering represents a significant improvement on existing services, to substantiate the promise of the fibre technology.

In the non-fibre areas, a separate tender process should be employed to secure third-party provision of fixed-wireless services. Cost modelling by the Implementation Study indicates this fixed-wireless network should extend to roughly 4 percent of premises between the 93rd and 97th percentiles. NBN Co should deploy two next-generation Ka - band satellites to deliver a step change in broadband service performance for the most remote premises, compared with today's remote data solutions.

NBN Co will capture a significant share of the fixed-line revenue pool over time. The superior quality of services offered will bolster the growth of fixed broadband services. Superfast broadband will increasingly become an essential utility for households and businesses, and their requirements are expected to exceed the capabilities of mobile networks over time.

In the early years, NBN Co should optimise pricing to drive take-up, acknowledging that other networks can still meet many of the needs of today's customers. Over time, the perceived value of superfast services will grow, yielding higher ARPUs. The long-term business case for the project generates a return exceeding the assumed Government bond rate under most reasonable assumptions for cost and revenue as described in Part B.

Part A consists of five chapters:

- Chapter 2 proposes a mandate for NBN Co—the extent of its network build, the premises it should cover, the approach it should take to pricing and the network architecture choices that will deliver the desired competition outcomes
- Chapter 3 describes the types of end-user services and business models that the NBN will enable and the implications for the wholesale service NBN Co should offer
- Chapters 4, 5 and 6 discuss the technical, operational and competition issues relating to the design and implementation of the fibre access network, non-fibre access networks and transit backhaul network respectively.

2 Establishing a mandate for NBN Co

SUMMARY

- Government should set NBN Co an objective to provide wholesale-only FTTP coverage to 93 percent of Australian premises and wholesale-only satellite coverage to the remaining 7 percent of premises. A separate tender process should be run for a commercial operator to provide fixed-wireless service to premises in the 94th to 97th percentiles.
- By the end of network roll-out, NBN Co should ensure availability of wholesale broadband NBN services (or acceptable equivalents) to all homes, schools and workplaces in Australia, including those constructed during the roll-out period. During the network build, NBN Co should implement a transparent, public process for communicating its progress against this goal via a coverage register.
- Government should permit NBN Co to provide connections to non-premises locations on a commercial basis, and retain the option to require NBN Co to cover specified classes of non-premises on terms approved by Government.
- NBN Co should intervene in markets only where necessary to ensure end-user access to NBN services and that retail service providers have affordable and equivalent access to bottleneck assets. In practice, this means limiting NBN Co's participation to the access network and transit backhaul on monopoly backhaul routes.
- NBN Co should create a set of enduring assets (through ownership or long-term rights of access) which accommodate population and demand growth and technology innovation. FTTP should be the preferred fixed-line technology, however hybrid-fibre-coaxial (HFC) technology could be used for an interim period if it provides open-access services meeting NBN specifications.
- NBN Co should price its wholesale services to ensure affordable access to all end users and encourage take-up.
- End-user disruption should be minimised during the transition to fibre services, with legacy services continued where necessary and legacy networks deactivated in a managed fashion including sufficient notice for users and service providers.
- As future custodian of Australia's predominant broadband platform, NBN Co should consider the needs of consumers, businesses, public institutions, service providers, employees, suppliers and other partners in designing and operating its network. This should include regular, transparent consultations with relevant stakeholders.

Government has established NBN Co as the primary vehicle for deploying the National Broadband Network to meet Government's coverage objectives, deliver affordable broadband services and manage the transition to a new industry structure. This chapter discusses how NBN Co should fulfil its mandate, laid out in 5 sections.

2.1 Implementing the coverage objective

2.2 Creating a platform to meet future needs

2.3 Ensuring affordability and encouraging take-up

2.4 Managing a smooth transition from today's services and networks

2.5 Aligning NBN Co operations with stakeholder needs.

2.1 Implementing the coverage objective

Government has set an objective for the NBN initiative of delivering FTTP services enabling speeds of up to 100 Mbps to at least 90 percent of premises in Australia, with the final 10 percent provided speeds of at least 12 Mbps. NBN Co will act as the primary vehicle for achieving this coverage objective and should ensure services are available to all valid premises in Australia, addressing infrastructure gaps and bottlenecks where necessary.

A first step is to define premises for the purpose of the coverage objective. This is key to estimating costs and planning for roll-out. This section considers the criteria that should apply for all homes, schools and workplaces, including hospitals, in Australia.

A further step is to understand the number and location of premises in Australia. The Department of Broadband, Communications and the Digital Economy estimates that there were 10.7 million premises in Australia as of November 2009. The NBN will also need to account for new premises constructed during the planned 8-year roll-out. The Implementation Study estimates that approximately 1.3 million new premises will be constructed by the end of 2018.

Within the coverage objective, there will also be some premises for which NBN Co need not provide all new network elements—for example, premises that are covered by an existing fibre network.

In the following, NBN Co's proposed obligations to deliver the coverage objectives are outlined:

2.1.1 Delivering NBN services to all Australians

2.1.2 Classifying fibre and non-fibre areas

2.1.3 Maximising fibre availability to multi-dwelling units

2.1.4 Catering for new premises

2.1.5 Monitoring NBN Co's progress.

2.1.1 DELIVERING NBN SERVICES TO ALL AUSTRALIANS

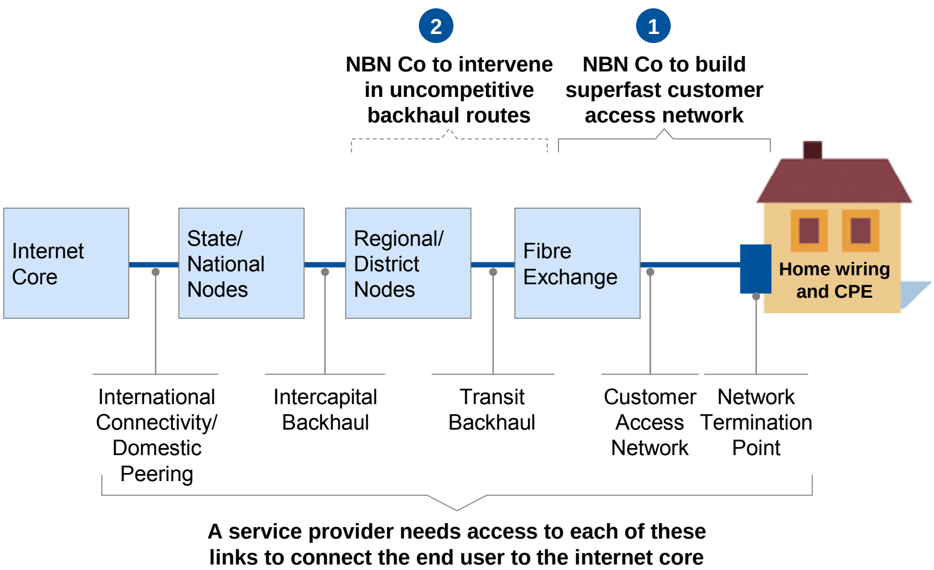
The NBN initiative aims to ensure that ‘every house, school and business in Australia will get access to affordable fast broadband’.[1] However as Australia’s first national wholesale-only, open-access broadband network, NBN Co will not deliver retail services directly to end users. Government’s vision for the NBN is that it will provide a platform that allows service providers to compete on a level playing field to deliver retail services to end users.

Delivering a national open-access network through efficient intervention

Government has specified that the NBN will be a ‘national wholesale-only, open-access network.’ The conclusion of the Implementation Study is that NBN Co does not have to build a ubiquitous network across the nation to deliver on this objective, and that doing so would be an inefficient use of funds. Rather, NBN Co should focus on those areas of the network that represent bottlenecks today, and where provision of superfast connectivity at competitive wholesale prices will open the market to retail access seekers.

To deliver superfast services, service providers must construct or purchase a range of inputs that form links in the connectivity chain from an end user to the core of the Internet (Exhibit 2–1).

Exhibit 2–1. Network components for delivering superfast broadband



SOURCE: Implementation Study

[1] K Rudd, W Swan, L Tanner, S Conroy (Prime Minister, Treasurer, Minister for Finance, Minister for Broadband), *New National Broadband Network*, media release, Canberra, 7 April 2009

Two principal issues may prevent a competitive retail market emerging for the provision of superfast broadband services:

- **Missing links.** On some links, there is insufficient infrastructure to support superfast broadband services.
- **Restricted access to bottleneck assets.** Where the infrastructure providing a link in the chain of connectivity is controlled by only one or two providers, there may be insufficient competition to deliver wholesale services at reasonable prices to retail service providers. This problem is exacerbated where the owner of the bottleneck asset is vertically integrated and hence competes with the service providers seeking access to its asset. In this situation the owner of the bottleneck asset has an incentive to frustrate or over-price third party access.

For most end users, the customer access network is a missing link in superfast broadband connectivity. The legacy copper customer access network is insufficient to deliver superfast broadband speeds to all but a few premises. DSL technologies (such as ADSL 2+) are capable of delivering data at broadband speeds over standard copper pairs for premises that are within about 5 km of an exchange. For those premises located extremely close to the exchange, speeds of 20 Mbps or more may be possible, but this is true for a small minority of homes and businesses. Faster speeds can be delivered over very short copper runs—for example; symmetric speeds of up to 100 Mbps can be delivered using VDSL2 technology, sometimes deployed in multi-dwelling units (MDUs) where fibre is taken to the building basement and copper is used to deliver the service to individual units.[2]

To achieve the desired speeds of up to 100 Mbps across the majority of premises in Australia, fibre infrastructure is the most reliable technology. The electronics deployed on fibre can deliver speeds well in excess of 100 Mbps today, with an upgrade path to much faster speeds over time. Currently, only around one percent of residential premises are served by fibre-to-the-premises (FTTP).

The high cost of constructing an Australia-wide FTTP access network makes it likely that such a network, once constructed, will become a bottleneck asset. Government has stipulated that NBN Co offer wholesale services to all access seekers on an equivalent basis, in an attempt to ensure that all retail service providers will be able to gain reasonable access to its bottleneck asset.

Government's announcement also envisaged that NBN Co would provide fibre optic transmission links or backhaul routes to connect cities, regional centres and towns. Existing backhaul networks in Australia, with appropriate upgrades of electronics, have sufficient capacity to service the superfast FTTP network to be deployed by NBN Co. However some backhaul routes that will service the fibre exchanges—analogous to

[2] International Telecommunications Union 2006, *ITU-T Standard G.993.2: Very high speed digital subscriber line transceivers 2 (VDSL2)*, Geneva

today's copper exchanges—are served by only one or two vertically-integrated providers, third parties have struggled to gain commercial access. To ensure service providers can deliver superfast broadband at affordable prices, NBN Co will need to ensure availability of backhaul services at affordable prices by purchasing or constructing infrastructure over uncompetitive links, or acquiring appropriate rights of use, as discussed in Chapter 6.

NBN Co should not construct an end-to-end network across the country. Where the market already provides the necessary infrastructure to enable superfast broadband services, and retailers can access that infrastructure at reasonable prices, NBN Co should not enter. Entry by NBN Co into these markets would be an inefficient use of funds, provided that a market emerges to support adequate national connectivity for those service providers who desire it. The Implementation Study believes such a market will develop, and this issue is dealt with in more detail in Chapter 9.

Similarly, NBN Co should not enter the market for providing international connectivity, where the market provides sufficient competing infrastructure to enable superfast connectivity and prevent bottleneck pricing.

> **Recommendation 1.** That NBN Co only enter markets where there is insufficient infrastructure to support superfast broadband or where retail service providers are unable to access bottleneck assets on reasonable terms.

Defining coverage

Premises should be considered 'covered' for the purposes of NBN Co's coverage objective if the company offers a wholesale service over a customer access network capable of supporting superfast broadband services to those premises. NBN Co may own the customer access network serving these premises or may have acquired access from the owner of an existing access network. Premises should be considered 'activated' once a service is being delivered by a retail service provider. Some commentators have used the term 'connected', which is ambiguous—it does not refer to actual service activation, but could be misinterpreted as a requirement to connect the premises physically without owner consent, prior to services being ordered. The Implementation Study uses the terms 'covered' and 'activated' to avoid this ambiguity.

The existing customer service guarantee (CSG) outlines the maximum number of days it should take to activate a service for a customer to a standard fixed-line telephone service 'where in close proximity to facilities with available capacity'. The timeframe varies according to whether the house is physically connected or passed by the network, and the size of the community in which the premises are located (Exhibit 2–2). This guideline is established and well understood, and should be used as the test for when premises should be considered covered by the NBN.

Exhibit 2–2. Times for telephone service activation under the Customer Service Guarantee

Connection type	Community location	Community size (people)	Connection time after customer application received (working days)[a]
In-place connection	All	All	within 2
No in-place connection *(close to available infrastructure)*	Urban	=> 10,000	within 5
	Major rural	2,500–10,000	within 10
	Minor rural and remote	Up to 2,500	within 15

a. If customer's phone company commits to connect in shorter time, the reduced time becomes the connection time

Source: ACMA 2009, Customer Service Guarantee Standard 2000(No. 2) Fact Sheet

By analogy, NBN Co should be required to pass premises with its network infrastructure in such a way that a service can be activated within agreed timeframes when a retail service provider requests a service on behalf of an end user. Exhibit 2–3 outlines the minimum extent of network installation that should be required to consider various premises covered by the NBN.

Exhibit 2–3. Suggested extent of network installation required to cover premises

Coverage type	Extent of network installation to meet coverage objective
Single-dwelling unit in FTTP network	Fibre distribution cable deployed along the street. One fibre separated from the distribution cable and terminated in a fibre distribution terminal (FDT) at the street in either a pit for underground deployments or on a street pole for aerial deployments.
Multi-dwelling unit in FTTP network	Fibre distribution cable deployed along the street. Distribution cable extended into basement. Separate fibres for each unit deployed from the basement. Fibre for each unit terminated in an FDT positioned to enable easy access for final connection.
Fixed-wireless coverage area	Wireless base station and radio equipment installed in sufficient proximity to premises that with installation of a fixed external antenna, premises would be capable of receiving 12 Mbps peak speeds at specified average data rates.
Satellite coverage area	Premises falls within a satellite beam such that with installation of satellite CPE the premises would be capable of receiving 12 Mbps peak speeds at specified average data rates

Source: Implementation Study; Industry interviews

The recommended extent of installation outlined in Exhibit 2–3 does not require NBN Co to connect premises physically to meet the coverage objective. In the case of the FTTP network, connecting premises would require NBN Co to enter the relevant land to install the drop cable and optical network termination (ONT), which is the customer premises equipment that enables a customer to connect to the network.

Where the drop cable is deployed underground and an existing conduit is not available, a trench will need to be dug from the fibre distribution cable running along the street to the side of the premises. Installing the ONT would generally require internal access to the premises (Chapter 4).

Requiring NBN Co to complete the physical connection to premises for them to be deemed 'covered' would be inadvisable:

- Physical connection of premises without owner consent would not be feasible;
- It would involve significant additional cost to connect users who do not want an NBN service;
- The additional deployment work involved would delay the roll-out.

For satellite and wireless services the economic objection to full pre-emptive installation is more obvious—it would make little sense to install a satellite dish or a high-gain antenna until an end user has ordered a service to be activated.

Government should therefore not require NBN Co to install any customer CPE such as an ONT, a high-gain antenna or a satellite dish to meet its coverage objective. For fibre, it should also not require the network to reach the actual building—a fibre separated from the distribution cable and terminated in an FDT is sufficient.

As NBN Co rolls out the distribution network to provide coverage to premises in the FTTP footprint, it should anticipate that some premises may request multiple connections. NBN Co should ensure the distribution network can support this. NBN Co should be permitted to charge a commercial installation fee for additional connections.

There may be situations where premises are already served by a customer access network which meets Government's performance and competition objectives. In these situations, requiring NBN Co to enter and provide services over the network would be an unnecessary duplication, and the services should be deemed 'covered'.

The ACCC should be authorised, at NBN Co's request, to declare an area as 'adequately served' and relieve NBN Co of the obligation to offer services to premises in that area in pursuit of its coverage objective. A request would need to specify whether the existing access network should be assessed against the requirements for NBN Co's FTTP customer access network or the non-fibre customer access network.

Conditions for adequate service in an area should be limited to:

- **Performance meets Government's objectives.** If assessed against the requirements of the FTTP footprint, the existing access network would need to be an FTTP network capable of delivering broadband speeds of 100 Mbps to end users. It would also be required to support an upgrade path that is in line with NBN Co's FTTP network.
- **Open-access wholesale arrangements or FTTP infrastructure competition in place.** High speeds in themselves are not sufficient to achieve Government's objectives. Without open-access wholesale arrangements and the confidence that prices will be affordable, an alternative bottleneck FTTP network will not deliver the NBN policy of achieving a national wholesale-only, open-access network. FTTP infrastructure-based competition provides an alternative and adequate competitive framework, although limited largely to CBDs.
- **Wholesale prices competitive with NBN Co services.** The wholesale services or, in the case of areas experiencing FTTP infrastructure-based competition, retail services, should be priced at a reasonable level. The ACCC should consider the wholesale services reasonably priced if they are comparable with those offered by NBN Co over its FTTP network, and retail services reasonably priced if they are comparable with those offered by retail service providers over the NBN Co FTTP network.
- **No gaps in coverage footprint.** The network should provide comprehensive coverage in the area. If a premises is not covered but is surrounded by the access network, declaring the area as adequately served and so removing them from NBN Co's coverage objective would put these premises at risk of never receiving coverage in line with Government objectives. Before declaring an area to be adequately served, it should be considered how premises falling in coverage gaps will be served. It may be that small coverage gaps can be filled in through extensions of the existing access network, or there may be alternative networks offering sufficient coverage (e.g. wireless operators). In the situation that in-fill is not feasible and there is not an adequate alternative network, coverage could be provided by NBN Co's satellite network rather than extending fibre to a small area.

NBN Co will ultimately cover the majority of premises across Australia, as few existing access networks are likely to be declared as adequately serving an area. The most likely exceptions would be greenfield FTTP networks and CBD or business park areas where FTTP infrastructure-based competition exists.

Some industry participants have suggested that NBN Co should not provide services to enterprise premises already served by FTTP access networks. A competitive market exists today for point-to-point FTTP connections to large commercial buildings in major CBDs around Australia. A number of participants have installed optical fibre rings that offer managed Ethernet services. Speeds can range up to 1 Gbps. Some participants, including PIPE Networks have even begun to offer customers dark fibre products.

Premises connected in this way are already receiving services that meet (and sometimes exceed) Government's NBN performance specifications. While the infrastructure in these areas is not available on a wholesale, open-access basis, in many cases there is sufficient infrastructure-based competition resulting in choice for end users.

Where enterprise premises are deemed by the ACCC to be 'adequately served' by competing FTTP networks, NBN Co should not be obliged to provide additional services in pursuit of the FTTP coverage objective.

However, this is likely to be limited to areas where there is a highly profitable concentration of enterprise customers—that is, CBDs and business parks. Outside these areas, the enterprise FTTP market looks very different. FTTP connections exist, but speeds vary greatly. For example, DEEWR reports that although 47 percent of schools have FTTP connections, 67.5 percent of schools use download speeds of 4 Mbps or less, and 29.7 percent of schools use download speeds of 5–20 Mbps.[3] Infrastructure-based competition in these areas is limited.

The incremental cost of NBN Co providing coverage to these areas is relatively small outside CBDs and business parks, because enterprise premises are typically interspersed among residential premises. The Implementation Study sees no rationale to exclude such enterprise premises from the coverage objective.

The assessment of areas that are already 'adequately served' by the market should occur at the time of planning a roll-out for a geographic region. This allows for the possibility of a new, high-speed broadband network being rolled out before NBN Co enters an area.

Recommendation 2. That Government's objective of providing superfast broadband to premises be measured in terms of coverage, with premises considered covered by the NBN where:

1. NBN Co is able to provide a wholesale service to those premises at the request of a retail service provider within a maximum number of days, specified by Government. For premises to be defined as 'covered', NBN Co should not be required to install CPE, or for fibre to perform the 'drop' and install the ONT. NBN Co should not perform the 'drop' and install the ONT until services are ordered via a retail service provider;
2. The ACCC or appropriate agency has declared the premises to be 'adequately served' by other providers where premises already have access to last-mile services of the required speed, with infrastructure-based competition and/or open-access wholesale arrangements in place, and with pricing comparable with NBN services; that to the extent that premises are deemed to be 'adequately served' by FTTP infrastructure, these should be counted towards the FTTP coverage objective.

[3] Department of Education, Employment and Workplace Relations 2009, *High speed broadband to schools overview*, viewed 11 January 2010, <http://www.deewr.gov.au/Schooling/DigitalEducationRevolution/HighSpeedBroadband/Pages/HighSpeedBroadbandToSchoolsOverview.aspx>

Identifying the premises NBN Co is required to cover

Government has made it clear in its policy announcement that all premises—defined as homes, schools and workplaces—in Australia should be covered by the NBN. As such, to define the coverage requirement, Government should provide NBN Co with clear guidance as to the criteria which should be used for determining whether a building (or part of building) is a home, school or workplace.

Telstra applies a test, reproduced in Exhibit 2–4, for the purpose of identifying homes and workplaces eligible for the provision of a standard telephone service (STS) under the universal service obligation (USO). The USO guarantees the provision of voice services to all people in Australia 'regardless of where they live or conduct business'.[4]

Exhibit 2–4. Test for premises eligible for a Standard Telephone Service under USO

Test for premises under the current USO

In determining whether a person requesting a standard telephone service already has reasonable access to a standard telephone service, Telstra will consider the following general factors together with any other relevant circumstances:

- Is a standard telephone service already provided at the place of residence or place of business where the standard telephone service is requested?
- Does the place of residence or place of business where the standard telephone service is requested meet with any applicable ordinary principles of the meaning of a residence or business, for example, local planning laws?
- Is the place of residence self-contained? In other words, does it contain facilities to support independent living, for example, a separate kitchen and bathroom as opposed to shared facilities?
- Has the standard telephone service been requested for non-voice purposes? A service requested for telemetry purposes, for example, water level, weather data or traffic flow and the like will not be supplied under the universal service obligation.
- Has the standard telephone service been requested for a temporary site, for example, a mining exploration site? For temporary sites, Telstra will consider the supply of an interim service for the duration of the customer's stay to ensure the universal service obligation is fulfilled in an efficient and economic manner.
- Is there sufficient physical security for telecommunications equipment, particularly at properties in remote areas or that are not permanently occupied?
- Is the standard telephone service able to be supplied in an effective, efficient and economic manner?

Source: Telstra 2005, Universal Service Obligation Policy Statement; Telstra 2005, Universal Service Obligation Standard Marketing Plan

[4] Telstra 2005, *Universal Service Obligation Policy Statement*

The complexity of Telstra's test shows that it can be difficult to formulate a simple set of criteria for identifying homes and workplaces.

In formulating a test for NBN Co, the aim is to ensure NBN coverage for the following:

- All residences or businesses that currently have a standard telephone service activated as defined under the USO;
- Any premises that currently have a fixed-line residential or business broadband product activated;
- Buildings used continuously for residential, business or educational purposes but currently do not have a telecommunications connection (or are newly constructed premises).

Schools are currently not defined for the purposes of the USO. While schools will likely be captured by the criteria for a workplace, having a clear mechanism for identifying schools ensures that the NBN achieves Government's policy of facilitating greater access to high-speed broadband connections for schools under the Digital Education Revolution.[5] To identify schools, NBN Co should rely on the definition of a school provided by the Department of Education, Employment and Workplace Relations. Hospitals and other premises where health services are delivered would be considered as being used for business purposes.

Recommendation 3. For the purposes of NBN Co's coverage requirement, that premises be defined, to mean any building (or part of a building) that meets one of the following criteria:

1. Currently has a standard telephone service activated as defined under the USO;
2. Currently has a fixed-line residential or business broadband product activated;
3. Is used on an ongoing basis for residential, business, health or educational purposes; or,
4. Is defined as a school by the Department of Education, Employment and Workplace Relations.

Exhibit 2–5 outlines how the recommended definition of premises would be applied to illustrative cases.

5 Department of Education, Employment and Workplace Relations 2009, *High speed broadband to schools overview*

Exhibit 2–5. Applying the definition of premises to example locations

Location	Premises	Non-premises
House or place of business with existing STS	✓	
Homeowner subscribed to naked DSL service	✓	
School	✓	
Apartment in an apartment building	✓	
Assistance telephones in elevators		✓
Assistance telephones at side of highways		✓
Payphones		✓
ATMs		✓
Weather monitoring stations		✓
Mobile cell site		✓

Source: Implementation Study

Estimating the number of premises to serve

To develop the coverage objectives, it is necessary to assess the number and location of all premises in Australia. The primary means of doing so is to use databases of address information. For the purposes of mapping the network architecture, the geographical location of each address point should be identified by specific geographic location data (i.e. geocoded).

The most comprehensive database of geocoded address information is the Geocoded National Address File (G-NAF). Its 12.7 million address points include a number that do not meet the coverage criteria proposed earlier in this section, including duplicate addresses and vacant lots of land. Based on its application of a filter to the G-NAF database, the Department of Broadband, Communications and the Digital Economy estimates that there were 10.7 million premises in Australia as at November 2009. Exhibit 2–6 shows the methodology used for creating the database of premises.

NBN Co will also need to cover premises constructed during the course of the roll-out. The Implementation Study's modelling projects that by the end of the 8-year roll-out there will be an additional 1.3 million premises in Australia.

Exhibit 2–6. Methodology for creating the database of premises

Methodology for creating the database of premises

DBCDE created a database of premises from the Geocoded National Address File (G-NAF). Maintained by the Public Sector Mapping Agencies (PSMA), the database is compiled from:

- Commonwealth, state and territory mapping agencies and land registries
- Australia Post
- The Electoral Council of Australia and the Australian Electoral Commission.

PSMA assigns location information to each address (geo-coding).

The G-NAF database of 12.7 million address points includes address information for a range of points that do not meet the coverage criteria for NBN. It includes land lots that have been assigned addresses by state agencies in anticipation of future development. It also contains address aliases—where multiple records refer to the same premises. For example, single premises falling on a street corner may have addresses recorded for both street names.

To estimate the number of premises that do meet the NBN coverage criteria, DBCDE:

- Removed address aliases
- Cross-checked with Australia Post's mailing addresses and the Australian Electoral Commission's registered voter addresses
- If a G-NAF point matched the address in one or both of these, recorded it as premises for NBN purposes.

The resulting database provides a comprehensive list of geocoded address points that should meet the coverage criteria. The Implementation Study used it to model the architecture and cost of a network that would meet Government's coverage objectives. In executing the roll-out there will inevitably be some G-NAF points on the database that are not in fact premises. There will also be premises found during the roll-out that were not included as G-NAF points in the database or that were in the database but at the wrong location. However, the Implementation Study believes the overall impact on the accuracy of modelling will be immaterial.

Source: Implementation Study

Serving non-premises

A large number of fixed lines currently connect to non-premises. Non-premises include locations that are not a home, workplace or school. Exhibit 2–7 gives examples.

Service providers and end users who require services to be delivered to non-premises may request a fibre access connection from NBN Co. Today, most non-premises are not covered by specific service obligations on Telstra or any other carrier, with the exception of public payphones.

Exhibit 2–7. Examples of non-premises telecommunications services

Non-premises service	Scale
Permitted attachment private lines (PAPLs)	Telstra's plan to shut down all PAPL services by the end of 2009 means they are being migrated over to other networks[a]
Banking communications	180,000 EFTPOS terminals, many of which are located in non-premises locations and 27,000 ATMs[b]
Payphones	~23,000 public payphones[c]
Assistance telephones	Fewer than 50,000 elevator phones[d], over 1000 roadside phones[e]
Traffic management	~15,000 traffic devices[e]
Weather monitoring	~3,000 flood warning data loggers, 400–600 automatic weather monitoring stations[f]
Mobile cell sites	~15,000 mobile phone towers[g]

a Announcement made on Telstra website in 2009, since removed

b Australian Payments Clearing Association 2009, *Number of ATMs and EFTPOS terminals*, Sydney

c Australian Communications and Media Authority, *Communications Report 2007–08*

d Industry interviews

e Estimate based on interviews with roads authorities

f Estimates provided by Australian Bureau of Meteorology

g Estimate based on a filter applied to ACMA 2009, *Radio communications Record of Licences*, Canberra

Source: Implementation Study

At present, Telstra supports most of these non-premises with commercially-priced services.[6] Some end users, such as traffic management companies, pay to extend Telstra's copper network to their equipment.

By definition, none of these locations qualify under the coverage definition for premises set out earlier in this section. As such the Implementation Study believes NBN Co should not be required to cover these locations as part of its roll-out. Such a requirement could slow down the roll-out to premises.

Since these non-premises have activated services today—even though the current regulatory regime does not require carriers to cover them—it is assumed these services are in general profitable for carriers to provide. We also expect that the bulk of services to non-premises delivered over the copper network will continue during the NBN roll-out period. Where Telstra decides, as a result of an NBN Co roll-out in a particular area, to deactivate its copper network and discontinue services to non-premises along with premises, the Implementation Study recommends (Section 2.4) that Government require Telstra to issue a public notice well in advance of such deactivation. This is to allow

6 Industry interviews

sufficient time for owners of non-premises assets to find alternative ways to connect, either through the NBN or otherwise. In many cases, wireless networks will offer a competitive alternative to the copper network for providing connectivity to non-premises.

However, there are many situations where connecting non-premises with fibre will be the most sensible solution. A clear example is in greenfield developments that are provisioned by NBN Co with FTTP infrastructure but are not served by copper. In such a case non-premises that require fixed-line connections will need to be serviced by fibre. Similarly, in the event that the copper network is deactivated, critical systems for which wireless solutions are inadequate, such as traffic lights, will require a connection to the fibre network.

There may also be situations where NBN Co would be willing to provide fibre connections to non-premises in areas where there is a copper network alternative. This would result in greater choice for end users looking to purchase connections to non-premises. An NBN Co non-premises offering would be an attractive option for non-premises applications such as banking services that can utilise the greater capabilities offered by fibre-based IP solutions.

The Implementation Study therefore recommends that NBN Co be permitted, but not required, to provide wholesale connections to non-premises. As there is competition for the provision of these services from wireless and copper networks, NBN Co should be allowed to price these connections on a commercial basis.

Different considerations apply to mobile base stations and other non-premises that need a fixed-line connection to provide backhaul for a telecommunications service that will compete with NBN Co's access network. For these specified classes of non-premises, Government may need to require NBN Co to provide services on acceptable terms. Chapter 6 discusses these considerations with respect to backhaul and Chapter 10 discusses them more broadly.

Recommendation 4. That Government permit NBN Co to provide connections to non-premises on a commercial basis; that Government retain the option to require NBN Co to cover specified classes of non-premises on terms approved by Government.

Setting NBN Co's coverage requirement

Having identified the specific premises to be covered by the NBN, the next step is to determine which should be served by fibre and which by alternative technologies.

Government's stated objective is that the NBN will 'connect 90 percent of all Australian homes, schools and workplaces with broadband services with speeds up to 100 megabits per second' using a fibre-to-the-premises (FTTP) network and 'connect all other premises in Australia with next-generation wireless and satellite technologies that will deliver broadband speeds of at least 12 megabits per second'.[7]

As discussed in Chapters 4 and 5, our detailed geospatial and costing analysis indicates that it will be both commercially sensible and feasible within Government's initial expenditure estimate to extend the fibre footprint to 93 percent of premises.

Chapter 5 contains a detailed discussion of the potential technologies available to serve the remaining 7 percent of premises. In summary, Government should run a public tender for a provider to build and operate a fixed-wireless service for premises in the 94th through 97th percentiles and NBN Co should provide a wholesale-only satellite service covering all 7 percent, but likely to be mostly taken up by the final 3 percent.

The Implementation Study therefore recommends that Government set the following coverage requirement for NBN Co:

Recommendation 5. That Government set NBN Co the objective that, once NBN roll-out is complete, all premises in Australia have access to superfast broadband services, specifically that:

1. 93 percent of premises be covered by a fibre-to-the-premises (FTTP) network that can deliver speeds of up to 100 Mbps;
2. All other premises be covered by NBN Co via satellite technologies that deliver peak speeds of at least 12 Mbps;
3. A fixed-wireless network be provided beyond where fibre is deployed to 4 percent of total premises, but that this not be the responsibility of NBN Co unless there are no acceptable tenders by commercial operators;
4. These coverage objectives be reviewed over time based on actual costs of deployment and technology developments.

Ensuring provision of retail services

NBN Co will deliver wholesale services over any bottleneck asset that it constructs or to which it secures access. However, this will not be of benefit to end users unless there are retail service providers willing to exploit the associated NBN services. Vibrant retail competition is necessary to ensure service innovation and maintain downward pressure on prices.

The creation of fibre access areas that aggregate large numbers of end-user premises and offer wholesale services at affordable prices is expected to form a highly attractive proposition for retail access seekers. Since NBN Co plans to offer services at Layer 2, for reasons discussed in Chapter 3, service providers seeking national connectivity at the

[7] K Rudd, W Swan, L Tanner, S Conroy (Prime Minister, Treasurer, Minister for Finance, Minister for Broadband), *New National Broadband Network*, 7 April 2009

Layer 3 level will need either to purchase capacity on the required non-NBN (competitive) backhaul routes, or rely on Layer 3 wholesale providers to emerge. Our expectation is that a Layer 3 wholesale market will develop over time (Chapter 9).

The willingness of a service provider to enter an area will depend on its belief that there is a viable business case to deliver attractive retail offers for end users over NBN wholesale services. To facilitate this, NBN Co intervention in the access and backhaul markets will stimulate retail competition by:

- **Creating a level playing field.** By providing an open-access network with equivalence for service providers, NBN Co will ensure that retailers compete on an equal footing.
- **Reducing the cost of reaching remote end users.** Chapter 6 outlines how NBN Co can aggregate fibre exchanges to provide points of interconnect that connect to competitive backhaul, so that high-cost uncompetitive backhaul does not prevent service providers from serving customers in regional and rural areas.
- **Providing comparable wholesale prices across the country.** Government has stated that NBN Co will provide wholesale services at affordable prices across the country (Section 2.3). Service providers will face similar network costs to serve customers in all areas.

Regardless of the level of service provider competition on the NBN, end users will retain access to services guaranteed under the USO. In the absence of regulatory change, Telstra will continue to act as the universal service provider and have the flexibility to meet the USO through whichever technology is most appropriate for the premises concerned, including the legacy copper network or the NBN. This obligation does not currently extend to providing broadband—so there is the possibility, albeit unlikely, that some customers are covered by the NBN but are not offered any retail services. If such situations arise, NBN Co should not be required to expand beyond its wholesale-only mandate and become the retailer of last resort. More detail on how these retail obligations could evolve is in Subsection 2.4.4.

2.1.2 CLASSIFYING FIBRE AND NON-FIBRE AREAS

As discussed in Chapters 5 and 7, geospatial modelling undertaken by the Implementation Study suggests fibre can, and should, be extended beyond the initial 90 percent target to reach 93 percent of premises by the end of the roll-out. In any event, rules should be established by the company to establish which premises in a given area are covered by fibre and which are covered by other technologies. These rules will be amended over time as NBN Co gains experience.

Setting a path to achieving the fibre coverage objective

It will be challenging initially for NBN Co to determine exactly which premises should be served by FTTP and which should be served by other technologies. Its primary concern will be to select those premises which are the most economical and practical to cover with FTTP to meet its coverage objective.

All other things being equal, the higher the density of premises in an area, the cheaper it is to provide the distribution network for FTTP infrastructure. However, the cost of digging trenches and installing fibre in an area is not the only consideration which should drive roll-out. For example, where there is a pocket of premises which have a higher cost to serve than those surrounding it, it will be practical to cover these higher cost areas and create a contiguous area of FTTP coverage rather than cover a cheaper group of premises which are in a pocket isolated from the existing FTTP network. Once a roll-out team is in an area, there are scale economies in covering all of the premises within that area rather than creating a 'Swiss cheese' effect that leaves holes in the coverage footprint. Creating contiguous areas of FTTP coverage also facilitates marketing and ongoing maintenance. In addition, serving an isolated group of premises with FTTP could increase the cost of providing adequate backhaul to serve the FTTP footprint.

Moreover, it is difficult to estimate with accuracy which premises will be the cheapest to cover before the roll-out has commenced, even when considerations are limited to civil works. There is a range of assumptions that drives the estimate of the average cost per premises, and these could change after roll-out teams conduct on-the-ground site assessments on an area-by-area basis. For example, the team may find that the soil type in a specific area presents a greater obstacle to trench construction than was anticipated in initial desk-based modelling.

As NBN Co develops roll-out plans for specific areas, it will need to find a practical methodology for determining which premises should be covered by FTTP. It is important that NBN Co demonstrate to Government that the methodology it is using will result in the 93 percent (or other agreed) FTTP coverage requirement being achieved once the roll-out teams have covered all areas in Australia. However, the identification of specific premises or areas that will fall inside the 93 percent should be at the complete discretion of NBN Co. At all times, NBN Co should have a geospatial model that identifies the planned fibre boundary—this is required for reporting on experienced and expected costs, identifying the premises that will be in scope for the fixed-wireless tender and for evaluating requests for community-funded extensions.

To test the assumptions of the pre-roll-out modelling, the initial phase of the roll-out should aim to include a group of areas around the country that are expected to have different roll-out costs. The areas should have a mix of premises that represent the major cost drivers, for example, different geology, different housing types and densities and different legacy telecommunications infrastructure (e.g. aerial vs. underground). Selecting a representative group of areas for the first phase of the roll-out would be consistent with

Government's expectation that the NBN 'be rolled-out, simultaneously, in metropolitan, regional, and rural areas.'[8] As discussed in Chapter 10, the Implementation Study also recommends that this opportunity be used to explore the costs of alternative network topologies.

Once NBN Co has completed its roll-out to a representative mix of the country, Government should review whether NBN Co is on track to achieving the objective for FTTP coverage. If the results of the first phase of roll-out suggest the FTTP coverage target will not be reached, Government should use its performance management mechanisms to correct the course of the roll-out and/or revise its target. Government should continue to review progress against the FTTP coverage requirement over the course of the roll-out.

Recommendation 6. That NBN Co select a number of priority areas for roll-out that together comprise a representative mix of the country; that, once NBN Co has completed its roll-out to these priority areas Government review whether NBN Co is on track to achieving the objective of 93 percent FTTP coverage and use performance management mechanisms as required; that the Minister request NBN Co include details of its progress in achieving the 93 percent FTTP coverage objective in each corporate plan.

Considering community funded extensions of the fibre footprint

In areas outside the planned fibre footprint, individual end users or groups of end users may be willing to contribute funding to obtain FTTP connections (Exhibit 2–8). If communities are willing to contribute to the cost of extending the roll-out of the fibre network beyond the footprint proposed by NBN Co, then there may be a rationale for NBN Co to extend its FTTP network to cover them. Communities that might be interested in such a scheme could include businesses with high-bandwidth needs (e.g. mining sites) or affluent local municipalities.

The decision to cover communities that are contributing funding should not lead to NBN Co reducing its coverage footprint in other areas. Premises covered under such community-funded extensions should be considered as additional to those that NBN Co would achieve in pursuit of its coverage objectives.

[8] K Rudd, W Swan, L Tanner, S Conroy (Prime Minister, Treasurer, Minister for Finance, Minister for Broadband), *New National Broadband Network*, 7 April 2009

Exhibit 2–8. Community-funded extension program: OnsNet, the Netherlands

OnsNet community funded fibre network

Nuenen is a medium density suburban area in the Netherlands with 8000 premises where the cooperative OnsNet network was created to deliver FTTP services to the community. Through OnsNet, Nuenen became the first city in the Netherlands to deploy a municipal FTTP network.

OnsNet was developed with the support of a national research and development program called 'Kenniswijk' (KnowledgeDistrict). Initiated in 2000 by the Dutch Ministry of Economic Affairs, Kenniswijk was designed to encourage network providers to experiment with new ICT services in small trial roll-outs around the country. These would test services and, it was hoped, demonstrate their business case for market-led roll-outs across the country.

In 2003, an organisation called Close the Gap submitted a business plan for building an FTTP network connecting all premises in Nuenen. It was to be implemented through a cooperative consisting of Nuenen residents called OnsNet (Dutch for 'Our Net'). Due to the high cost and uncertainty of returns of FTTP networks, and the reluctance of incumbent telecommunications and cable companies to invest in them, the network qualified for support under Kenniswijk. A subsidy of €800 was offered for each premises in the proposed FTTP roll-out.

The proposal was to construct an FTTP network with a two-fibre point-to-point architecture—i.e. two fibres would be run to each premises. One of the fibres would be dedicated to the transmission of CATV, the other to a point-to-point Ethernet connection capable of delivering symmetrical download and upload speeds of up to 100 Mbps.

The average cost per household activated was about €1500. The funding model for the roll-out involved residents contributing their €800 subsidy to the OnsNet cooperative which used the money to fund a joint venture with the network construction company Reggefiber. OnsNet members hold 95 percent of the shares, with Reggefiber having 5 percent. The remainder of the investment was financed through a loan secured against the proposed network and to be repaid using revenues generated by the cooperative delivering services over the network.

With the incentive of one year's free service, 97 percent of premises owners became cooperative members and contributed their subsidy. Prior to deployment of the FTTP network, Nuenen already had cable and DSL broadband infrastructure. Thus, OnsNet faced significant competition from existing providers. However, even after the first year of free service ended, penetration has remained above 80 percent. Residents pay an ongoing membership fee of €20 per month and the full package of telephone, television and Internet costs €60 per month.

The OnsNet model shows the potential for government and community funding to be combined to fund the roll-out of FTTP infrastructure to areas that would not otherwise be served with fibre. It also demonstrates the importance of high take-up in reducing the average cost of delivering broadband infrastructure to homes.

Source: Sadowski, B. et al. 2009, 'Providing incentives for private investment in municipal broadband Networks: Evidence from the Netherlands', *Telecommunications Policy*, vol. 33, issues 10–11, pp. 582–595; Close the Gap 2009, *Next Generation Broadband: From Dream to Reality*, visited 10 February 2010 <http://www.closethegap.nl>

As described in Subsection 2.1.5, NBN Co should maintain a Coverage Register to track which premises have been covered by the NBN. On this Coverage Register it should be clearly identified that premises have been covered under the community funding scheme, so that they can be excluded from consideration in assessing progress against the 93%

target. If such a mechanism were not introduced, there would be an incentive for NBN Co to bias its demarcation of the fibre footprint on the grounds of community contributions.

If a community-funded program did not cover the full cost of fibre deployment, it would result in an increase in the total capital cost of the NBN roll-out, as costs incurred to deploy FTTP to communities under the program will be in addition to the cost estimated for providing fibre to the areas identified as part of the agreed coverage target set by Government. Government may wish to consider contributing matching funds to encourage such deployment.

However, it is important that any community-funded extensions not disrupt the broader roll-out plans for the network. Community-funded extensions should as far as possible be integrated into the roll-out plan for the area from which the extension will be deployed, so that they are carried out while NBN has its roll-out teams in the area.

To ensure that any such scheme does not endanger NBN Co's primary objectives, NBN Co should retain ultimate discretion over when and how to implement it. For at least the first two years of roll-out, it is likely that NBN Co will not wish to create the distraction of this additional process. When it does create such a process, it will need to establish a materiality threshold for applications, to ensure that its administrative resources are not unduly burdened with, for example, applications for coverage of isolated individual premises and disputes about the costs quoted.

Integrating the community-funding mechanism into the broader NBN roll-out could be achieved in the following manner:

- NBN Co undertakes a field survey of an area;
- NBN Co publishes an area roll-out plan on its website and begins notification process to prepare home and business owners. The area roll-out plan would show the boundary between the fibre and non-fibre networks;
- Communities not covered by proposed FTTP network can contact NBN Co and request a quote for extending the FTTP network, subject to a materiality threshold set by NBN Co;
- The community and NBN Co enter into an agreement to provide for funding. The agreement should specify that ownership of the network remain with NBN Co.

Recommendation 7. That NBN Co be permitted to establish a mechanism by which a community can fully or partially fund the extension of the FTTP network to cover its location, provided that these premises will not be counted towards the FTTP coverage objective. This could include financial contributions towards the network extension from businesses, not-for-profit organisations, state and local governments or from Government, independent of its equity investment in NBN Co.

Setting eligibility criteria for non-fibre solutions

Chapter 5 proposes an approach to serving the final 7 percent of premises in which Government would run a commercial tender for a fixed-wireless network covering the 94th to 97th percentiles, and NBN Co would offer a wholesale-only, high-throughput satellite service that is available across all 7 percent of premises.

Eligibility for the fixed-wireless service would be set by NBN Co's geospatial modelling The tender would either be designed to identify the specific premises beyond the 93rd percentile and up to the 97th percentile, or alternatively, to allow the tenderer to identify those 4 percent of premises it proposes to cover. The successful tenderer would be required to offer both a wholesale service and a retail service to prevent market failure for some customers. Customers falling in this area would qualify for provision of fixed external antennas to be installed to ensure access to broadband at speeds and throughput consistent with Government's objectives for the final 10 percent.

All customers in the final 7 percent of premises would qualify for the provision of the satellite service and associated CPE, to ensure all premises nationally are covered by a wholesale-only offer. Since the fixed-wireless service will offer superior performance to the satellite service (for example due to much lower latency), few premises in the 94th to 97th percentiles are expected to take up a satellite service. Since both the fixed-wireless and satellite CPE would be provided under the proposed approach, households and businesses that selected one type of service would not subsequently qualify for provision of CPE under a different service.

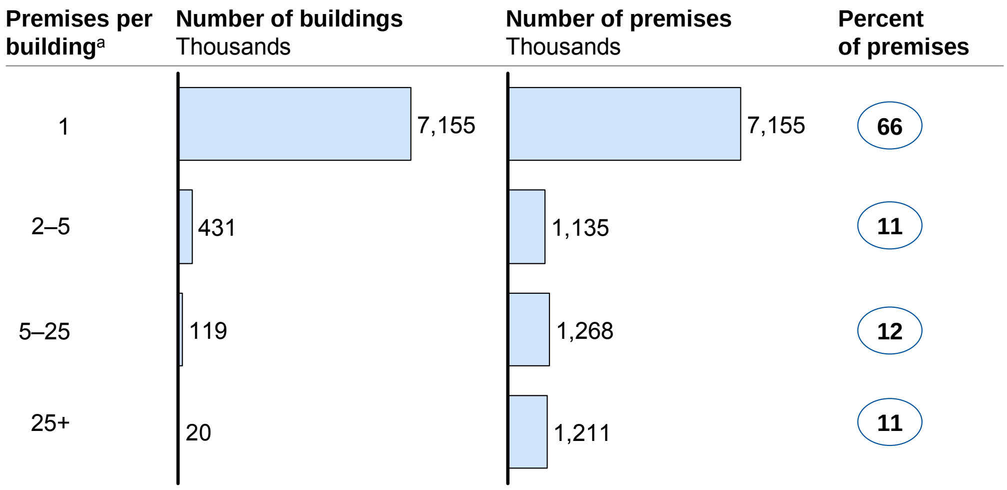
Prior to the FTTP roll-out reaching a given area of the country, the existing rules for eligibility under the Australian Broadband Guarantee (ABG) should continue to apply to determine whether premises are eligible to receive a subsidised satellite service—namely, whether that premises is able to access a metro-equivalent (e.g. DSL) service.

> **Recommendation 8.** That until the FTTP roll-out is complete in a given area, only premises that cannot access a metro-equivalent service as defined under the Australian Broadband Guarantee program be eligible for an NBN satellite service.

2.1.3 MAXIMISING FIBRE AVAILABILITY TO MULTI-DWELLING UNITS

Multi-dwelling units (MDUs), such as apartments and office blocks, comprise 34 percent of the premises in Australia as at November 2009 (Exhibit 2–9). Due to the higher density of premises in MDU buildings, it is often cheaper to provide FTTP infrastructure to premises within MDUs than it is to provide FTTP infrastructure to single-dwelling units (SDUs), i.e. freestanding houses. Being lower cost and typically found in higher-density areas, most MDUs are likely to fall within the fibre footprint of the NBN and are also likely to be commercially attractive to NBN Co. Providing FTTP coverage to MDUs is therefore important to NBN Co both for its business case and for meeting its FTTP coverage requirement.

Exhibit 2–9. Single dwelling and multi-dwelling units in Australia, November 2009



a. Multiple premises are deemed to be in same building if geographic address points lie within 3 metres of each other on the Implementation Study's filtered G–NAF database.
SOURCE: Implementation Study

MDUs can present unique challenges relative to stand-alone premises during a roll-out of FTTP infrastructure. There are two factors that make MDU installation a greater challenge than installation in detached houses:

- **Intervening property rights.** To provide a service to the owner of a unit within an MDU, NBN Co should first obtain permission from the MDU entity to install the elements of the fibre network through the common areas of the building to reach each customer premises. This differs from freestanding residences, where the owner of the premises generally also owns the land through which the drop cable must be deployed.
- **Variation in the requirements for installation methods.** Because of the variations in physical layout and communications infrastructure in MDUs, the method of installing FTTP can vary widely from one MDU to the next (Exhibit 2–10).

The challenge of catering for MDUs creates a number of risks in the roll-out of the NBN:

- **End users denied access to services even though within network footprint.** MDU entities preventing end users from accessing NBN services by denying permission to NBN Co to install the network through the building will compromise Government's policy objective to provide high-speed broadband access to all Australian premises.
- **Underestimating the cost and time involved in covering MDU premises.** The need to tailor installation of the network to the specific characteristics of an MDU means that it can be difficult to estimate the time and cost of installing the network in an MDU without conducting a site assessment. Until a site assessment is

conducted, there is a risk that NBN Co's estimates of the time and investment required to deploy the new network throughout the building, and the area in which it is located, will be incorrect. Delays could also result from the process of engaging with MDU entities to obtain access to the building. Delays in the roll-out schedule or the need for roll-out teams to revisit areas can increase the cost of the roll-out.

- **Risk to achieving coverage requirement.** NBN Co may be prevented from achieving the FTTP coverage requirement set by Government if a large number of MDU entities deny NBN Co access. If cost overruns related to MDU installation are widespread, this would threaten the ability of NBN Co to achieve the coverage requirement within the Government's initial expenditure estimate.

Exhibit 2–10. Factors that lead to variation in requirements for MDU installation

Factor	How this can change installation method
Density of premises	The density of premises in an MDU will determine the extent of infrastructure that should be deployed in the building in addition to the normal infrastructure provided to detached houses. For lower-density MDUs, it may only be necessary to install additional Fibre Distribution Terminals (FDTs). For high-density MDUs that have a large number of units it may make sense to locate a splitter cabinet in the basement.
Space in risers	In many MDUs, telecommunications wiring is run from the basement to the upper floors of the building through vertical shafts called risers. If there is sufficient space within the risers of an MDU, fibre can be installed by pulling it through. This technique is generally cheaper and quicker than other installation options
Duct capacity	In buildings where existing copper wiring is ducted, retrofitting with fibre can be achieved by blowing fibre through the existing ducts, a cheap and quick process. However, where no ducts exist or there is insufficient space in the ducts, blowing fibre is not an option. To install fibre cables from the telecommunications room to the individual premises, a path should be created either through the building fabric (e.g. installation through walls) or along the external surface of the building (e.g. by laying fibre through conduit attached to the outer wall).
Space in telecomm-unications or services room	To house shared components of the FTTP installation such as a main distribution frame (MDF) or splitter cabinets, there should be sufficient space in a dedicated and secure telecommunications or services room. Where there is insufficient space, other solutions may be involved.
Space on floors to accommodate floor boxes	One installation method is to place floor boxes on each floor that house the FDTs for all premises located on that floor. When homeowners or businesses request an NBN service, connecting the premises involves running cable from the floor box to the premises. In some buildings there may not be a suitable location for a floor box, preventing this option.

Source: Industry interviews; Implementation Study

Giving NBN Co right of access to MDU common spaces

One challenge which will confront NBN Co in its network roll-out is obtaining entry to common spaces in an MDU.

In some MDUs, meetings with residents or bodies corporate may be required in relation to works on the property (Exhibit 2–11). Such processes, if contested, may result in substantial delay and additional cost, if NBN Co is required to return to a neighbourhood where an MDU was bypassed during initial roll-out.

> *The rights of carriers …to install cable to allow access to services in strata titled or other multi-owner property should be stronger, in particular, carriers should have the right to install access cables to any tenant or resident who orders a service and such access must not be prevented or frustrated by other tenants or residents.*
>
> Internode (2009)[9]

To alleviate this difficulty, it is appropriate that Government enact a right of entry for NBN Co to enter common areas for the purpose of network deployment and maintenance, and a statutory obligation on bodies corporate and building managers to take reasonable steps to assist NBN Co in obtaining access.

Exhibit 2–11. Decision-making structures in multi-dwelling units

Decision-making rights over common spaces in MDUs are linked to ownership

Single owner. Where the entire building is owned by a single landlord, who leases the units within the building to tenants, decisions over the common spaces are wholly within the domain of the landlord or building owner. This is the case in many commercial office buildings within CBD areas.

Several owners. The situation is different where ownership is shared between multiple owners, as is the case in many apartment buildings. Most of these are governed under strata title where the structure of the building, including the concrete supporting structures, services (including electrical, hydraulic, ventilation and communications), most walls and slabs, are owned by a statutory *body corporate* or *owners' corporation*.

Individual owners of apartments usually own the airspace within their apartment only. Each owner of an apartment or unit within the building is a member of the owners' corporation and has voting rights in relation to certain decisions of the owners' corporation. The voting rights of the apartment owners depend on the plans of registration which are registered during the process of developing a strata title building. The body corporate can make decisions regarding common spaces at its annual general meeting. Decision-making is normally by majority vote. Outside the annual general meeting, the decision-making power of the body corporate is normally vested in a committee.

In this report, we use the term 'MDU entity' to refer to the body that has the right to decide whether NBN Co should be granted access to the building to carry out installation of FTTP infrastructure.

Source: Implementation Study

[9] Internode 2009, *Submission to the National Broadband Network Company legislation and access regime*

While some MDU entities might object, common areas in MDUs are analogous to streets in single dwelling neighbourhoods. To allow bodies corporate to block NBN Co's access to common areas would be akin to allowing neighbours to prevent a resident of a single-dwelling premises from obtaining access to NBN services. The proposed right of entry and obligation to assist would not apply to residents' private space within the MDU.

Even with such an obligation, there may be practical challenges in gaining access to an MDU where a building manager is determined to be uncooperative, as enforcement of the obligation will be difficult. However, a statutory obligation would, at the very least, help to resolve disputes within MDU decision-making bodies by removing the discretion to prevent entry.

Recommendation 9. That NBN Co be granted a right of access to shared property in multi-dwelling units to undertake the inspection, installation and maintenance of FTTP infrastructure and that an obligation be imposed on building managers and bodies corporate to facilitate NBN Co exercising that right of access.

Defining NBN Co's coverage obligation in the event that an MDU entity denies access

Government should provide clear guidance to NBN Co about how it should respond in the event that an MDU entity denies NBN Co access to deploy the network in the building. Upon receiving a denial of access, Government should require NBN Co to undertake the following steps:

- Undertake a notice process to ensure that the MDU entity is given sufficient information to make a fully-informed decision about denying access.
- If the MDU entity does not grant NBN Co access to the building after the notice process, then NBN Co can list the MDU on the NBN Coverage Register as 'frustrated.'
- If the MDU entity later requests FTTP installation by NBN Co, the building should be removed from the 'frustrated' category of the NBN Coverage Register and NBN Co should be required to cover the premises. However, NBN Co should be given flexibility on the time at which it undertakes this installation so that the broader roll-out process is not compromised. Government could also consider allowing NBN Co to charge an installation fee for these subsequent installations. Exhibit 2–12 summarises the approach used in Singapore, where both cost and schedule incentives are used to encourage MDUs to install fibre as it is rolled past.

Recommendation 10. That NBN Co follow a defined process in the event that it cannot install FTTP infrastructure in a multi-dwelling unit (MDU) because it has been denied access to the building; that this process include:

1. NBN Co conducting a notice process to ensure the building entity understands the implications of its decision;
2. If the building entity does not grant NBN Co access to the building after the notice process, then NBN Co can list the MDU on the NBN Coverage Register as 'frustrated';
3. If the building entity later invites NBN Co to enter the building and install FTTP infrastructure, NBN Co is to undertake the installation but to have flexibility over when it will do so.

Preferring FTTP over FTTB in MDUs

Fibre roll-outs in some countries have used fibre-to-the-building (FTTB) combined with VDSL to deploy to MDUs. This involves the placement of a fibre node in the basement of the building and the installation of a DSLAM that converts the optical signal carried by the fibre into an electronic VDSL (or VDSL2) signal that is carried over the existing copper wiring in the building to individual units.

The rationale for a FTTB roll-out to MDUs is that it generally requires less time to install than FTTP, thus increasing the speed of the roll-out. VDSL is also typically cheaper, particularly for larger MDUs, reducing the cost of coverage for premises in MDUs. As the copper length over which the DSL signal runs is short, high speeds can be delivered to end users. For example, VDSL2 systems can deliver 100 Mbps symmetric services.[10]

However, the time and cost savings which can be obtained by choosing a VDSL roll-out come with significant tradeoffs. As FTTB relies on copper to provide the final connection to the premises, it will not follow the same upgrade path as the FTTP network. As FTTP electronics are upgraded, premises activated on FTTB are likely to fall behind in performance. Retrofitting MDUs from FTTB to FTTP would erode the initial cost advantage of FTTB.

FTTB deployments are also difficult to unbundle. To serve customers on a FTTB network, a second provider would need to invest in a DSLAM for each building it wishes to serve. The economics of doing this are challenging because of the small number of premises served by any one DSLAM.

Implementation Study modelling indicates that in many cases providing MDUs with FTTB is comparable to the cost of FTTP. Providing MDUs with FTTP is significantly cheaper on a per-premises basis than providing single-dwelling units with FTTP (because

[10] ITU 2006, *Very high speed digital subscriber line transceivers 2 (VDSL2)*

the cost of distribution is shared over more premises), so it is therefore difficult to justify MDU residents receiving FTTB instead of FTTP.

The Implementation Study therefore recommend that in the initial stages of the roll-out, NBN Co should be required to install FTTP in MDUs and not be permitted to offer FTTB as an option. Should significant problems emerge with achieving FTTP coverage in MDUs in the early stages of the roll-out, then Government may consider reviewing this policy.

> **Recommendation 11.** That NBN Co be required to install FTTP in MDUs as opposed to alternative technologies such as VDSL; that Government review this policy if widespread building access problems or cost overruns emerge as NBN Co seeks to cover MDUs in the early phase of the roll-out.

Implementing an integrated approach to MDUs

NBN Co should consider implementing measures specifically designed to facilitate the roll-out of the FTTP network to MDUs. In particular, NBN Co should:

- **Conduct an early notification and engagement process with MDU entities.** Because of the added complexity of needing access to common spaces within MDUs to undertake the installation, NBN Co should aim to contact MDU entities earlier than they would for owners of individual premises. NBN Co should do this even if it is granted a right of entry into MDUs, since the proactive assistance of the MDU entity will facilitate installation.
- **Develop standard installation approaches for different MDU types**. NBN Co should have the ability to adapt the installation methodology it uses to the specific variations in physical layout and communications infrastructure in MDUs as illustrated by the Singapore example discussed in Exhibit 2–12. International experience demonstrates that it is possible to develop a small number of standard approaches which cover the vast majority of installation scenarios that the FTTP roll-out teams may come across in MDUs. These approaches would provide guidance to roll-out teams on how to cable different types of MDUs. They should be designed in a way that is sensitive to the needs of building owners and premises owners. For example, the installation should utilise existing ducting, entry points and services rooms wherever possible to minimise disruption. Providing these kinds of archetypes is essential for making fibre installation attractive for MDU building entities and owners of premises in MDUs, while ensuring that costs are controlled.

Exhibit 2–12. Approach to multi-dwelling units in Singapore

International experience in activating MDUs

OpenNet is leveraging its years of experience in MDUs in Singapore to roll out an FTTP network to 100 percent of premises (about 94 percent of residential premises are MDUs[a]).

Communicating with owners. At least three weeks prior to installing fibre in residential and public units, OpenNet sends an initial letter of offer requesting them to sign-up to fibre. End users can also register their interest on OpenNet's website. They are then notified when OpenNet's teams approach their area.

Landlord-tenant relationship. The tenant must obtain permission from the landlord because minor drilling and installation works may take place.

Installation. For residential MDUs, OpenNet installs up to the first Termination Point—i.e. the first internal wall outlet that provides access to the FTTP network. Installation takes less than four hours and up to three installers. For non-residential buildings, OpenNet rolls out to the Main Distribution Frame (MDF) room or Telecommunication Equipment Room (TER). The building owner is responsible for connectivity from the MDF to each premises. Installation takes less than four hours and up to four installers.

Incentives for residents/tenants. Charges for a first installation during an offer period are waived if the first Termination Point is within a 15 metre fibre-run starting from the door (for high-rise residential) or the gate pillar (for free-standing premises). Beyond 15m, cost-oriented charges apply. Owners who initially refuse and then request a connection pay installation charges of $220 for residential premises in an MDU and $450 for free-standing premises.

Incentives for building owners. OpenNet waives installation charges up to the MDF/TER rooms when the network first reaches a building. If linked buildings share a postal code, the fibre is deployed to the MDF room that serves that cluster. If an owner denies access after the initial offer, a later installation can be requested for a fee, and the owner may need to accept a much later slot in the roll-out.

Minimising disruption. OpenNet minimises disturbance where possible. The installation reuses existing ducts, risers and telecommunications rooms. OpenNet's contractor consults with the homeowner to determine a location to mount the fibre box and use existing points of entry. OpenNet can arrange to have the installers work between 9am and 5pm.

a. Statistics Singapore 2010, *Resident Households by Type of Dwelling*, viewed 10 February 2010, http://www.singstat.gov.sg/stats/themes/people/household.html

Source: OpenNet 2010, *OpenNet*, viewed 12 February 2010, <http://www.opennet.com.sg>

- **Develop a guide for planning authorities, developers and builders to adopt when approving new developments.** Providing guidance on the approach NBN Co would recommend for the installation of telecommunications infrastructure in newly constructed premises can ensure that new MDUs are constructed in a way that facilitates cost-effective and consistent installations of FTTP infrastructure. Telstra currently publishes a guide for the purpose of informing property developers on the correct method for installing copper infrastructure in MDUs.[11]

[11] Telstra 2009, *Cabling of multi-storey residential buildings*

- **Establish a team specialising in MDU roll-outs.** Because of the special considerations which should be taken into account in undertaking roll-outs to MDUs, NBN Co should consider establishing a specialist MDU team that would be dedicated to managing relationships with MDU entities and building management and addressing specific technical issues arising from installing FTTP infrastructure in MDUs. Having a centre of expertise and dedicated point of contact for MDUs would improve the experience for MDU entities, tenants and owners of individual premises and reduce the average time required for MDU roll-outs.

Advice. Given the added complexity of MDU installation, that the NBN Co Board ensure that measures to facilitate MDU installation are implemented by NBN Co's roll-out team. These could include:

1. Early notification to MDU entities of the intention to roll out FTTP infrastructure in their area requesting permission to access the building to execute the installation;
2. Potential establishment of a specialist MDU roll-out team that is dedicated to managing relationships with building management and addressing specific technical issues arising from installing FTTP infrastructure in MDUs;
3. The development of standard approaches to installing FTTP in MDUs, which would provide guidance to NBN Co roll-out teams on how to cable different types of MDUs. The standard approaches should aim to maximise the use of existing points of entry for telecommunications services and minimise disruption to residents/tenants during the installation process;
4. The development of standard approaches for planning and building authorities to adopt when approving new developments.

Ensuring open-access to shared assets in MDUs

The part of the FTTP network installed in an MDU that is shared by multiple residents is a bottleneck asset. A provider that controls the shared infrastructure in an MDU could use that control to restrict choice of fixed-line providers for building residents.

Examples of this behaviour have emerged in the United States where local incumbent cable and telecommunications providers have limited competitor entry by denying access to the wiring that they have installed in MDUs. If a competitor wanted to offer services for residents in an MDU, they needed to install their own wiring in each building. In response the FCC issued a ruling making it clear that incumbents must give competitors access to this wiring.[12]

Under Australian law, ownership of internal wiring running through an MDU depends on the network medium. In a copper network, the carrier owns all wiring up to the Main Distribution Frame (MDF), which is generally located in a telecommunications room in

[12] Federal Communications Commission 2007, *Report and Order and Declaratory Ruling: FCC 07-111*, CS Docket No. 95-184, MM Docket No. 92-260, WC Docket No. 01-338, Washington, D.C.

the basement of the building. Wiring running from the MDF to the individual premises in the building is classed as 'customer cabling' and belongs to the building owner(s).

The situation is different for an FTTP network. For these networks, the carrier owns all cabling up to the Network Termination Device (NTD).[13] This means that under current regulation, NBN Co would own all optical fibre cabling up to the point where it connects to the Optical Network Termination (ONT). Cabling installed on the customer side of the ONT would be owned by the customer. This is the case, even if the building has an MDF, since the MDF is not defined by the ACMA Cabling Rules for optical fibre networks.

The current regulations would ensure that NBN Co has ownership of the internal cabling within an MDU, which is the potential bottleneck asset. Access to these assets will be included in NBN Co's access service, which is defined in Chapter 4 as running from the fibre exchange to the ONT.

Serving MDUs beyond the FTTP footprint

There are likely to be some MDUs which fall outside the FTTP footprint of NBN Co. To meet its coverage requirement, NBN Co will need to provide coverage to these premises in the same way it covers other premises in the non-fibre customer access network. As with the FTTP network, MDUs can present unique challenges to the deployment of non-fibre solutions. For example, due to the configuration of the building some premises may not be able to install CPE which can obtain a wireless or satellite signal.

To meet the coverage requirement for any MDUs outside the FTTP footprint, it may be necessary to install a common aerial or satellite receiver for the building, and install internal wiring from this equipment to each premises within the building. Such a situation presents similar challenges to those outlined for FTTP installation in MDUs, and the recommendations and advice outlined in relation to MDUs in the FTTP footprint should also apply to MDUs beyond the FTTP footprint. In addition, NBN Co will need to consider standard approaches for overcoming the challenges of providing coverage to MDU premises with wireless or satellite technologies.

13 Australian Communications Industry Forum 2006, *AS/ACIF Standard S009:2006: Installation requirements for customer cabling (Wiring rules)*, Canberra

2.1.4 CATERING FOR NEW PREMISES

Australia's population is growing. By the end of 2018–19, when the NBN roll-out is targeted for completion, it is estimated that there will be an additional 1.3 million new premises, including those constructed in both greenfield and brownfield developments (Exhibit 2–13). These new premises will constitute 11 percent of projected total premises in 2018–19.

To meet Government's policy objective of providing superfast broadband to all Australian premises, premises constructed during the roll-out period should be included in NBN Co's coverage requirement. Recognising this, the Minister for Broadband, Communications and the Digital Economy released for comment an exposure draft of legislation 'to support the roll-out of fibre optic networks in new developments around Australia.'[14] If enacted, the legislation would require fixed telecommunications lines installed in new developments to be optical fibre. While the scope of the draft legislation is broad and applies to both greenfield and brownfield developments, there is provision for the Minister to outline exemptions to the requirement. The outline accompanying the draft legislation makes it clear that the Minister would specify developments, or classes of developments, to which the legislation is to apply in a Ministerial declaration.

The policy framework for these new premises should require NBN Co to provide fibre when it has fibre infrastructure sufficiently close to be able to deploy fibre to the new development economically. If NBN Co has not yet deployed close enough, then Government should encourage the most efficient transition path to those developments having fibre by the end of the roll-out.

Exhibit 2–13. What are greenfield and brownfield sites

Greenfield and brownfield developments
Development can occur on greenfield or brownfield sites. In the Australian urban development industry, a brownfield site is a parcel of land that has previously been used for urban development and is being redeveloped. A greenfield site is a parcel of land where urban development occurs for the first time. The National Housing Supply Council defines greenfield sites as 'former agricultural or undeveloped natural land on the periphery of towns and cities that has been rezoned for urban development.[a] This is sometimes referred to as 'new release' land.
a. Department of Families, Housing, Community Services and Indigenous Affairs 2009, *State of Supply Report 2008,* National Housing Supply Council, Canberra Source: Implementation Study

14 Australia, House of Representatives 2009, Telecommunications Legislation Amendment (Fibre Deployment) Bill 2009 (Exposure draft), Canberra

The priority where NBN Co cannot provide the fibre should be to encourage fibre to be deployed, but in a way that makes integration with NBN Co's network simple. This requires setting specifications for a fibre provider to comply with so that the network can be integrated as is or so that the underlying fibre can be used with NBN Co electronics.

Where fibre is not deployed, the objective should be to ensure that costs for NBN Co to deploy fibre subsequently are minimised. This requires insisting that all new premises are built with duct, pit and pipe infrastructure that NBN Co can use to deploy fibre to each of the premises in the new development.

Implementing this policy framework is quite complicated in practice, and is laid out below in the following sections:

- Including new premises in NBN Co coverage objective and roll-out;
- Establishing a national standard for FTTP networks to enable integration with the NBN;
- Minimising the cost of subsequently providing fibre where it is not deployed upfront.

Including new premises in NBN Co's coverage objective and roll-out plans

Currently, the vast majority of newly constructed premises are provided with telecommunications services by Telstra. Telstra estimates that every year it provides infrastructure for approximately 90,000 greenfield building lots and for a further 90,000 brownfield building lots.[15]

Only around 10 percent of these greenfield lots are currently provisioned with FTTP. The remaining greenfield and brownfield lots are generally served through extensions of the copper network. This is because bespoke FTTP infrastructure is more expensive to install than an incremental extension of an existing, large-scale copper network. The difference is magnified to developers, who only pay for the costs of digging the trenches for the copper network.

From NBN Co perspective, once it has deployed its customer access network nearby, greenfields and brownfield developments are typically relatively cheap to deploy to, as is summarised in Exhibit 2–14. While it is envisaged by Government that the provision of FTTP to new developments will be competitive,[16] NBN Co would be the natural party to provide FTTP if it has deployed its customer access network nearby.

15 Telstra 2009, *Submission to DBCDE's FTTP in greenfield estates consultation process*

16 Department of Broadband, Communications and the Digital Economy 2009, *National Broadband Network: Fibre-to-the-premises in greenfield estates consultation paper*, Canberra

Exhibit 2-14. The economics of serving greenfield and brownfield sites with FTTP

Greenfield and brownfield economics

When NBN Co provides FTTP services to the existing stock of premises during the national roll-out, it will need to build exchanges, lay feeder and distribution cables, and for premises that choose to take a connection, install a drop cable and an ONT. During the roll-out, NBN Co should over-provision the network, by laying additional fibre to cater for new premises growth (discussed further in Subsection 2.2.2).

After NBN Co's fibre access network is deployed, serving brownfield sites which occur within the fibre access network is relatively low cost: only the drop and ONT need to be installed—the costs of the exchange and feeder/distribution have already been incurred. An exception is where a brownfield development involves subdivision of a large area of land into smaller blocks served by a new road network. For example, the conversion of an industrial estate into residential housing. Here, the deployment of FTTP infrastructure more closely resembles a greenfield.

Greenfield estates adjacent to NBN Co's fibre access network would typically be provided with FTTP at a much lower cost per premises than retrofitting existing housing stock. In most cases, the new premises could be served by an existing fibre exchange (the only cost being additional line cards if the OLT needs extra capacity). If the network has been over-provisioned, feeder cables could be extended from the edge of the fibre access network into the new estate. Civil works would need to be conducted to extend the feeder network and install a distribution network, but these could typically be done at the same time as the road network is constructed and other utilities (including power and water) are installed. A drop cable would need to be installed to each premises in the new estate. This could also be done using pit and pipe infrastructure that is installed during construction, rather than retrofitted.

Greenfield estates which are not adjacent to an existing fibre network can be expensive to serve. A new fibre exchange may be required, and connecting the exchange to a competitively-priced backhaul network may require an long and expensive link to reach existing backhaul links.

If FTTP is deployed during the construction of a greenfield estate which is adjacent to the fibre access network, then the economics for an FTTP provider are typically very favourable: the cost to install the fibre is relatively low and because FTTP is the only fixed-line infrastructure available, penetration will be high. Today, many premises on greenfield estates with FTTP are sold with a fixed-line connection included, and penetration is 100%.

Source: Implementation Study; Industry interviews

In fact, once NBN Co has deployed its access network in an area, it should be required by Government to act as the network provider of last resort for greenfield developments which are required to install fibre. However, it would be an unreasonable expectation for NBN Co to serve new premises constructed in areas where it has yet to deploy its access network. Serving dispersed pockets of new premises would be a significant distraction to the broader NBN Co roll-out, potentially leading to cost overruns and time delays.

> *[New] developments by nature occur on a random basis, location and size. Installing fibre in vastly isolated pockets of varying sizes requires premature investment in infrastructure which will struggle to secure sufficient initial return until neighbouring areas have fibre installed*
>
> Christchurch City Networks (2009)[17]

Nevertheless, NBN Co should, by the end of the roll-out period, have either provided a wholesale access service to all new premises or received confirmation from ACMA that new premises are adequately served. In doing so, NBN Co will have fulfilled its mandate to ensure that all premises in Australia have access to superfast broadband services by the end of its roll-out.

> **Recommendation 12.** That NBN Co's coverage objective include new premises that are constructed during the period of the roll-out; however, that NBN Co not be expected to cover these new premises prior to the NBN access network being deployed to that geographic area.

Due to the commercial attractiveness of some greenfield estates, it may make sense for NBN Co to serve greenfield developments in areas where it has not yet deployed its fibre access network. This would be a commercial decision for NBN Co and could include planning its roll-out schedule to cover high growth areas early. Alternatively, NBN Co could establish a Build-Operate-Transfer (BOT) contract with a network provider who would deploy FTTP networks in greenfield areas, operate them for a set period and then transfer operations and ownership to NBN Co at the relevant time during its roll-out. Such an arrangement could be made with Telstra, for example, as part of a broader agreement to migrate its customers to the NBN.

Exhibit 2–15 shows the likely coverage outcomes for new premises under the proposed approach to implementing NBN Co's coverage objectives for new premises. Three classes of new premises are described: those within NBN Co's FTTP footprint, those outside the FTTP footprint but likely to be covered by the copper network, and those beyond both the FTTP footprint and the copper footprint. The expected coverage outcomes are described for each class of premises, should they be constructed prior to the deployment of the NBN in their area and if they are constructed after the deployment of the NBN in their area.

[17] Christchurch City Networks Limited 2009, *Submission on 'Broadband Investment Proposal'*

Exhibit 2–15. Coverage outcomes for different classes of new premises constructed before and after NBN deployment in an area

		NBN deployment at time of construction	
		NBN not deployed in area	**NBN deployed in area**
Likely NBN coverage by end of roll-out	**FTTP footprint** 93% of brownfields ~100% of greenfields[a]	▪ Served by copper or developer-funded FTTP (likely Telstra) ▪ NBN FTTP installed later ▪ Fibre-ready duct, pit and pipe to facilitate NBN retrofit	▪ NBN Co install FTTP ▪ Developer covers cost of trenching, duct, pit and pipe ▪ Option to choose alternative provider to install FTTP
	Non-FTTP footprint, copper available 6% of brownfields	▪ Served by copper ▪ Covered by NBN non-fibre as deployed ▪ Fibre-ready duct and pipe within premises boundaries to give option for cost-effective overbuild with FTTP	▪ Served by copper and NBN non-fibre ▪ Fibre-ready duct and pipe within premises boundaries to give option for cost-effective overbuild with FTTP
	Non-FTTP footprint, no copper available <1% of brownfields	▪ Served by other providers ▪ Covered by NBN non-fibre as deployed ▪ No requirement to install ducts, pits and pipes	▪ Served by NBN non-fibre, satellite or other 'bespoke' solutions ▪ No requirement to install ducts, pits and pipes

a. Some limited small-scale greenfield developments may occur beyond the final NBN FTTP footprint, however extremely rare
SOURCE: Implementation Study

Exhibit 2–16 outlines a model for NBN Co to serve greenfield developments in an area where it has become the provider of last resort. Developers will continue to be required to cover the costs of trenching and the duct, pit and pipe network. However, in these areas NBN Co would cover the costs of installing all other FTTP network infrastructure up to the network boundary. For residential premises, this will involve all installation up to the first wall outlet. A different level of installation may be required in commercial premises, depending on the model of installation developed for them.

This model aims to replicate the responsibilities and funding arrangements currently in place when new premises are connected with copper infrastructure. This has the advantage of providing continuity for developers and local councils as well as preventing any additional impost being placed on the developer that could exert upward pressure on house prices. However, it can only apply once NBN Co is in a position to extend its existing network.

For brownfield developments in the vicinity of NBN Co's access network, only Phase 3 of Exhibit 2–16 applies. In all cases, NBN Co can choose to charge a connection fee to owners of premises. Today, Telstra's fee to connect new premises to the copper network is $299.[18]

18 Telstra, viewed 1 March 2010,<http://www.telstra.com.au/homephone/connections>

Exhibit 2–16. Responsibilities and funding for greenfield FTTP roll-outs in area where NBN Co has deployed its network

	Phase 1—trenching and headworks	Phase 2—passing homes	Phase 3—connecting homes (as built)
Elements of network	▪ Trenches to premises boundaries ▪ Feeder line and connection to fibre exchange	▪ Ducts, pits, pipes ▪ Fibre roll-out to FDT[a] ▪ OLT ▪ Other network elements up to FDT	▪ Home wiring ▪ Trenches and ducts on premises ▪ Drop cable ▪ ONT
Party responsible	▪ Developer (trenches) ▪ NBN Co (feeder line, fibre exchange)	▪ Developer (ducts, pits, pipes) ▪ NBN Co (all other)	▪ Developer (home wiring, trenches, ducts) ▪ NBN Co (drop cable and ONT)
Costs	▪ Developer passes through to homebuyer ▪ NBN Co	▪ Developer passes through to homebuyer ▪ NBN Co	▪ Home builder and developer pass through to homebuyer ▪ NBN Co covers costs, charges homeowner connection fee

a. Fibre Distribution Terminal. The point, on a pole or in a pit, where the drop cable will connect to the distribution cable
SOURCE: Implementation Study

Outside the fibre footprint, the responsibility of NBN Co in greenfields estates would be limited to the provision of satellite broadband services, based on the approach to the final 10 percent proposed by the Implementation Study. Since serving newly-built premises in this footprint requires installing the same CPE as for existing buildings (i.e. satellite dish or fixed-wireless antenna, modem) with no additional trenching or cabling, no unique requirement needs to be specified for greenfields in these areas.

Recommendation 13. That NBN Co be required to act as the network provider of last resort for premises constructed within, or adjacent to, NBN Co's fibre access network; that developers be required to cover the costs of trenching and providing the duct, pit and pipe network; that NBN Co cover the costs of installing all other FTTP network infrastructure up to the premises.

Establishing a national standard for FTTP networks to enable integration with the NBN

Providers other than NBN Co will play an important role in serving developments that choose to install FTTP infrastructure. With multiple providers installing FTTP throughout the country, there is a risk of inconsistent architectures being deployed. This would make it difficult to ensure that the FTTP networks installed will be capable of satisfying Government's performance specifications for premises within the fibre footprint and will make upgrades more challenging. There would be a risk that greenfields could become tomorrow's broadband access blackspots.

To ensure consistency in the fibre footprint, Government should require that where FTTP access networks are installed they should comply with national FTTP design standards administered by ACMA with the aim of advancing Government's broadband policy objectives. The design standards would ensure that where FTTP infrastructure is installed by another provider, the infrastructure will be of the same standard as the architecture that will be deployed by NBN Co. ACMA should consult closely with NBN Co in the development of these standards.

> **Recommendation 14.** That ACMA be tasked with issuing national FTTP design standards that all parties should adhere to when deploying an FTTP network for the purposes of providing telecommunications services to the public; that these standards should align with the network architecture deployed by NBN Co in its roll-out; that Government and NBN Co work with state governments to reference the design standards in state planning and building controls.

A national FTTP standard will ensure that the passive and active infrastructure provided over new FTTP networks is consistent with the architecture that will be used by NBN Co. A greenfield FTTP access network that is provided in a new development is likely to be a bottleneck asset, because it is unlikely to be duplicated and thus will be the only network enabling the delivery of superfast broadband to premises within its footprint. To comply with Government's broader NBN initiative, the network operator needs to offer wholesale products and pricing that enable service providers to enter and deliver services that meet Government's policy objectives.

Existing greenfield FTTP networks vary in the level to which they offer wholesale services on an open-access basis. While some providers operate wholesale-only, open-access networks, this is not the case for all. Some provide wholesale access to competitors as well as providing retail services themselves. The largest FTTP provider, Telstra, does not offer wholesale access to competitors.[19] Where Telstra's FTTP network is the only fixed network serving the area (i.e. there is no copper), these end users must choose between buying fixed-line services from Telstra or not buying a fixed-line service at all.

To facilitate the achievement of its policy goals, Government should require that FTTP networks installed in new developments provide an open-access, Layer 2, wholesale service to service providers on terms that meet the test of equivalence. This could be achieved either through the legislation for new developments or through the insertion of a requirement in the licence conditions (Chapter 10).

Product and price specifications should be regulated to meet the standards of NBN policy under the supervision of the ACCC. Nevertheless, the product specifications may

[19] Crozier, R 2010, 'Telstra Velocity fibre network remains closed shop', *itNews*, 15 February, viewed 16 February 2010 <http://www.itnews.com.au/News/167270,telstra-velocity-fibre-network-remains-closed-shop.aspx>

differ from NBN Co's and the active equipment used may not enable integration with the NBN. Rather than this meaning NBN Co would need to completely overbuild in such an estate, flexibility can be preserved by imposing a dark-fibre unbundling requirement on these third-party networks. With access to dark fibre, NBN Co will have the option of installing its own active equipment, enabling it to offer its national, wholesale service.

To enable unbundling to dark fibre, greenfield fibre providers should be required to deploy a home-run fibre topology under the national FTTP design standards. As discussed in Chapter 4, a home-run fibre topology is the best way of ensuring that the network can be unbundled to provide dark fibre services, provided that it is affordable. The biggest cost in providing home-run fibre is the creation of sufficiently large ducts—the additional cost of providing these ducts in greenfield developments is minimal. Hence requiring the installation of home-run fibre in greenfields is the best option for ensuring that these areas will receive wholesale services consistent with the rest of the NBN. The pathway to unbundling is described further in Chapter 10, and once the topology for the full network has been determined, Greenfield requirements should be aligned.

Recommendation 15. That the national FTTP standards require that the topology deployed in new developments be home-run and not shared; that this requirement be reviewed in conjunction with the broader review of topologies to be completed by the earlier of:

1. Coverage of 15 percent of premises within the proposed fibre footprint;
2. 31 December 2013.

Therefore, as NBN Co enters an area already covered by a third party FTTP network, to maximise the reuse of third party greenfield networks where possible, it should follow the sequence laid out in the recommendation below. Where the premises are adequately served, NBN Co may consider acquiring the local access network on a commercial basis.

Recommendation 16. That NBN Co overbuild third party FTTP networks that do not comply with the FTTP design standards; that, where a deployment does comply with the FTTP design standards established by Government, NBN Co may:

1. Apply to ACMA to have the premises declared 'adequately served';
2. Attempt to secure access from the network owner that would allow NBN Co to offer wholesale services over the network;
3. Overbuild the network where NBN Co is unable to secure necessary access and the premises are not declared 'adequately served'.

Telstra has suggested that where an FTTP network is deployed in a greenfields area, the USO be transferred to the operator of that network[20]. This issue should be part of a broader review of USO legislation. The current USO regulations give the universal

[20] Telstra 2009, *Submission to DBCDE's FTTP in greenfield estates consultation process*

service provider flexibility as to the technology platform used to deliver USO services. To ensure consistency with NBN Co architecture, the national FTTP standards should require that all FTTP networks deployed in new developments be capable of providing voice services. As these networks would be open-access, it would be open to the USO provider to provide standard telephone services over the FTTP network using wholesale services.

Minimising the cost of subsequently providing fibre where it is not deployed upfront

New developments that are not required, and elect not, to deploy fibre will be provided a standard telephone service by Telstra under the USO. This is likely to include developments smaller than the threshold contemplated by the legislation and also those where no commercial provider including NBN Co is willing to provide a service on commercial terms in these developments. One reason for this could be the lack of competitive backhaul to the area making the economics for an independent access network unviable.

These new areas served by copper when initially built during the roll-out period, but which fall within the future fibre footprint, will nonetheless later be overbuilt by NBN Co as part of its broader retrofit of copper areas. Government can take steps today to minimise the cost of this retrofit by requiring that any trenches dug and any duct, pit and pipe infrastructure deployed at the time of the new build be designed to provide sufficient space to allow for the retrofit with FTTP infrastructure.

This will greatly reduce the costs of NBN Co in retrofitting the area and reduce the time and disruption required to provide FTTP coverage to the estate. The additional cost to greenfield developers of complying with this regulation would be small, as the infrastructure currently deployed to house the copper network would require only minor adjustments to be suitable for fibre retrofit.

The requirement will differ depending on the type of development. For example, in the case of a brownfield development where a single new premises is constructed after subdividing a suburban block, the requirement should be to lay sufficient duct and pipe from the property boundary to the wall of the premises. Since no development occurs along the street, the requirement should not extend to deploying ducts, pits or pipes beyond the premises boundary.

Government should require all new developments served by copper to provide sufficient space for a fibre retrofit in this manner. Since the exact extent of the future fibre footprint will not be known at the outset, this means that some new developments that fall outside the fibre coverage areas will be future-proofed in this way even though they are not overbuilt with fibre as part of NBN Co's roll-out to achieve its FTTP coverage objective. This approach is still preferred however, since the number of premises falling into this category is expected to be small, and having the capacity to retrofit with fibre increases the chances of expanding the footprint further, should Government decide to do so.

Finally, an exemption should be considered for premises which are so remote that no fixed-line telecommunications infrastructure is installed at the time of build (e.g. those premises where Telstra chooses to fulfil its USO obligations through alternative technologies such as concentrated radio or satellite telephone). For these premises, requiring duct, pit and pipe infrastructure to be built is unnecessary as they are unlikely to be retrofitted with FTTP.

Recommendation 17. That all new developments where fixed telecommunications infrastructure is deployed be required to provide a duct, pit and pipe network with sufficient additional capacity to allow for an FTTP deployment by NBN Co; that this infrastructure be provided at the developer's expense—an exemption being made for new premises where no fixed-line telecommunications infrastructure is installed.

It is important that compliance with the requirement to install duct, pit and pipe infrastructure be assessed while the services trenches in a new development are still open. If not, there is a risk that non-compliance may only be identified when NBN Co comes to use the ducts in a development and finds them absent. In such circumstances, NBN Co should have the right to seek compensation from the developer for the additional costs it will incur. NBN Co should establish a team that provides a point of contact for developers seeking advice on how to comply with the requirement and undertakes site visits to verify that new developments have installed the required duct, pit and pipe infrastructure.

Advice. That the NBN Co Board ensure the company establishes a team that provides advice to developers on the necessary steps for complying with the requirement to install duct, pit and pipe infrastructure and to undertake site visits to verify that the correct duct, pit and pipe infrastructure is installed.

Finally, where new internal wiring is installed in new premises, it should be done to enable fibre-based services to operate effectively. The speeds that can be realised by an end user are affected by the medium over which data is transferred from the ONT or residential gateway to other devices in the home. If low-grade copper wiring is installed in a house in the fibre footprint, the performance the home is able to access will be constrained. The FTTP design standards should include a requirement that internal wiring installed in new premises be capable of high-speed data transfer (e.g. CAT 5 or CAT 6 cables).

Recommendation 18. That the national FTTP design standards include a requirement, to come into effect after a sufficient notice period, that internal wiring installed in all new premises be of a standard that allows high-speed data transfer, e.g. CAT 5 or CAT 6.

2.1.5 MONITORING NBN CO'S PROGRESS

There are two key measures of progress that should be tracked for NBN Co. The first is how many premises have been covered by the end-user premises network. The second is whether it has provided access in non-competitive backhaul markets. Government needs to establish clear mechanisms by which it can monitor NBN Co's progress against achieving these objectives so that it can assess whether its policy objectives are being achieved at an adequate pace and respond to any issues.

Maintaining a Coverage Register

To ensure transparency into the company's progress in meeting its coverage requirement for the high-speed customer access network, Government should require NBN Co to maintain an NBN Coverage Register. The Coverage Register would be a register of all premises in Australia, with each premises identified by its specific geographical location data. NBN Co should record those premises it has covered with its customer access networks and those that remain to be covered. Exhibit 2–17 describes some example categories that Government may wish to include on the register.

The coverage register should be made publicly available, subject to a review of compliance with privacy obligations. By doing so, Government ensures that there is an audit trail for NBN Co's activities. If premises are mistakenly listed as covered when the owner is in fact unable to access NBN services, it will be possible for the end user to request a correction. Publicity will also protect NBN Co from undue criticism, because end users who could not be covered for some reason of frustration can clearly see the reasons that they are not able to access NBN services. Identification of frustrated premises should also encourage MDUs to facilitate connection as it could be expected to impact real estate value.

The register could also be the basis for advising service providers on the premises that have been covered by the NBN at any point in time, for the purposes of marketing retail services. Similarly the Register could be used to create an online tool that end users can use to determine whether NBN services are available in their area. For example, in Singapore, the company responsible for the roll-out of the country's national FTTP broadband network provides a Coverage Check portal on its home page (www.opennet.com.sg), allowing home owners to check availability of FTTP services in their area by entering their post code or by registering for an alert when fibre does reach their area or building.

Exhibit 2–17. Example categories that may be included in the NBN Coverage Register

Category	Description
Total estimated premises	Estimate of all premises in Australia.
Covered by competitive markets	Premises in areas where it is determined that the services provided by the market satisfy Government's objectives.

Covered by NBN Co FTTP customer access network	Premises for which a fibre distribution terminal (FDT) has been provided.
Covered via community-funded extension	Premises for which a fibre distribution terminal (FDT) has been provided as a community-funded extension of FTTP.
Covered by NBN fixed-wireless access network	Premises within a defined distance from a NBN fixed-wireless base station provided by fixed-wireless provider.
Covered by NBN Co satellite access network	Premises within the range of NBN Co's satellite beam.
Coverage not possible due to frustration	Premises to which NBN Co has made reasonable attempts to deploy its customer access network but has been frustrated in doing so. NBN Co should be required to list how the coverage attempt for premises has been frustrated. Examples: ■ Access denied ■ Local authority has not granted planning permission
Estimated premises remaining to be covered	Total premises less those covered by an NBN customer access networks or served by competitors. Premises that have been frustrated will be removed from this total.

Source: Industry interviews

Recommendation 19. That a register (the NBN Coverage Register) be maintained of all premises in Australia; that the register meet the following requirements:

1. Be publicly available through mechanisms approved by Government;
2. List premises in specific categories that detail the coverage status of each premises;
3. Be updated at regular intervals;
4. Identify premises with specific geographical location data.

Measuring progress on backhaul

As discussed in Subsection 2.1.1 and Chapter 6, NBN Co should intervene selectively in the backhaul market by providing transit backhaul capacity to points where competitive backhaul is available. A list of monopoly routes should be identified by the ACCC and NBN Co should report on which of these routes it has secured access to and offered services on. The backhaul routes register should be made accessible to NBN Co's wholesale customers.

Recommendation 20. That a register be maintained of all monopoly transit backhaul routes between NBN Co's proposed fibre exchanges and POIs, on which NBN Co intends to build or purchase capacity; that NBN Co be required to update this register as it secures access to and offers services over each backhaul route; that the backhaul register be made accessible to wholesale customers of NBN Co.

Verifying progress

NBN Co should be required to detail in its annual report the progress it has made in rolling out its high-speed customer access network and in providing backhaul services on monopoly backhaul routes. Government should require NBN Co to include in these progress reports detailed information on the amount that NBN Co has spent to carry out its mandate. As part of this reporting process, NBN Co should arrange for an independent audit of its progress, which would be appended to the annual report.

In addition to these annual reports, NBN Co should provide such interim progress reports as Government requires.

Recommendation 21. That NBN Co be required to deliver in its annual report detail of its progress towards meeting its coverage objective, expenditure incurred in doing so and provide such interim progress reports as Government requires and are reasonable.

2.2 Creating a platform to meet future needs

The NBN is a long-term investment that will create a platform to support a vibrant telecommunications sector in Australia for decades to come. The network should therefore be capable of supporting the necessary industry structure and competition outcomes. This has several important implications.

First, NBN Co should secure long-term access to bottleneck assets in the network and offer them on an equivalent basis to access seekers. If these bottlenecks re-emerge, for example, if NBN Co were unable to renegotiate a dark-fibre contract for a backhaul link, then competition outcomes will not be achieved.

Second, the network should be built to accommodate service innovation and growth in bandwidth demands. The majority of the cost for deploying the network will be from civil works—for example the digging of trenches, installation of splitter cabinets and creation of fibre exchanges. The life of the assets created will be far longer than any reasonable attempt to predict future usage or technology, so flexibility is paramount. By ensuring that the physical aspects of the network have sufficient excess capacity and flexibility, NBN Co can avoid repeating costly civil works to upgrade or retrofit the network in the future. The choice of FTTP is an important future-proofing measure, because optical fibre can support huge increases in bandwidth by upgrading the electronics only. Where new ducts and access points are created, these should be accessible and have spare capacity to allow for future expansion.

Third, existing HFC networks should only be used as part of the NBN on an interim basis, due to challenges with providing both near-term services compatible with the rest of the fibre footprint, as well as providing a clear upgrade path consistent with fibre performance.

Finally, the choice of fibre architecture will be critical to enabling long-term innovation and competition on the network. Specifically, to ensure vibrant competition at the active layer (the electronics which send signals down the fibre and hence control bandwidth), the design of the fibre topology should anticipate the need to unbundle the physical fibres and allow competitive providers to introduce their own electronics. This topic is discussed in greater detail in Part C. This move towards unbundling should take place prior to the privatisation of NBN Co, to minimise the risk of anti-competitive actions by a privatised monopoly access provider.

2.2.1 Securing rights to essential network assets

2.2.2 Providing for usage growth and service innovation

2.2.3 Limiting HFC to an interim solution only

2.2.1 SECURING RIGHTS TO ESSENTIAL NETWORK ASSETS

To ensure a level playing field for service providers and encourage market entry, NBN Co should facilitate open access to bottleneck assets.

NBN Co could secure access to bottleneck assets through various means. It could construct the asset, as it will for its FTTP customer access network. It could also acquire assets, as may be an option in the case of existing greenfield FTTP networks. In both these cases, NBN Co's ownership of the bottleneck asset will ensure its ability to offer wholesale access to service providers.

NBN Co may also be presented with commercial offers to access bottleneck assets through leases. Consider the case of securing access to dark fibre on a backhaul link. A carrier may be willing to lease access to NBN Co for the purposes of providing transit services to a fibre exchange, but wish to retain ownership of the link for the purposes of serving its mobile network.

Relying on a lease to secure access to a bottleneck asset could present a problem for NBN Co if the lease is of insufficient duration. At the time that the lease expires there will be difficult renegotiation of access terms and conditions. NBN Co would need to bargain for access to an asset that was now essential to its operations, with little negotiating power. If NBN Co chooses to use a lease to secure access to a bottleneck asset, it should therefore ensure that it this lease is of sufficient duration to ensure confidence in the long-term viability of the network. In particular, NBN Co should have a preference for indefeasible rights of use.

> **Advice.** That the NBN Co Board ensure that where possible the company's operations are based on managing access to physical assets over which it has indefeasible or long-term rights of use. This may involve legal ownership of the physical asset, or arrangements that guarantee access to the asset for its lifetime or over long time spans. Limited access arrangements should only be used where NBN Co is confident that at the time the arrangement is concluded, renewal of the access rights or a substitute asset will be available for NBN Co to maintain continuity of services over its network.

2.2.2 PROVIDING FOR USAGE GROWTH AND SERVICE INNOVATION

Since many of the components of the NBN could last for a generation or more, it is important that the network is planned in a manner that maximises its ability to meet the long-term needs of the country. In 1960, when the national telephone numbering system was proposed in the Community Telephone Plan for Australia, the numbering system was designed to cater for a projected 2010 population of 33 million people—this at a time when the national population was approximately 10 million. The population projection was deliberately weighted 'on the liberal side' to ensure that the country would not run short of telephone numbers prematurely.[21]

A similar degree of foresight as was shown in 1960 needs to be exercised in the planning of the NBN. Over the life of the NBN, the demands on the network are likely to increase due to population growth, increasing penetration of high-speed broadband and the emergence of new services and business models.

Planning for growth in activations

The network needs to be built to accommodate growing demand for activations. Increasing demand for activations could be driven by three factors:

- **Increasing number of premises.** As it is proposed that NBN Co will act as the network provider of last resort in areas where it has deployed its network, it will need to design its network to accommodate new premises constructed within its network footprint.
- **Increasing penetration of fixed broadband.** As fixed broadband penetration increases, premises which previously did not have a fixed service may request one. Currently, broadband penetration is approximately 62 percent, suggesting there is room for further growth in take-up.
- **Increasing number of activations per premises.** It is foreseeable that premises begin to request multiple NBN activations to meet their increasing connectivity needs.

The steps that need to be taken to provide for increasing numbers of connections differs for the different networks that NBN Co will be operating. For the FTTP network, it will require the over-provisioning of fibre exchanges, splitters and the distribution network to ensure new connections can be supported without having to undertake an expensive retrofit of the central elements of the network.

In the non-fibre footprint, satellite services should be provisioned to anticipate growth in demand over their likely lifetime, and similarly, the tender for a fixed-wireless network provider described in Chapter 5 should stipulate a requirement to cater for expected growth in premises within the coverage area. For example, satellites selected should be able to provide for growth in demand over their likely lifetime, and the launch of replacement satellites with greater capacity should be planned to minimise lags in providing sufficient services to end users. For both satellite and wireless networks, the greater degree to which the network capacity is shared between end users means they must be designed to allow for growth in activations and growth in bandwidth demand.

[21] Director General Posts and Telegraphs 1960, *Community Telephone Plan for Australia 1960*, Canberra

Planning for growth in end-user bandwidth demands

Not only will the NBN need to be designed to accommodate new activations, it needs to be designed to accommodate the increasing bandwidth being used by end users over their connections. The amount of data downloaded each year in Australia is increasing dramatically. The average amount of data downloaded from an Internet connection in Australia grew by 58 percent per annum from 2004 to 2009 (Chapter 3).

By allowing Australians to experience superfast broadband speeds, and by enabling the development of new high-bandwidth services, the NBN is likely to accelerate the growth in demand for bandwidth amongst Australian Internet subscribers. For example, in industry interviews conducted by the Implementation Study it has been suggested that by increasing the availability of enterprise-grade broadband products in the Australian market, the NBN is likely to stimulate greater take-up of these products by the SME segment.

In selecting fibre-to-the-premises (FTTP) as the preferred technology for providing high-speed broadband connections to premises, Government has ensured that the majority of the network will have the capacity to be upgraded successively in response to increasing bandwidth demands. A single optical fibre has the potential for massive increases in speed and capacity through the upgrade of electronics at either end. To ensure that the NBN keeps pace with growing bandwidth demand, NBN Co should plan to upgrade these active electronics (Chapter 10).

Installation of equipment within end-user premises should be designed to accommodate future growth. For example, within the fibre footprint ONTs should be designed so that they can be easily upgraded. Similarly, wireless and satellite CPE have rapid innovation cycles and should be designed and installed in a manner that facilitates future upgrades.

To the extent that new in-home wiring is laid as part of the installation, it should be able to support the higher speeds available over the NBN. If in-home wiring is not upgraded, the speeds that can be obtained by end users may be limited. As outlined in Subsection 2.1.4, newly constructed premises should be required to have home wiring which supports high-speed data transfer within the premises.

Providing flexibility for future innovation

In addition to catering for likely increases in the number of activations and growth in the amount of bandwidth used over each connection, the network needs to be designed in a manner that provides flexibility for future innovation. Without doing so, innovation is likely to be stifled on the network and there is a risk that the network will be unable to support cutting-edge services offered internationally. To support innovation, the design of the NBN should anticipate that innovation can occur along a number of dimensions, including the physical layer of the network, the end-user devices connected to the network and services offered across the network, which is discussed further in Chapter 3.

Exhibit 2–18. Examples of high-speed broadband offers from HFC network operators

HFC network operator	Offers
Cablevision (US)	101 Mbps download and 15 Mbps upload. Other services: Digital television, voice
J:COM (Japan)	160 Mbps download and 10 Mbps upload. Other services: Digital television, voice
ZON Multimedia (Portugal)	200 Mbps download and 10 Mbps upload. Other services: Digital television, voice
Virgin (UK)	50 Mbps download, upload speed not advertised. Launched customer trial involving 100 end users in May 2009 for a service with download speeds of up to 200 Mbps.[a] Other services: Digital television, voice

a. Barnett, E 2009, 'Virgin launches 200 Mb broadband customer pilot scheme in Kent', *Daily Telegraph*, 6 May

Source: Implementation Study

2.2.3 LIMITING HFC TO AN INTERIM SOLUTION ONLY

Approximately 2.6 million premises in Australia are currently able to obtain services from HFC networks.[22] In many countries, HFC networks compete effectively with FTTP networks to provide customers with high-speed broadband (Exhibit 2–18). These international examples demonstrate that it is possible to achieve download speeds in excess of 100 Mbps over HFC networks and to deliver voice and television services.

In Australia, Telstra recently announced the completion of the upgrade to its HFC network and now estimates that almost one million households in Melbourne will be able to access download speeds of up to 100 Mbps and upload speeds of up to 2 Mbps.[23] Telstra has also signalled plans for further upgrades to its HFC that could enable download speeds of up to 200 Mbps.[24] However, at present it is unclear to what extent the Telstra upgrade will extend to other cities.[25]

Today, Telstra's network delivers download speeds of up to 30 Mbps and upload speeds up to 1 Mbps for homes in Sydney and download speeds of up to 17 Mbps and upload speeds of up to 256 kbps to homes outside Sydney and Melbourne.[26]

22 Australian Communications and Media Authority 2009, *Communications report 2008–09*, Canberra

23 Bingemann, M 2009, 'Telstra completes HFC upgrade', *Australian*, 19 November

24 Telstra, *Telstra unveils super-fast cable broadband*, media release, Sydney, 10 March 2009

25 Oakes, D 2009, 'Upgrade halt puts Telstra in for NBN role', *Age*, 21 October

26 Telstra, *Telstra unveils super-fast cable broadband*, 10 March 2009

Optus has also announced an upgrade to its HFC network to DOCSIS 3.0, and indicated its intention to offer speeds up to 100 Mbps by the middle of 2010.[27] The Optus network offers download speeds of up to 20 Mbps across its network and upload speeds of up to 512 kbps.[28]

International examples and the upgrade of local networks demonstrate that it is possible to deliver services with peak download speeds that meet Government's performance objectives. This raises the prospect that an HFC network could be used to provide NBN coverage to a significant proportion of the country. This could be done either by:

- NBN Co acquiring either full ownership or an indefeasible right of use for one of either Telstra's or Optus' HFC networks, or a combination;
- An HFC network owner designating the network an open-access network and meeting the requirements for an ACMA declaration that the premises it covers are adequately served.

However there are challenges that must be overcome if HFC networks are to be used to deliver NBN services:

- HFC networks have not historically been designed to offer wholesale open-access. While this is viewed as technically possible and is being pursued in Denmark and the Netherlands, the technology solution has not yet been proven in the field;
- While HFC networks are capable of high connection speeds, a download speed of 100 Mbps on HFC is not equivalent to a speed of 100 Mbps on an FTTP network. Due to typically higher rates of contention on HFC networks, end users are likely to experience lower average speeds on HFC than on fibre. HFC also generally offers lower upload speeds than fibre;
- HFC does not have sufficient capabilities to deliver the types of enterprise-grade products that can be delivered over point-to-point fibre connections. To serve these customers, NBN Co would still need to deploy a fibre network in areas where HFC serves residential customers;
- HFC networks may struggle to keep pace with upgrades to the fibre network, particularly in the long term;
- There are challenges in unbundling an HFC network, particularly when it has not been designed with that purpose in mind.

Further detail on these challenges is provided in Exhibit 2–19.

27 Crozier, R 2010, 'Optus to boost HFC network up to 100 Mbps', *itNews*, 9 February, viewed 10 February 2010, <http://www.itnews.com.au/News/166775,optus-to-boost-hfc-network-up-to-100- Mbps.aspx>

28 Whirlpool 2010, *Broadband choice: OptusNet*, viewed 15 February 2010, <http://bc.whirlpool.net.au/bc/isp-3/optusnet.htm>

The challenges of maintaining upgrades in line with FTTP and the difficulty of unbundling on HFC networks however, suggest that NBN Co would need to overbuild HFC networks by the end of the roll-out to provide for future growth. Notwithstanding these points, to the extent that NBN Co can demonstrate that the use of HFC to deliver services will be cost effective in achieving interim coverage sooner, Government should consider permitting its use as part of the NBN technology.

> **Recommendation 22.** That NBN Co be permitted to use HFC networks as an interim technology, provided that these networks are capable of providing wholesale open-access services; that NBN Co be required to plan and establish a construction schedule to achieve its FTTP coverage objective by the end of its roll-out, regardless of coverage of HFC networks.

Exhibit 2–19. Challenges to using HFC networks to provide NBN coverage

Challenge	Details
Upgrading to meet service requirements in fibre	To meet the performance requirements outlined by the Government for the NBN's FTTP footprint, the HFC networks will need to be upgraded. This will include node splits and upgrade to DOCSIS 3.0. Even with these upgrades, the upload speeds available over HFC are likely to be significantly lower than those available over FTTP. For example, while Telstra's DOCSIS 3.0 upgrade in Melbourne will deliver download speeds of up to 100 Mbps, upload speeds will only be up to 2 Mbps. In the case of Telstra's HFC network, a further upgrade would be required to enable voice services, which it is not currently capable of delivering.
Converting HFC to a ubiquitous platform for an area	HFC networks share bandwidth between end users connected to a node in the HFC network. For this reason performance is influenced by take-up—as more users connect to a node in the HFC network, contention for the bandwidth available on a node increases. Where take-up rates are higher, a greater number of node splits may need to occur to ensure performance for end users. In most markets, HFC is a competitive entrant in broadband —it is difficult to find examples where it is used as the platform for serving all customers in an area. To support higher levels of penetration, a greater investment in the upgrade of the HFC networks will be required.
Catering for business premises	Even with upgrades, HFC networks may not be a sufficient solution to deliver products that business demands due to the lower maximum and guaranteed speeds and greater asymmetry compared to FTTP networks. Cable companies have had limited success in serving business customers overseas. If HFC were used to achieve NBN coverage, NBN Co would likely still need to roll-out FTTP to provide business users with higher specification products. This occurs today when enterprise customers are provided with point-to-point FTTP solutions even though residential customers in the same area only have access to DSL technologies. However NBN Co is likely to aim to roll-out a greater proportion of point-to-point enterprise and connections than currently exist in the market. The incremental cost of

	providing these connections where the whole area is served with fibre is much lower than the cost where residential premises are served by HFC.
Providing open-access wholesale services over HFC	Expert interviews suggest that there should be no reason why an HFC network could not be used as a wholesale open-access network through either bandwidth allocation or channel allocation. However, traditionally cable modems have not been designed to support multiple operators in the home, although such solutions are currently under development. There are currently no international examples of a wholesale open-access HFC network. However in 2009, both the Dutch and Danish Governments announced they would require cable companies to provide wholesale services to competitors.[a] Dutch cable operators Ziggo and UPC are due to offer access to their analogue cable service at prices set by the regulator OPTA in March 2010.
Filling coverage gaps	There are significant gaps in the coverage of HFC networks. The Telstra network is unable to serve about 2 percent of houses within its coverage area.[b] The Optus network has more gaps with 36 percent of houses within its coverage area unserviceable.[c] Optus claims that its coverage gap is comprised of MDUs, distance and heritage overlays.[d] Any solution that relies on the HFC networks would require these gaps to be filled. Filling these gaps may require the rolling of additional coaxial cable to pass streets and connect homes. Alternatively there are solutions which can deliver cable electronics over optical fibre connections to premises.
Managing an uncertain future upgrade path	Fibre has the potential for massive increases in bandwidth and capacity through new electronics. Growth in bandwidth usage in future could lead to customer requirements outstripping the capabilities of HFC networks. While FTTP architecture is a superior technology for serving growing upstream and downstream bandwidth, there is sufficient capacity within HFC technology to provide services that deliver an equivalent experience for residential customers in the medium term through upgrade to DOCSIS 3.0. Node splits can be performed so that fewer customers are served per node, increasing the average speed and capacity for each customer. The life of existing HFC networks may also be extended by improvements in video encoding, reducing the bandwidth demands on the network. Recognition of the greater future-proofing characteristics of FTTP has led the international cable industry to develop a standard that allows cable technology to be delivered on an FTTP network, removing the constraints of the coaxial last mile.

a. European Commission, Commission clears Dutch regulator OPTA's proposal to enhance competition in the broadcasting markets, media release, Brussels, 11 February 2009; Commission endorses new Danish rules to open wholesale access to cable broadband, media release, Brussels, 12 March 2009

b. Ergas, H 2008, Wrong Number: Resolving Australia's Telecommunications Impasse, Allen & Unwin, Sydney

c. ACMA 2008, Communications Report 2007–08

d. ACCC 2008, Telstra’s exemption application in respect of the Optus HFC network, Canberra

Source: Implementation Study

2.3 Ensuring affordability and encouraging take-up

Government has a policy objective to provide access to broadband to all Australians at an affordable price.

Two aspects of affordability are relevant. First, services need to be offered at affordable prices to drive take-up of broadband. Second, a person's ability to access broadband services should not be dependent on where they live. Currently, the accessibility and affordability of broadband varies significantly across the country. The impact of this is that the quality of broadband offers and hence broadband penetration is lower in more remote areas of Australia.

NBN Co's wholesale services will comprise the majority of service provider costs. Therefore NBN Co will have significant influence over the retail prices that end users pay through the prices it charges service providers for its wholesale access and transit services. By setting its wholesale prices at a level that encourages take-up across the country, NBN Co can enable service providers to deliver affordable broadband throughout Australia.

By creating a competitive retail market across the country the NBN initiative will help ensure that affordable wholesale prices translate through to affordable retail prices. While there are other components required to deliver retail broadband services that are beyond the control of NBN Co (e.g. international backhaul capacity), these represent a relatively small component of the per-customer cost of delivering connectivity.

NBN Co should focus on rapid take-up. Higher penetration means that the costs associated with the construction, maintenance and operation of the shared elements of the network are distributed between a greater number of end users, reducing the average cost of providing services.

> *Failure to achieve scale in connections will lead to a high-cost operation which will not be commercially sustainable and will not provide the economic benefits the government desires.*
>
> Ericsson (2009)[29]

2.3.1 Pricing to encourage take-up and usage

2.3.2 Providing affordable prices across the country

[29] Ericsson 2009, *Submission to New Zealand Government Broadband Investment Initiative*

2.3.1 PRICING TO ENCOURAGE TAKE-UP AND USAGE

NBN Co should bias towards achieving take-up rather than maximising revenue. Government's investment in the NBN is directed at increasing the access to and availability of high-speed broadband. If services offered over the network are too expensive for end users then the services cannot be considered reasonably available.

There are two take-up considerations that should guide pricing:

- **Stimulating greater household penetration of broadband services.** An affordable price for entry level products can help stimulate greater Internet penetration by bringing Internet services within the reach of a greater number of households.
- **Stimulating take-up of higher speed services by households that already have broadband.** By enabling higher speeds to be delivered for similar prices as lower speed products today, the NBN should stimulate the take-up of faster broadband speeds across the country.

It is difficult to assess what households would consider to be an affordable price for a service delivered over the NBN. The reason for this is that many end users have not yet experienced the kind of broadband speeds and services the NBN will enable. Chapter 3 recommends that NBN Co's prices should enable service providers to offer an entry level product to end users that is comparable in price to an entry-level DSL product but offers significantly faster speeds than the top level ADSL2+ product.

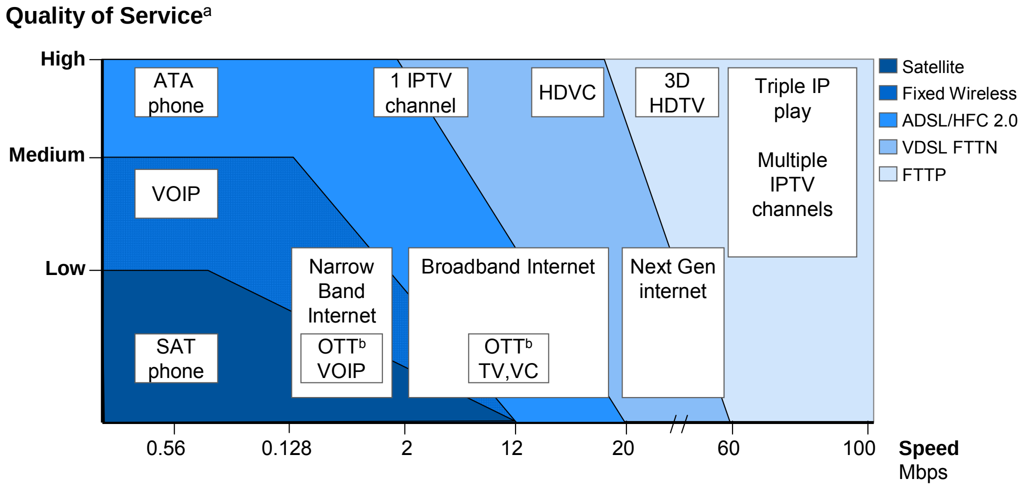
Policies targeted at ensuring reasonable affordability of services across the country should be distinguished from policies that are directed at providing broadband to low-income households. The need for and shape of policies directed at providing broadband to low-income households is a matter for Government beyond the scope of the Implementation Study.

> **Recommendation 23.** That NBN Co be directed to set wholesale prices and offer migration incentives with the objective of achieving broadband take-up targets that Government sets at regular intervals and in accordance with the applicable regulatory pricing regime.

2.3.2 PROVIDING AFFORDABLE PRICES ACROSS THE COUNTRY

A fundamental principle underlying Government's NBN initiative is that a person's ability to access broadband services should not be dependent on where they live. Providing affordable access to telecommunications and broadband services across Australia has long been a challenge for policy-makers. The wholesale pricing of NBN Co should provide a powerful tool for ensuring broadband is affordable for Australians no matter where they live.

Exhibit 2–20. Capabilities of broadband access technologies



a. Comprises (1) Sustainability of data rate. In shared networks, such as wireless, data rate is not guaranteed but distributed on best effort principle. Hence, quality of service drops as data rate increases to indicate the contention of these networks. (2) Latency, i.e. the time data takes to travel through the network. High latency is highly noticeable in voice, gaming and security enabled services. Satellite networks are extremely susceptible to latency and this caps quality of service.
b. Over The Top
SOURCE: Implementation Study

Recognising the different capabilities of access network technologies

The NBN will use multiple access technologies to deliver broadband services across Australia. Setting uniform prices (i.e. charging the same price for the same service) across the entire country is not feasible because the technologies are unable to provide the same service. In particular, FTTP is capable of much higher speeds than wireless and satellite.

Wireless and satellite also have higher latency meaning that even when the same download speed is offered on these technologies as on FTTP, the user experience can be very different.

Exhibit 2–20 portrays technical capabilities of different technologies based on data rates and quality of service. Technologies that have a higher data rate and quality of service are able to support a greater range of applications. Importantly, FTTP is able to support a number of applications that satellite and wireless cannot. It is therefore not meaningful to discuss the provision of identical services at the same price over different access technologies.

In addition, the cost for providing services is different for each technology platform. This is particularly relevant in the case of future upgrades to technology. For example, it is far cheaper to double the download speed over fibre than it is to double the download speeds over satellite. To provide NBN Co with an ongoing incentive to fund network upgrades, NBN Co must be able to reflect differences in the costs to upgrade different technologies in its prices.

Within the footprint of an access technology, Government should require uniform wholesale pricing for all access products as the same services can be enabled across the platform. It is also worth noting that the amount of additional revenue that is likely to be realised from charging higher prices for services in more remote areas is limited, since increased prices will harm take-up levels.

Recommendation 24. That NBN Co be permitted to apply differentiated wholesale pricing for each technology platform used in its customer access network; that, within each technology platform, uniform wholesale pricing be required for all access products.

Ensuring affordable entry-level prices for access products across the country

While NBN Co will have different product and price offerings for each access technology platform, entry level products in each access technology should be priced at a similar level of affordability. This adheres with the principle that a person's access to broadband services should not be dependent on where they live.

Recommendation 25. That the entry-level services offered over each technology platform in NBN Co's customer access network be available to end users at a comparable but not necessarily identical price; that the same performance specifications of entry level services on different technology platforms not be required.

Reducing regional backhaul costs

Even if NBN Co charges uniform wholesale prices for the access network, its services are not the only inputs to a retail service, and some of these other input costs are also expected to vary regionally. A major driver of variation in price across geography is the cost of providing backhaul. There are some parts of the country where a significant retail price increase would result from cost-based pricing of backhaul.

The backhaul routes where this would have the greatest impact on retail prices are typically the same routes for which NBN Co will be providing a transit backhaul service. By pricing its transit service at affordable levels, NBN Co can reduce the impact of backhaul costs on the retail prices of services in regional and rural Australia.

Where NBN Co does provide transit backhaul, it should be priced separately from access services. It is important to retain the connection between infrastructure cost and associated service pricing to preserve market signals and enable future investment in backhaul infrastructure. To strike a balance between this consideration and the Government's affordability objective, The Implementation Study recommends that NBN Co, supported by any necessary Government action, set a maximum price of backhaul for given contention rates. The mechanisms for achieving this are explored in greater depth in Chapter 6.

2.4 Managing a smooth transition from today's services and networks

Various telecommunications services, including Internet and telephone services, currently operate over the copper customer access network (CAN). These services are provided to millions of customers and are critical to public wellbeing. Providing such essential telecommunication services is part of the mandatory obligations for Telstra and other carriers.

Maximising customer take-up will be vital to the success of the NBN and can only be achieved by minimising customer disruption during the transition to NBN services. In addition to new services, customers must be confident that existing services will be maintained. This means ensuring continuity of essential services such as emergency calls and tele-health. Additionally, existing equipment should be used where possible to avoid customer retraining and the extra cost of replacement equipment. Installation should also be smooth, with minimum time spent at the premises.

Existing services will be less affected by the roll-out of the NBN so long as Telstra continues to operate the copper CAN. However, if Telstra elects to deactivate the copper service—either because it becomes uneconomic to operate or it strikes a deal with NBN Co to migrate its traffic to fibre—then the NBN will become the only fixed-line communications infrastructure available to deliver these services (including to non-premises).

> *End-user migrations processes must provide a good customer experience, protect against inappropriate sales and marketing activities … and ensure that end users are able to take informed decisions. A process which meets these objectives will give citizen/consumers the confidence to switch and therefore benefit from competition.*
>
> BT (2009)[30]

In the event that copper is decommissioned, managing a smooth migration will be pivotal. The migration of telecommunications services from the copper CAN to the optical fibre NBN will be a complex process and must be managed well. The customer migration experience will initially be a measure of the success of the NBN policy implementation.

This section focuses on the actions for Government to take to ensure there is an effective migration process and continuity for existing services in the future.

2.4.1 Enabling existing services on the NBN

2.4.2 Addressing the needs of security and law enforcement agencies

2.4.3 Planning for copper decommissioning

2.4.4 Reviewing carrier and carriage service provider obligations.

[30] BT 2009, *Response to Ofcom's consultation document: Next generation networks*

2.4.1 ENABLING EXISTING SERVICES ON THE NBN

There are a wide variety of services delivered over today's copper network. In deciding which of these should be supported by the NBN, a balance should be struck between

- Coverage and demand from end users;
- Importance of the service in maintaining public order and wellbeing;
- Cost and complexity of transitioning these services onto the NBN;
- Natural upgrade cycle for equipment and software.

After considering these tradeoffs, The Implementation Study recommends that the NBN should be built to support three specific capabilities in addition to the services described in Chapter 3: PSTN emulation; customer location identification; and lifeline communications to customers identified as having a special requirement by Government.

Minimising need to replace copper network customer premises equipment

Many services still operate using plain old telephone services (POTS), including existing PSTN handsets, fax machines, tele-health devices and disability telecommunications equipment. Emulation through an analogue telephone adaptor (ATA) built into an ONT would allow users to keep using most devices.[31] Consequently, customer disruption is minimised as no end-user equipment retraining is required and installation within the premises does not require significant rewiring.

POTS emulation also costs less than alternative migration paths by avoiding the need to replace equipment and rewire premises. If emulation is adopted, no incremental funding is required to replace expensive equipment. Additionally, POTS emulation would avoid the need to rewire premises with CAT 5 cable for certain devices, which would require skilled labour.

It is possible that POTS emulation may not be compatible with a small percentage of legacy devices and these would need to be replaced by the consumer or retail service providers, depending on existing ownership arrangements.

> **Recommendation 26.** That NBN Co be required to provide industry standard PSTN emulation at the ONT on all connections to its FTTP access network and bear the associated network costs.

31 Industry interviews

Offering lifeline functionality in case of power outages

Existing copper lines provide power to traditional wire-connected handsets allowing them to continue operating during a power outage. This allows emergency calls to be made on such devices during power outages if users are in distress.

Optical fibre does not carry electricity. If devices connected to the FTTP network require electric power to operate they must be connected to the electricity network or have an alternative power supply. In the event of a network power outage, these devices will only continue working if they have a backup source of power. To ensure functionality even during electricity outages, it is possible to provide battery backup for these devices.

Lifeline functionality is not available to all telephone customers today. For example, cordless telephones used by many residential and business customers generally need to be connected to the electricity network to function. If there is a power outage, cordless telephones will not be able to make or receive telephone calls even though they are connected to the copper telephone network.

An alternative way to make emergency calls is on mobile phones, which are now at a penetration of 115 percent in Australia and currently account for over 60 percent of all emergency calls.[32] Furthermore, only 4 percent of Australians claim they need a fixed-line telephone service for emergency call purposes.[33]

Providing battery back-up for all 11 million fixed-line voice subscribers in Australia would cost an additional $90–150 million each year. This estimate is based on a high-quality sealed lead acid battery, which costs approximately $40 and has an operational life of 3–5 years.[34]

Furthermore, providing batteries universally would involve disposing of approximately 2–4 million batteries annually. This could cause an environmental hazard if the toxic lead-acid batteries used are not recycled or disposed of safely. If a battery backup approach is pursued, NBN Co should explore available technologies to reduce the cost of the solution—for example, batteries that automatically enter standby mode unless a call is in progress, which reduces the required battery size to provide a given duration of coverage in a power failure.

Given the cost, disposal issues and mobile phone prevalence in households, the Implementation Study considers NBN Co should not be required to provide battery back-up to all Australians. However, NBN Co should provide a power supply unit (PSU) with the option to insert a back-up battery for all FTTP customers.

[32] Ovum 2009, *Australia mobile market statistics and tracker 1H09*

[33] ACMA 2009, *Convergence and communications*, vol. 1, *Australian household consumers' take-up and use of voice communication services*, Canberra

[34] Company websites of battery suppliers and retailers (including Century, Panasonic, Enersys, Farnell, Radio Shack)

If the customer wishes to insert a battery into the slot, then they would be responsible for the battery cost, installation, maintenance and disposal.

Government should establish a program for subsidising the provision of back-up batteries for end users that Government identifies as requiring lifeline services at the time that those customers migrate from the copper network to the NBN. End users that might be subsidised under such a program could include those with special reliance on lifeline communications due to health issues.

Whether an end user requests a back-up battery voluntarily or is provided one by Government under its subsidy scheme, the distribution, installation and ongoing maintenance of the batteries should not be NBN Co's responsibility. NBN Co's wholesale-only nature means that it will not have a relationship with or the necessary information relating to end users that would be required to administer the provision of these batteries. Instead the back-up battery distribution would more suitably be undertaken by service providers, who have a direct relationship with end users.

Recommendation 27. That NBN Co be required to provide an ONT power supply unit to all FTTP customers with the potential for a back-up battery to be installed; that Government establish a program for subsidising the provision of back-up batteries for end users that Government identifies as requiring lifeline services at the time that those customers migrate from the copper network to the NBN—with the distribution and maintenance of batteries to be undertaken by retail service providers; that beyond these identified end users, provision of a battery be the choice of the end user and supply and maintenance be the responsibility of the end user.

Highlight. Given the adoption of cordless phones and the increasing number of premises that do not have a fixed telephone—neither of which will be addressed by providing battery back-up on NBN Co ONTs—Government may wish to consider alternative ways of ensuring access to emergency services during power outages. One potential option would be to provide a '000' mobile handset to premises which is able to operate across the networks of all wireless carriers and is kept permanently charged. Such a program should be funded and administered by Government as a social service program and not be the responsibility of NBN Co.

Enabling end-user location identification

At present, emergency call operators, receiving calls over Telstra's copper network, can automatically identify the location of a caller. This significantly improves the response process during emergencies. It is especially important when the caller cannot audibly communicate their location during the emergency call.

Retail service providers are currently required to provide the emergency call operator with the phone number of the caller. The phone number allows the emergency call operator to access the location details in the emergency call service database. Retail service providers are also responsible for entering a new customer's information into the

Integrated Public Number Database (IPND), which is the source of customer location details for the emergency call service.

International experience has demonstrated that this location functionality can be provided over an FTTP network, either by using media access control (MAC) addresses on the ONT or static IP addresses associated with the handset.[35] To enable this on the NBN, the existing regulations regarding the IPND would continue and NBN Co would need to ensure that the service providers can access the information they require regarding customers on its FTTP network to comply with these obligations.

> **Recommendation 28.** That NBN Co be required to support retail service providers' ability to provide end-user location information including the enablement of emergency call operators to automatically locate a caller.

2.4.2 ADDRESSING THE NEEDS OF SECURITY AND LAW ENFORCEMENT AGENCIES

In designing its network, NBN Co should consult with Commonwealth security and law enforcement agencies to understand the associated national security threats and risks and to develop appropriate strategies to mitigate those risks.

Given the NBN will become part of Australia's critical infrastructure, it is important that the NBN is adequately protected and provides reliable and secure services with appropriate levels of redundancy and resilience.

NBN Co should cooperate with Commonwealth security and law enforcement agencies to identify risks and develop mitigation strategies for the security and resilience of the network. Examples include:

- Redundancy in connections to critical end users including hospitals, utilities and other essential services;
- Appropriate protocols to minimise the impact of a potential fibre access network outage;
- Mechanisms to ensure continuity of voice services and other essential services, especially to those with special needs;
- Robust control systems limiting access by service providers to prevent unauthorised access to NBN control systems, and to maintain the confidentiality and integrity of information traversing the NBN;
- Robust security mechanisms to prevent electronic attacks for denial of service;

[35] Industry interviews

- Protocols on shared fibre systems to ensure end users can only access data addressed to their specific premises;
- Appropriate controls around secure storage of data by NBN Co and supply chain security, especially vendors supplying equipment and services supporting the NBN;
- Consideration of the impact of the NBN on issues related to cyber security.

The network design should also ensure adequate provision of equipment and capability to meet legislative requirements such as the *Telecommunications* (*Interception and Access) Act* 1979.

> **Advice:** That the NBN Co Board ensure the company engages with national security and law enforcement agencies to ensure the network design provides reliable and secure services with appropriate levels of redundancy and resilience.

2.4.3 PLANNING FOR COPPER DECOMMISSIONING

Providing lead time to transition off copper

The advent of the NBN is likely to hasten the retirement of the copper network, so it is appropriate that Government consider measures to minimise end-user inconvenience through the copper shutdown.

The primary basis for a notice period is to allow retailers and end users to deploy new solutions, which may be complex and require significant resources. There are likely to be lead times for new equipment, and organisational constraints that prevent early action (for example, budgets may not be allocated to migration efforts until a definite shutdown date is announced).

> *NGNs should enable evolution and innovation, and while emulation may have a part to play, NGN operators should not be obliged to design their networks so that all legacy equipment continues to work, no matter how old or obsolescent.*
>
> BT (2009)[36]

Only a limited number of end users will have additional costs associated with transitioning off the copper network when it is shutdown as POTS emulation—recommended above—should support most existing devices. Furthermore, during the migration period, there should be growth in the IP-enabled technology market, providing opportunities for customers to naturally upgrade their equipment. As a result, end users should bear the costs associated with transitioning their current services, which is consistent with previous telecommunications network upgrades.

> **Recommendation 29.** That a minimum public notice period be required for deactivating any copper exchange; in this context 'deactivating' would mean the withdrawal of a significant proportion of copper services.

36 BT 2009, *Response to Ofcom's consultation document: Next generation networks*

There is a precedent for enacting such measures. Several countries have declared a notice period prior to altering or switching off legacy infrastructure. There is no consensus on the length of this period, with timeframes varying from 1 to 5 years.[37]

Maintaining copper voice service beyond the fibre footprint

Once deployment of the NBN fibre network is completed, there will remain a set of end users who fall outside the fibre footprint who have copper connections. If it retains the voice USO, Telstra will need to choose whether to continue to supply voice services to these end users over its remaining copper network or by other means, such as wireless.

Telstra has over 99 percent mobile voice coverage today, and with the advent of 4G technologies such as LTE, the quality and reach of its coverage is expected to improve further, to reach 70 km or more from a tower location. The large and increasing share of total voice usage captured by mobile telephones demonstrates that for many users wireless is already an acceptable substitute for fixed-line voice services.

Even with an expanded footprint enabled by 4G radios, a small number of premises will remain that cannot be served by a wireless network, however. Providing voice to these premises remains challenging for the industry. Telstra fulfils its USO obligation for many of these premises today with long copper loops, except for around 20,000 premises where fixed radio solutions are deployed, and an even smaller number where voice is delivered via satellite. As the industry transitions to the NBN, either Telstra will retain the USO for these premises or Government will need to find an alternative USO bearer, as discussed in Section 2.4.4. In either case, a mix of technologies such as those described above will continue to need to be deployed for the foreseeable future.

2.4.4 REVIEWING CARRIER AND CARRIAGE SERVICE PROVIDER OBLIGATIONS

As a vertically-integrated provider, Telstra bears responsibility for end-to-end service delivery of the USO to all its end users. In a future market structure where NBN Co owns the only remaining access network serving most premises, network services will be separated from retail services. Treatment of the USO will need to be re-examined in the context of such a market evolution.

NBN Co's objective of covering 100 percent of premises will form a de facto 'wholesale broadband USO', which may be converted into a binding obligation once network roll-out is complete. However, even with NBN wholesale services available, availability of retail services is not guaranteed. NBN Co has wholesale obligations that do not and should not extend to the provision of retail services. Cases where retail services are

[37] ERG – Report on Next Generation Access 2009; International experts

unavailable should be rare, as NBN services will be designed to enable viable retail business models. However, given the unacceptability of such a situation, some form of retail voice USO will need to be retained even after completion of the NBN.

Preparing a review of Telstra obligations

The coverage objectives of NBN Co will support the availability of network infrastructure across the country. However, NBN Co, as a wholesale-only operator, cannot replace the role of Telstra as the retail service provider of last resort.

Government will need to review the state of retail service competition in markets across the country to determine the best policy response for ensuring that end users in all areas of the country have a service provider willing to offer them service. While a detailed examination of this topic is beyond the scope of the Implementation Study, in light of Government's intention to hold a subsequent review, Exhibit 2–21 outlines several options that Government may consider to achieve this.

Exhibit 2–21. Options for providing retail services after USO transition

Category	Description
Telstra retains the USO	Telstra would be free to fulfil the obligation using NBN wholesale services. Assuming that NBN wholesale services are priced appropriately, Telstra's net liability should decline significantly over time. Outside the fibre footprint, under the current USO, Telstra would be required to offer voice services over copper, the fixed-wireless network where available, or any other available technology satisfying the obligation.
Reallocate USO through a tender process	At such time as the nature of the retail USO liability can be estimated, Government could seek offers to provide those services within a reasonable subsidy.
Create a new entity to be retailer of last resort	Government creates a new entity that acts as retailer of last resort in situations where no other service provider will provide service.

Source: Industry interviews

Government will have to consider how to transition a range of existing carrier obligations contained in licence conditions, the *Telecommunications Act 1997* and other legislation, including:

- Standard telephone services and payphones must be reasonably accessible to all Australians on an equitable basis as per the USO outlined in the *Telecommunications (Consumer Protection and Service Standards) Act 1999*. A standard telephone service is defined as a voice telephony service that allows customers to communicate with each other on the same service;

- Disability telecommunications devices. Carriers who provide a standard telephone service must also provide telecommunications equipment for customers with disabilities, as outlined in Part 1 of the *Telecommunications (Consumer Protection and Service Standards) Act 1999* and the *Disability Discrimination Act 1992* requires it. Telstra, as the only universal service provider, is currently obliged to provide equipment through its Disability Equipment Program;
- Emergency call services. All carriers and carriage service providers must provide emergency call services free of charge as outlined in the *Telecommunications (Emergency Call Service) Determination 2002*;
- Integrated public number database (IPND). An industry wide database of telephone numbers and certain details, currently managed by Telstra as part of their *Carrier Licence Conditions (Telstra Corporation Limited) Declaration 1997*;
- Other existing carrier and carriage service provider obligations may also require adaptation or removal, depending on their relevance within the new market structure.

Recommendation 30. That a review be undertaken to determine how the universal service regime and other carrier and service provider obligations may apply to NBN Co and other carriers and service providers; that this review be completed by the end of 2011.

2.5 Aligning NBN Co operations with stakeholder needs

As custodian of Australia's principal broadband platform, NBN Co must consider the needs of consumers, business, public institutions, service providers, suppliers and many adjacent industries. The capacity of the NBN to serve the national interest through the economic and social benefits associated with its services will be correlated with responsiveness to stakeholder needs. This Section outlines the priorities of relevant stakeholder groups and suggests how Government and NBN Co should align with them.

This topic is explored in these parts:

2.5.1 Operating to serve needs of end users

2.5.2 Operating to serve needs of retail service providers

2.5.3 Operating to serve needs of content and application service providers

2.5.4 Operating to serve needs of suppliers, employees, and partners

2.5.5 Instilling operating principles to ensure stakeholders' interests are served

2.5.6 Balancing commerciality with Government guidance on policy.

2.5.1 OPERATING TO SERVE NEEDS OF END USERS

As a wholesale-only operator, NBN Co is not intended to directly serve end users, and in general will rely on retail service providers to understand the demands of the market. However NBN Co should still be cognisant of their needs, for example:

- Understanding the home user experience during installation;
- Identifying needs outside those served by traditional service providers (e.g. smart grids);
- Developing wholesale propositions and prices to ensure end users have access to the range of services they require.

End users can be divided into four distinct segments, which differ in scale and needs, as shown in Exhibit 2–22.

Exhibit 2–22. Estimated fixed-line market revenues by segment

Segment	Subscribers	Annual retail revenue ($ billion)	Annual revenue per subscriber ($)
Consumer	9,000,000[a]	9.0	1,000
Small Business	700,000[b]	4.0	6,000
Enterprise	3,000[c]	4.0	1,300,000
Public Institutions	12,000[d]	2.0	160,000

[a] Estimate of residential premises as at 2009 (Department of Families, Housing, Community Services and Indigenous Affairs 2009, *State of Supply Report 2008*, National Housing Supply Council, Canberra)

[b] Estimate of businesses with less than 200 employees (ABS 2009, *Business Use of Information Technology 2007–08*, cat. no. 8129.0)

[c] Estimate of businesses with greater than 200 employees (Ibid.)

[d] Includes federal, state and local government units and government schools, universities, TAFEs (ABS 2004, *Government Technology 2002–03*, cat. no. 8119.0, Canberra)

Note: Revenue estimates indicative, based on company and analyst reports. It is difficult to disaggregate industry revenues into unambiguous segments and product lines due to differences in operators' definitions.

Source: ABS, Buddecomm, company reports

Residential consumers

As Exhibit 2–22 shows, residential consumers are the largest segment to receive retail services over the NBN. Their interests will centre on availability and pricing of fast broadband, voice and new entertainment services. They are likely to be highly price sensitive and concerned about the physical process of network changeover—trenching, home entry, ONT installation—which should be reflected in NBN Co's planning and operating procedures.

The Implementation Study assesses the requirements and revenue opportunities of the consumer segment in some detail, as it:

- Will comprise the bulk of NBN revenues;
- Has the lowest penetration of fibre, so offers the greatest opportunity to improve the speed of services;
- Requires careful tuning of price points.

Small businesses

There are approximately 700,000 small businesses in Australia. While fewer in number than residential consumers, small businesses are much more valuable on a per line basis, with an estimated average revenue per user of $6,000 per year compared with $1,000 for residential consumers. For these end users, fibre connectivity is a productivity enabler, and they are prepared to pay higher amounts if the NBN can support business performance tools and reliability that justify the costs in economic terms. NBN Co should consider the future needs of these users in its network design and operations. For example, the increasing shift towards the use of e-business tools amongst small business could mean that there is increasing demand for enterprise-grade products such as point-to-point connections,[38] with implications for fibre provisioning in the network.

The Implementation Study assesses the small business segment as another part of the 'mass market', albeit with different revenues and product requirements to consumers. They are included in all revenue and cost modelling.

Corporate and large private institutions

The complex ICT requirements of corporate and large private institutions have driven the roll-out of FTTP networks in areas such as CBDs and business parks, with many of these end users enjoying the benefits of infrastructure-based competition. Many already have access to fibre—typically with 'point-to-point' services. The market is complex, pricing is opaque, and the nature and intensity of competition vary significantly by location. In some areas, wholesale access is available on multiple fibre networks, while some locations are served by a single vertically-integrated provider.

It is important that the capabilities of the NBN be made available to Australia's large enterprises, to the extent that they are inadequately served by existing services. However, it is difficult to develop a detailed view of the commercial opportunities for NBN Co in this market. For this reason, while an estimate of the costs of connecting enterprise premises has been included, the modelling takes a very conservative approach to including revenue.

Public institutions

A significant element of Government's rationale for NBN roll-out is its potential for digital delivery of government and social services such as health and education. The institutions that deliver these services have a wide range of requirements for connectivity.

[38] Industry interviews

The Implementation Study specifically addresses future broadband needs for ‘e-government’ services in Chapter 3, and discusses the role of the NBN in meeting those needs.

2.5.2 OPERATING TO SERVE NEEDS OF RETAIL SERVICE PROVIDERS

NBN Co’s customers can broadly be considered ‘service providers’. They will likely range in size from niche small businesses offering specialised applications, to Telstra, the largest telecommunications company in Australia. Today, the market for wholesale network elements—such as ULL—is comprised mainly of carriers and service providers. In the future, many other businesses may choose to exploit NBN wholesale services to deliver content, applications, or services.

Fixed-line telecommunications carriers

The majority of industry revenues are captured by ‘carriers’—integrated providers who operate network equipment and provide services such as calling and data carriage. The two major fixed-line carriers in Australia are Telstra and Optus, who together account for 91 percent of fixed-voice and access revenues.[39]

Currently, both Telstra and Optus operate access and backhaul networks, and use these to deliver retail services. The NBN will therefore constitute both a potential supplier to their retail operations, and as a competitor against elements of their fixed-line infrastructure. A significant challenge for NBN Co is to provide sufficient incentive for these providers to migrate services onto the NBN.

ISPs

ISPs are broadband providers who focus primarily on providing Internet connectivity. Many have evolved from their beginnings as dial-up providers to offer fixed-voice and broadband across multiple access platforms. There has been a trend for ISPs to move away from providing applications and content over time—for example, email is shifting from ISPs to webmail services such as Gmail and Yahoo!. However, ISPs will continue to play an important role in the NBN ecosystem, leveraging their expertise in customer and network management.

While NBN Co will initially supply Layer 2 services over its access network and bottleneck backhaul links, its customers will need to coordinate network elements to deliver connectivity to users. Retailers must balance customer satisfaction with network capacity, and decide where and how to invest in new capacity. Customer support for broadband is a substantial burden—ISPs regularly receive customer complaint calls about

[39] Buddecomm 2008, *Australia – telecoms industry – fixed & mobile statistics*

broadband performance where the cause of the problem is the customer's own computer. There are also significant costs in customer acquisition and OSS/BSS.

The business model that will characterise successful ISPs in the future remains uncertain. It is possible that they will derive profits by playing a role in services, such as IPTV. Alternatively, they may come to resemble utility resellers, primarily billing and managing basic service issues of moves, adds, and service changes. The NBN should be designed to enable either of these possible outcomes.

Mobile carriers

There are three major mobile operators in Australia—Telstra, VHA, and Optus. They are competing aggressively in mobile broadband, driving strong growth in data traffic across their networks. As these data volumes grow, they will require increased backhaul capacity, and are likely to seek to use the NBN fibre network as backhaul where competitively-priced links are unavailable today.

In addition, mobile carriers are exploring the prospects of selling fixed-line services. They have large customer bases, established OSS and BSS systems and substantial marketing and sales capability, so they are well placed to sell fixed-line services. The availability of high quality wholesale services over the NBN may prompt mobile providers to expand their fixed-line operations. Internationally, Vodafone has already built a substantial business offering DSL services over ULL. For example, in New Zealand, Vodafone installed DSLAMs in all 40 exchanges in Auckland within the first year of the local loop unbundling regime in New Zealand. It has plans to extend its Red Network to other cities in New Zealand and has signed a wholesale agreement with retailer Slingshot, which resells Red Network services.[40]

2.5.3 OPERATING TO SERVE NEEDS OF CONTENT AND APPLICATION SERVICE PROVIDERS

Currently, most mass-market applications are delivered 'over the top', via the Internet. Application Service Providers (ASPs), as defined for the purposes of this report, are those application providers whose services cannot be adequately delivered over an Internet connection. They exist widely in the corporate and business segments—for example, secure banking information networks—but are largely nascent in the mass market.

There is speculation in the industry that a mass-market ASP sector may emerge with appropriate Layer 3 service availability. The Implementation Study believes that wholesale Layer 3 services are likely to emerge (Chapter 9) and that these services should develop in a way that supports the provision of services by ASPs across the NBN.

[40] Buddecomm 2010, *Vodafone New Zealand Ltd*

Television companies

There are three commercial free-to-air operators, two government-owned free-to-air operators and two commercial pay TV providers in Australia. As major content providers, television operators could look to play an increasing role in the provision of high-quality web-based content over the NBN or use their strength in content and national brands to expand into new businesses enabled by the NBN.

The NBN offers a new distribution platform for television services. Free-to-air is delivered mainly over terrestrial broadcast towers. Pay TV is delivered through a combination of HFC and satellite. Fibre-to-the-premises networks are already used to distribute both free-to-air and pay TV content in some greenfield estates. Chapter 3 provides a detailed discussion of how video and television services should be delivered over the NBN.

Internet-delivered applications and content

Currently a range of providers deliver their applications and content services over-the-top (OTT) of an Internet connection. These OTT providers may exploit the increased bandwidth of FTTP networks to enable enhanced services, or may seek to move to an ASP delivery model on the NBN to allow them to provide higher quality of service applications and 'always on' connectivity.

2.5.4 OPERATING TO SERVE NEEDS OF SUPPLIERS, EMPLOYEES, AND PARTNERS

The roll-out of the NBN network will be one of the largest infrastructure projects ever seen in Australia. Construction is planned to take place over 8 years, and beyond the roll-out there will be an ongoing industry created to provide the equipment and labour for operating and maintaining the network.

The scale of the project means that NBN Co will need to coordinate a wide network of vendors, contractors, employees and wholesale customers to deliver the network and ensure the prompt delivery of services to end users.

In establishing its operating model for achieving the network roll-out, NBN Co's first priority should be to achieve the coverage objective of Government within the planned roll-out schedule and funding parameters. However, NBN Co should also be sensitive to the impact that its entry in the market will have on the industry.

The NBN roll-out will transform the telecommunications network construction and maintenance industry in Australia. As such, it is appropriate for NBN Co to consult with industry, government and labour groups. NBN Co will need to work with these groups to ensure that it can attract the large workforce of skilled labour it will need to construct, operate and maintain its network as well as to develop and manage its products, pricing, marketing and customer relationships.

In practice attracting the workforce it needs to achieve the roll-out of the network will require NBN Co to deploy a mix of employees and contract labour. The existing contractor industry has the capacity to provide a range of services relevant to the design, planning, management and construction of the NBN, and this industry will develop to meet NBN Co's demand. Using contractors can help NBN Co access capabilities quickly while managing its fluctuating and geographically mobile requirements for labour during the roll-out period. However, there will also be the need for NBN Co to establish a significant body of in-house employees.

The scale of the project means that opportunities will be created for a range of contractors, from global equipment vendors to SMEs. There will be significant opportunities for Australian businesses, large and small, and because of the national extent of the roll-out, these opportunities will present themselves in all parts of the country. It is in the interests of NBN Co to consult with local businesses prior to roll-out in each area to assess the availability of relevant skilled labour required for deployment and ongoing maintenance of the network.

While the Australian workforce already has significant skills in a range of areas that NBN Co needs, there are likely to be shortfalls in some skilled labour sets (e.g. fibre splicing). Specialised labour such as this can take time to build and NBN Co should, from the start of the roll-out, be proactive in planning to meet its skill requirements for the lifetime of the roll-out. NBN Co should work with trade unions, the education and training sector and Government to align relevant Government programs with the skills required to effect the roll-out.

NBN Co should conduct a rigorous procurement process in choosing the vendors that will supply the equipment and IT systems which will comprise the network, balancing thoroughness against the constraints of its schedule and bearing in mind the substantial long-term implications of its decisions. Managing the supply chain for equipment is essential to preventing delays to the roll-out. NBN Co should quickly establish relationships with suppliers and vendors to enable their early involvement as partners in planning the design and scheduling of the roll-out. NBN Co has already commenced this process, issuing requests for expressions of interest to suppliers of network equipment and OSS/BSS platforms. While many of the vendors will be major international providers, there will be a need to establish local vendor production facilities to reduce supply chain risk. Through this and through the establishment of an NBN facilities such as an integration laboratory, there is the potential to develop Australian capabilities in the sector.

2.5.5 INSTILLING OPERATING PRINCIPLES TO ENSURE STAKEHOLDERS' INTERESTS ARE SERVED

It is important that NBN Co establish a culture of consultation with its stakeholders. NBN Co will not always be able to satisfy the priorities of all stakeholders on all issues, but it should adopt practices which engender trust, respect, and understanding across the industry.

It is appropriate that NBN Co formulate practices for achieving this level of standing in the industry. As demonstrated by Telecom NZ's Wholesale business over the past three years, it is possible for a wholesale provider to create its own strong culture that is well received by the industry (Exhibit 2–23).

> **Recommendation 31.** That NBN Co be directed to develop a Charter that outlines how it will conduct its affairs to best meet the needs of stakeholder groups—for example, the Charter should state a commitment to consultation with the industry and end-user groups.

The charter should incorporate a commitment to transparency, which is a powerful mechanism for ensuring NBN Co serves the interests of its diverse stakeholder group. For example, publishing the coverage status of premises will allow end users and retailers to know when services are available to a given household, and therefore when they can offer or receive services. Similarly, releasing regular product roadmaps will allow small and large retailers alike to anticipate the opportunity to deploy new products.

Availability of information will enhance the quality of industry and regulator engagement. The telecommunications industry is complex and dynamic, and it is difficult to manage the evolution of regulatory regimes in response to changing conditions. Regulators around the world observe that information asymmetry is a major challenge in administering and developing the regulatory framework.

Although these measures may go beyond what is common practice amongst privately held providers today, they can be maintained through privatisation. Once the requirements and norms for transparency are well-established and potentially codified in binding form, future private investors will accept these as pre-existing factors bearing on their investment. This will represent a significant improvement from today's industry norms, in which large infrastructure operators are reluctant to disclose information relating to their assets.

Specific recommendations throughout this report will propose mechanisms to reinforce these principles. Chapter 10 contains specific considerations with respect to competition.

Exhibit 2–23. Telecom New Zealand Wholesale Charter

Categorising new premises as fibre or non-fibre

The New Zealand government announced functional separation of Telecom NZ in 2006. Telecom NZ offered to reorganise voluntarily into wholesale and retail. To ensure equality of access to unbundled network services, the government required further separation of the network assets (later named Chorus). Three-part functional separation took effect in 2008.

Telecom NZ's units must uphold the undertakings made with the government. Telecom NZ established an Independent Oversight Group (IOG) to report and advise on its compliance. Prior to separation, the company developed the Telecom Wholesale Charter to work collaboratively with wholesale customers and address end-user experience. Three principles guide customer interaction:

- Consistent end-user service between Telecom NZ retail and other customers
- Consistent Intermediate products between Telecom NZ retail and other customers
- Greater transparency and communication.[a]

The Charter does not legally bind Telecom Wholesale, but aims to establish healthy customer relationships.

The industry response has been positive to Telecom NZ's efforts to comply with the separation undertakings. Customers say that Telecom NZ Wholesale has shifted towards a more transparent and open culture. CallPlus CEO Martin Wylie said: 'I do think there has been a genuine attempt to start consulting and… to try and break the kind of stand-off mentality that had been there previously'.[b]

Telecom NZ Wholesale breached the equivalence of inputs principle in its separation undertakings in 2008 in offering a loyalty discount to wholesale customers. The company subsequently withdrew the offers. A Telecom NZ employee raised the matter through an Honesty Box installed to establish greater transparency. IOG reported that there had been 3800 submissions made by Telecom NZ employees.

a. Telecom NZ Wholesale 2006, *Telecom Wholesale Charter*

b. Hendery, S 2007, 'Next generation arrives on quiet', *NZ Herald*, 15 February

Source: Independent Oversight Group 2009, *IOG Annual Report 2009*

2.5.6 BALANCING COMMERCIALITY WITH GOVERNMENT GUIDANCE ON POLICY

NBN Co has been established to achieve a set of policy objectives, through a vehicle that can act in a commercially disciplined way, and eventually be privatised. This raises questions of governance. As shareholder, Government should strike a balance between directing the NBN to achieve various outcomes for the public good, and allowing independent management judgment to steer the company towards more commercial outcomes.

Government's chosen structure for NBN Co recognises the value of a Board and management team who strive to operate commercially, delivering greater efficiency, financial rigor, and decision-making based on sound economics. It is important that, to the extent possible, Government provide the policy outcomes and framework within which NBN Co should operate, and allow the management team to deliver those outcomes.

There are, however, issues in relation to which NBN Co may wish to seek guidance from Government. Chapter 11 discusses the challenges in accommodating the oversight and support required for NBN Co under approaches more typically applied to well-established GBEs.

3 Enabling a new generation of services

SUMMARY

- In the early years, the focus of the NBN will be on replacing copper infrastructure with fibre to serve current fixed-line demand for voice, Internet, and other broadband applications, over a faster and more open delivery platform.
- The initial NBN service set should be limited to Layer 2 wholesale services in the fibre access network, and should ensure that these services are specified in a way that enables other service providers to deliver sophisticated Layer 3 services such as IPTV. The NBN service set may also evolve to include passive fibre services.
- Longer term, the NBN will transform the end-user experience by enabling faster and richer services and supporting innovative applications and devices. To facilitate this, NBN Co should upgrade its Layer 2 active equipment over time, with reference to international benchmarks and industry standards.
- In the non-fibre footprint, wholesale services should be delivered at Layer 3, given the limitations of the access technologies deployed.
- Video delivery should be enabled primarily through bitstream services. RF services should only be offered where they support a multiple-operator platform but are not expected to be commercially attractive to NBN Co.
- The NBN will also provide a platform to support the delivery of new e-government applications and other public services such as smart infrastructure over broadband—although is only one element of an e-government capability

The NBN will need to serve and enable an evolving set of market needs. Today, fixed-line networks mainly deliver Internet connectivity, voice, and broadcast RF television. The NBN will initially serve these same needs, only better—with faster Internet, interactive on-demand IPTV and VoIP. Over time, the superior platform offered by the fibre access network will unlock new value-creating services and business models—for example, through direct delivery of applications, premium classes of service, and other innovations. It will also provide a platform for government e-services.

This chapter explores the expected needs of the market, and how the NBN can meet these needs through a portfolio of wholesale services. It is organised in four sections:

3.1 Meeting end users' evolving needs

3.2 Delivering wholesale services to meet end-user needs

3.3 Delivering video services over the NBN

3.4 Enabling future e-government capabilities.

3.1 Meeting end users' evolving needs

Communications services are rapidly evolving, with increasing demand for speed and performance. The NBN will serve existing market demand, while enabling a new generation of superfast services. This section outlines how the NBN will best meet these demands:

3.1.1 Serving current market demand

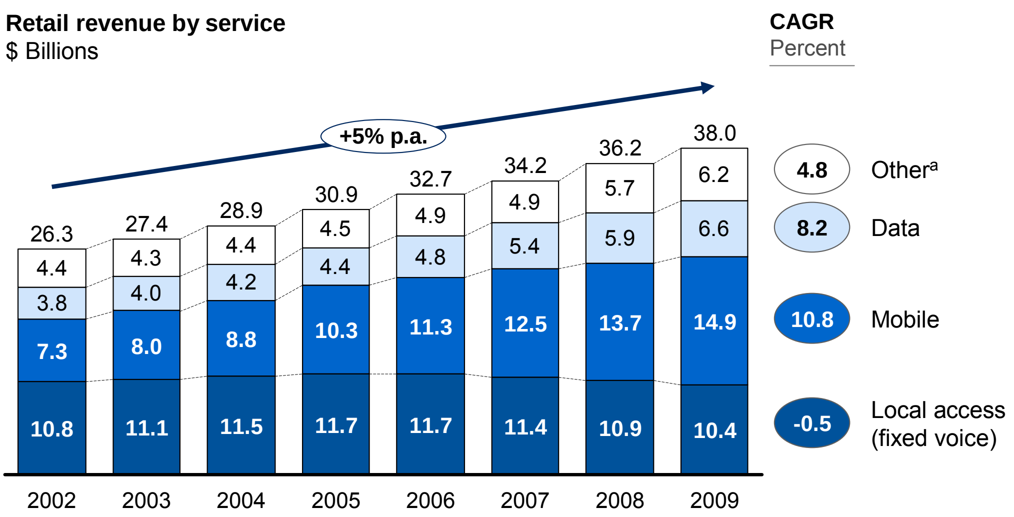
3.1.2 Facilitating a superfast broadband future.

3.1.1 SERVING CURRENT MARKET DEMAND

In the short term, the NBN will primarily serve current market demand. Despite offering a step-change in industry structure and network performance, the nature of this demand is unlikely to transform immediately. Demand for fixed-line services is driven by fixed-voice and broadband Internet (Exhibit 3–1). This section assesses the market requirements that the NBN will serve, now and in the future.

Exhibit 3–1 shows recent growth in retail revenues has been driven by mobile and fixed-broadband services. While fixed-voice revenues have declined, they still comprise approximately one-quarter of the revenue pool.

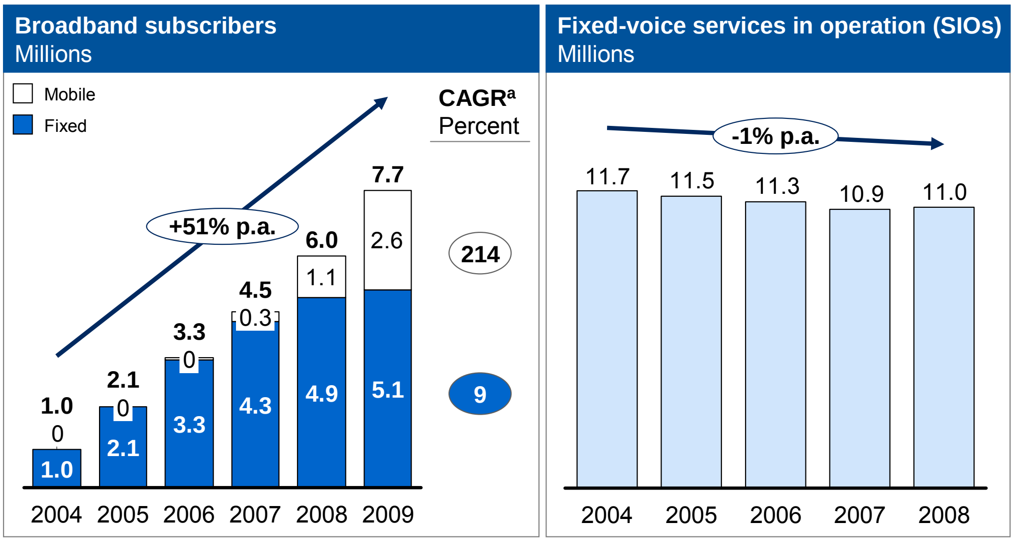
Exhibit 3–1. Retail telecommunications revenue by service



a. Includes: specialised data and IP access, business services and applications, online advertising and directories, pay TV, overseas activities and other minor items

SOURCE: Buddecom

Exhibit 3–2. Retail broadband and voice subscribers



a. 2007–09

SOURCE: J.P. Morgan 2009, *Australian Telecom Sector in FY09*; DBCDE 2009, *Statistical snapshot*

Increased broadband revenue has been driven by rapid growth in the number of broadband subscribers (Exhibit 3–2). Approximately 62 percent of households have a fixed broadband service.[41] This is still lower than many OECD countries, for example the Netherlands (83 percent), France (74 percent) and the UK (68 percent).[42] However, mobile broadband subscriptions have grown rapidly in the last three years, so actual broadband penetration is higher than fixed-only statistics.

Driving continued growth of fixed-line broadband Internet access

Once the NBN fibre network is widely deployed, it will establish fixed broadband as an essential service for households. From an end-user perspective, the NBN will address two factors currently limiting broadband in Australia: slow fixed-line data rates, and high costs for data usage.

The average broadband data rate in Australia is slow relative to other OECD countries. In a 2008 Information Technology and Innovation Foundation survey, Australia ranked 27th out of 30 countries for speed, with an average download data rate of 2 Mbps.[43] This is low compared to the US at 5 Mbps, the Netherlands at 9 Mbps and Japan at 64 Mbps.

41 Goldman Sachs JB Were 2009, *Telecommunications services: Revisions to industry forecasts to reflect shift to wireless*

42 J.P. Morgan 2009, *Australian telecom sector in FY09*

43 Information Technology and Innovation Foundation 2009, *2008 ITIF Broadband Rankings*

Exhibit 3–3. Fixed-line access technologies in Australia

Access medium	Active layer technology	Data rates, Mbps	Coverage, households	Contention of access medium	Data-rate variability
Copper	ADSL2+	< 20	92%	No	Significant—users 5 km from exchange may only receive 1 Mbps
HFC	DOCSIS 1.1	< 20	20%	Yes	Not significant
	DOCSIS 3.0	< 100	5%	Yes	Not significant
FTTP	GPON	100	1%	Yes, but with managed allocation	No

Source: ACMA 2009, *Communications Report 2008–09*; press reports

Fixed broadband in Australia (Exhibit 3–3) is delivered mostly by ADSL technology or over HFC cable. The combined coverage of superfast broadband, including Telstra's Melbourne DOCSIS 3.0 cable network and pockets of FTTP or FTTN, is only around 6 percent of premises.[44] This compares with markets in Europe and North America, where platforms delivering 50 Mbps or more—including FTTP, DOCSIS 3.0 cable and VDSL networks—are being deployed extensively. The fibre access network will offer a step change in data rates, without the variation or unmanaged contention of ADSL and cable. These increased data rates will be noticeable even for casual web users, and certainly for gamers and other high-bandwidth users.

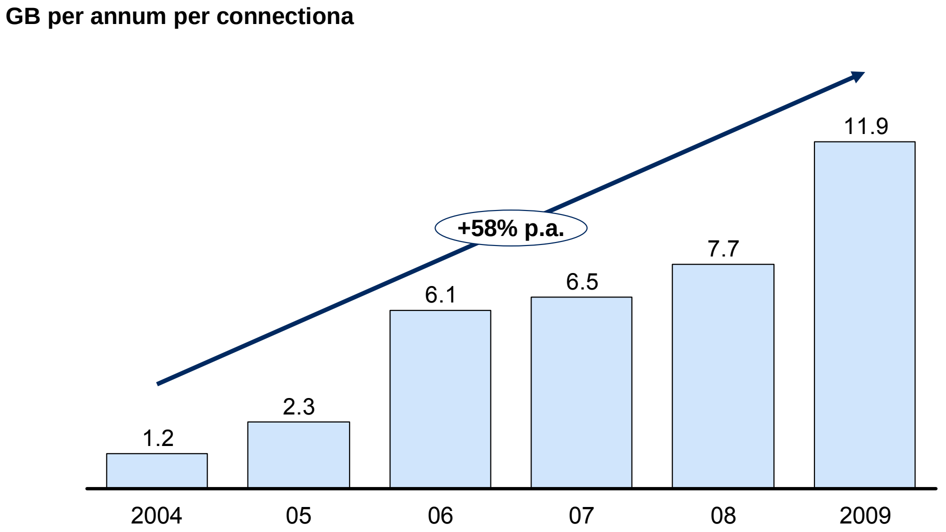
In areas without ADSL, users experience lower data rates and variable performance. Despite access to world-class mobile networks, such as Telstra's NextG HSPA service, there are gaps in coverage, limited choice of service providers, and variations in service performance.

Current access technologies will struggle to support continued growth in bandwidth requirements. The trend from 2004 to 2009 is 58 percent compound annual growth (Exhibit 3–4), however there is evidence that is accelerating—the ABS estimates that Australians downloaded 80 percent more data in the June quarter of 2009 compared to the same period in 2008.[45] Over-the-top (OTT) video services, for example YouTube, are one cause of the recent increase in broadband usage. ADSL can deliver these services in standard definition; however the user experience is often inconsistent. Some current

44 Telstra's DOCSIS 3.0 network in Melbourne currently covers 1 million homes (Telstra 2009, *Telstra unveils superfast cable broadband*)

45 Australian Bureau of Statistics 2009, *Internet activity, Australia, June 2009*, cat. no. 8153.0, Canberra

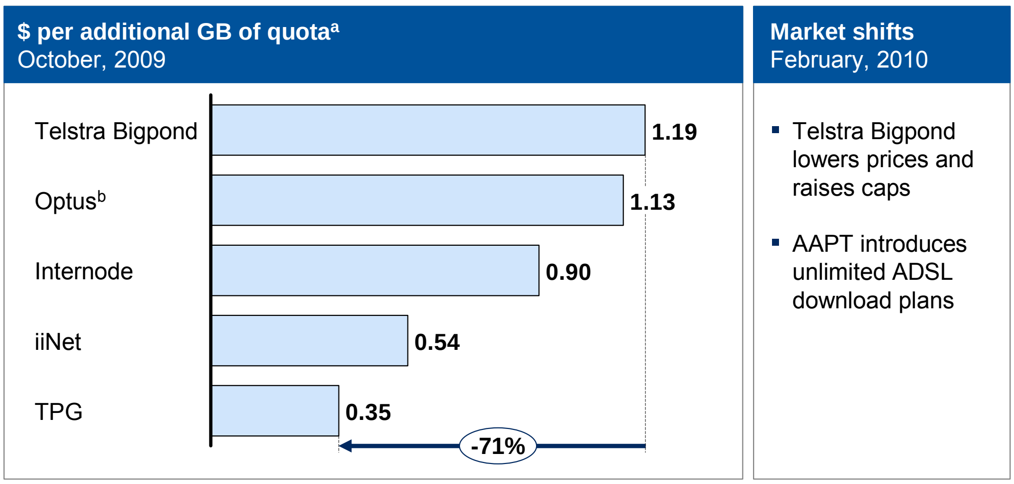
Exhibit 3–4. Growth in Internet usage per connection, Australia, 2004–09



a. Estimated from data downloaded and number of subscribers
SOURCE: ABS, *Internet Activity, Australia*, various releases 2004–09

wireless and satellite technologies are poorly suited to deliver video content at scale—due to limitations on the speed and capacity of data downloads over wireless and contention between users accessing wireless transmitters or satellite transponders simultaneously. The NBN will address the growth in bandwidth requirements through much higher data rates, and the implementation of efficient distribution functionality such as multicast.

Exhibit 3–5. Average marginal retail price of downloads



a. ADSL, ADSL2+, Naked ADSL2+ services (excludes Cable and Fibre). Marginal price calculated as price difference between adjacent download quotas within a service of the same specifications e.g. the retail price difference between Naked DSL 30GB and 50GB packages for iiNet
b. Naked ADSL prices only—other ADSL prices are affected by bundling with fixed line and/or mobile
SOURCE: Whirlpool 2009; Implementation Study

In addition to lacking superfast networks, broadband in Australia is also constrained by usage-based pricing. Broadband plans in Australia generally come with a monthly download cap. If users exceed their cap, they must either pay charges for additional data or have their download speed constrained or 'throttled'. Download caps are less common in other countries.[47] In Australia, many local providers face genuine costs for IP traffic—national backhaul, peering and international transit are all more expensive than in many other OECD markets. However, the range in usage pricing of different ISPs suggest that the prices charged by many providers are well above the level that would be explained by the cost of providing data downloads. (Exhibit 3–5).

> *SP Telemedia may introduce uncapped broadband offers if it acquires Pipe Networks*
>
> Telemedia Executive Chairman[46]

Market shifts in early 2010 confirm this view with ISPs such as Telstra, TPG and iiNet reducing download prices. Nevertheless, usage-based pricing continues to impact Australian content providers and end users. Demand for 'heavy' services is growing—usage per connection has increased significantly in recent years (Exhibit 3–4). Two factors drive this. First, standard Internet websites are becoming increasingly rich in content. For example, many websites are now embedded with videos or other interactive features. Second, users are consuming increasing quantities of data-rich services, such as video and music downloads.

The NBN will loosen usage constraints in several ways. Although ISPs will still face the cost of international capacity, the NBN's provision of transit services at affordable prices would directly reduce the cost of national backhaul. With respect to peering, increased retail competition can be expected to support development of exchange points and shared fabrics at a lower cost to service providers.

> **Highlight**. Current usage caps for fixed-line broadband packages in Australia are among the most restrictive in the world. Retail usage caps are likely to become less restrictive on the NBN due to increased backhaul affordability and greater retail competition.

Addressing the fixed-voice market

Despite sustained growth in fixed-line broadband, fixed-voice services are still an important revenue pool in telecommunications. In 2009, Australians spent just over $10 billion on fixed-voice services—equivalent to one-quarter of the industry revenue.[48]

[46] White, D 2009, 'Unlimited downloads in pipeline', *Australian Financial Review*, 18 November

[47] Organisation for Economic Co-operation and Development 2008, *OECD Broadband Portal*, viewed 16 February 2010 <http://www.oecd.org/sti/ict/broadband>

[48] Buddecomm 2009, *Australia: Internet, broadband and convergence statistics*

The fixed-voice market has declined in recent years, but will remain a substantial source of revenue and profit for the telecommunications industry. Penetration in Australia has declined nearly 3 percent per year since 2005 (Section 4.4). This decline has been driven by fixed-to-mobile substitution and the increasing use of VoIP at the expense of PSTN technology. Section 4.4 discusses both of these trends. Analysts differ in their expectations about the rate of continued decline in the fixed-voice revenue pool, but under any scenario, it will remain significant for some time.

The NBN should therefore consider voice functionality and pricing carefully in the development of its wholesale services. Failure to address this revenue pool could lead to significant leakage of industry value at both wholesale and retail levels. It would also alter consumer willingness to pay in a way that permanently affects the commerciality of NBN Co and its customers.

The typical approach for ensuring continuity of voice services and revenues in many international markets, as well as in Australian greenfield fibre deployments, is PSTN emulation at the ONT. This allows users to keep their existing phones and home wiring, significantly reducing barriers to migration to the NBN from legacy networks. However, retailers currently operating pure PSTN calling networks will need to develop new IP platforms to interconnect with these services. A broader issue exists regarding the future of interconnect between carriers in an all-IP world, but this primarily concerns core network operators and is therefore beyond the NBN's ambit.

Advice. That the NBN Co Board recognise the value of fixed-voice revenue for sustainable retail models in the way it develops and prices its services and manages migration onto the network, for example by providing PSTN emulation on the ONT.

Enterprise-grade fibre services

It is critical that fit for purpose access and other wholesale products are available to support the specific needs of enterprise customers. Business customers typically require enhanced product offerings when compared to the needs of consumers.

COLT Telecommunications, UK[49]

In the corporate and carrier market, fibre point-to-point services are well established. Specific revenues from these services are difficult to track, however, as Section 2.5 outlines, overall fixed-line revenues for large enterprises and public institutions are estimated at $6 billion. Telstra is the largest provider in this market, with limited competition for multi-site and non-CBD customers. The NBN will offer more affordable services, grow the market, enable innovative retail service offerings, and allow all service providers to compete for national accounts.

49 COLT 2009, *Response to Ofcom's consultation document: Next generation networks*

Access network operators—including mobile, DSL and cable providers—also require enterprise-grade connections. Many of these operators, particularly mobile networks, are currently constrained by a lack of affordable connections due to high prices on many backhaul routes (Chapter 6). Enterprise-grade services on the NBN will address these bottlenecks to allow these operators to deliver improved levels of service to end users.

3.1.2 FACILITATING A SUPERFAST BROADBAND FUTURE

As discussed above, the NBN will improve today's services. However, the platform also creates the potential for a new generation of applications, services and user devices. This Section discusses some of the types of services and models that rely on a superfast, open-access NBN platform.

Enabling richer applications

Beyond faster access to current services, the increased speed and performance that NBN offers will enable a new generation of richer, premium applications. The step change in customer experience will be similar to the change experienced in the move from narrowband to broadband, which enabled a new generation of Internet services—for example, iTunes, YouTube.

Predicting exactly which services will emerge or will succeed is difficult. The Implementation Study has considered a wide range of service types that represent the types of demand that will be made of a next-generation network. Exhibit 3–6 outlines a selection of potential services.

Exhibit 3–6. Potential NBN-supported services

Type of service	Examples
Super-rich content delivery	■ 3DTV ■ Interactive TV—for example, selection of multiple camera views in real time
Lifelike human interaction	■ High-definition video-conferencing ■ Simulated touch experience
Video gaming	■ Virtual reality video gaming, including motion-sensing and feedback ■ Low-latency peer-to-peer virtual LAN games
Monitoring and response	■ Tracking diagnostic indicators of chronically ill patients ■ Video surveillance
Machine-to-machine systems	■ Remote power management (feature of some 'smart grid' solutions) ■ Supply chain management for small businesses

Source: Implementation Study

Exhibit 3–7. Example devices that exploit superfast capabilities

Type of device	Examples
Bigger and smarter screens	■ Widespread implementation of software on large screens, allowing viewers to access content previously limited to small computer displays (e.g. YouTube) ■ 3D screens, approaching mass-market price points ■ Large touch-screen displays—e.g. Microsoft Surface
Next-generation human interfaces	■ High-definition video conferencing, with supporting ‘environmental’ enablers such as superimposed backgrounds and surround sound ■ Feedback touch interfaces—e.g. gloves that simulate feeling a virtual object ■ Remote presence, including ‘virtual workers’ (Exhibit 3–8)
Seamless mobile devices	■ Voice handsets that hand-off between macro networks and home base stations ■ Smart network selection on mobile web devices—phones that automatically select highest quality / lowest cost network ■ In-car navigation systems which download map and point-of-interest updates when garaged

Source: Implementation Study

Supporting new and innovative devices

The evolution of new services will rely on the concurrent development of devices. The NBN is also likely to facilitate the emergence of new and innovative devices that transform the way users experience the services that emerge.

17 percent of respondents that upgraded to FTTH now work from home more

Ovum[50]

Exhibit 3–7 outlines a range of potential devices that could emerge as NBN services become ubiquitous. Exhibit 3–8 provides an example of the types of devices that can take advantage of superfast broadband connectivity.

50 FTTH Council Asia-Pacific 2009, *Submission to the New Zealand Government Broadband Investment Initiative*

Exhibit 3–8. Case study: Advances in devices transforming life at work

Telepresence in the workplace: the IvanAnywhere robot	
Situation	A worker in Canada found that his remote working regime was proving difficult. However, his alternative was a 1,350 km commute. Given these constraints, he devised a means for being 'virtually present' in the office—a robot avatar, remotely controlled via broadband.
Innovation	Dubbed IvanAnywhere, this robot was a highly specified and functional device. It was equipped with a full set of inputs and outputs: ■ Microphone to hear office goings-on and conversations ■ Video camera to allow navigation and view faces of colleagues ■ Monitor to display face of Ivan ■ Speakers to project voice of Ivan ■ Fully-mobile chassis with battery pack, electric motor
Outcome	The tool proved highly effective at enabling remote productivity for Ivan. For example, he could now: ■ Interact face-to-face with colleagues ■ Attend meetings ■ Make presentations
Implications for NBN	Although seemingly futuristic, ubiquitous fast broadband will make innovations such as this one more common—potentially leading to improvements in productivity, and interactivity.
Source: Walcoff, M 2007, 'Meet IvanAnywhere', *Record*, 1 September	

Acknowledging the difficulty of predicting business models and value creation for the NBN

Given the wide array of innovative and valuable services that may emerge, NBN Co could reasonably expect to capture value beyond today's broadband services. However, it is difficult to predict which business models will prevail, and the quantum of value that NBN Co may capture.

First, new services may be delivered in a variety of ways.

- **Over-the-top, via the Internet.** Although there are advantages to managed IP connections, many services will continue to function adequately over the Internet.
- **Through a specified bitstream, in conjunction with a retail provider.** Retail providers are likely to have a primary billing relationship with each activated premises, based on a core service such as broadband, voice, or TV.
- **Standalone, using a wholesale bitstream service**. In this scenario, an application provider—say, a healthcare monitoring service—would offer services directly to the end user, without an interaction with a traditional telecommunications service provider. The user would access the service through an identified ONT port and pay the application provider directly.

As new and innovative services emerge on the NBN, value will be created for industry, users and the wider economy. However, NBN Co, as a wholesale-only network provider, is unlikely to capture significant proportions of this value as direct revenue. This challenge is recognised when modelling revenue for the NBN. Hence, the modelling takes a conservative approach to new sources of revenue that NBN Co can reasonably expect to capture. The approach to revenue modelling for the fibre and non-fibre networks is explained in Chapters 4 and 5 respectively.

3.2 Delivering wholesale services to meet end-user needs

As a wholesale-only provider, the NBN will not directly serve end users. Rather, it should offer services that allow its customers—retail providers and intermediate wholesalers—to meet end users' needs. It is important for NBN Co to design and offer the right services, as they will affect end-user experience, competitive outcomes, and the ability of NBN Co to generate revenue. This section outlines the principles that should guide the NBN service portfolio, now and in the future, to balance these needs:

3.2.1 Defining a set of services to fit the current market

3.2.2 Ensuring NBN services meet future needs.

3.2.1 DEFINING A SET OF SERVICES TO FIT THE CURRENT MARKET

In its broadest sense, NBN's service offering is defined by two considerations: the layer in the network stack in which it will operate; and the geographic extent of its offer. These considerations define the logical and physical boundaries of the network, and the activities that will need to be undertaken by service providers using the NBN to deliver services to end users. Therefore, these considerations influence the degree of innovation and control left open to service providers as well as the nature of their business models and the industry structure that is expected to emerge. Exhibit 3–9 demonstrates how the options for NBN service offerings fit within these considerations.

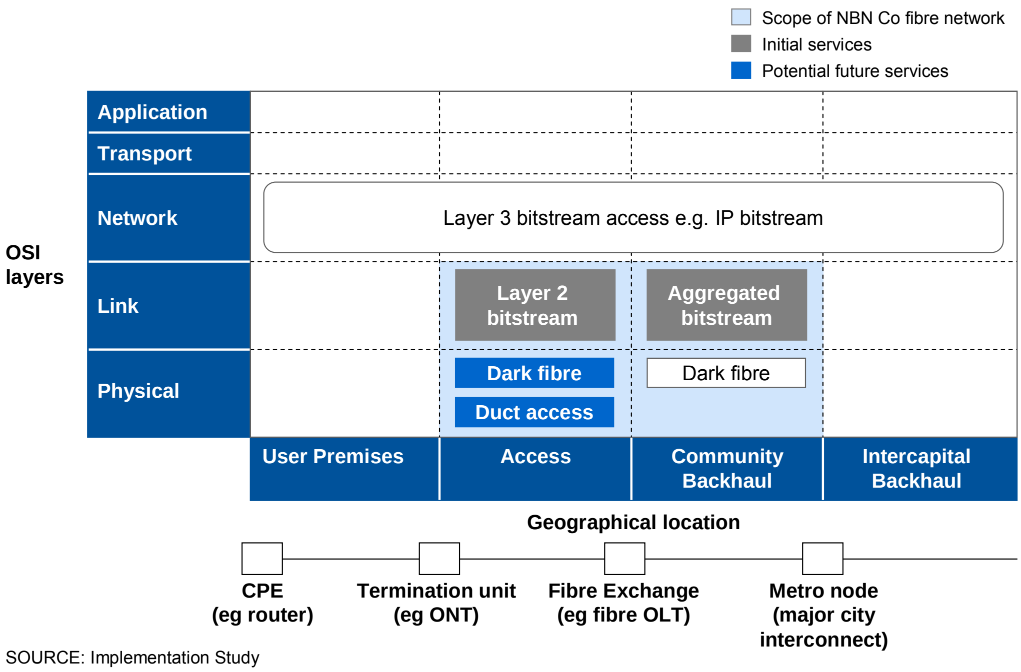
Defining the layer in the network stack

The Open System Interconnection (OSI) network stack is a widely referenced framework for understanding networks. It comprises seven layers, of which the lowest—or most fundamental—three are commonly discussed when constructing telecommunications networks.[51] Exhibit 3–10 shows the OSI stack, and the key terms which will be used in our discussion of the NBN. These layers are not entirely discrete, and there are different interpretations of the appropriate boundaries between them. For ease of comparability, the Implementation Study has aligned the definitions below with those used by NBN Co in its industry consultations.

Service providers have greater control of the network, and therefore more scope to innovate, at lower layers of network access. The NBN is an enabler of innovation, rather than a driver of it. The NBN should therefore offer services at the lowest layer of the

[51] Although there is no official Layer 0, conceptually it exists as the physical link

Exhibit 3–9. Options for NBN service offerings



SOURCE: Implementation Study

network stack that enables vibrant retail competition. We discuss the features and requirements of a healthy retail market in Chapter 9. In this section we focus on the performance implications of services at different layers in the stack.

Exhibit 3–10. OSI network stack model

OSI network 'stack'	Example wholesale service	Function
7 Applications layer 6 Presentation layer 5 Session layer 4 Transport layer	N/A	**Service enablement** ▪ Provides functionality for user services
3 Network (IP) layer	IP stream	**Cross-network communication** ▪ Controls routing and ensures reliability
2 Link (active) layer	Ethernet bitstream	**Area networking** ▪ Creates connection and transfers data
1 Physical (passive) layer	Dark fibre	**Transmission medium** ▪ Defines mode of transmission and receipt
0 Medium (passive) layer	Duct access	**Physical medium** ▪ Transports physical network medium

SOURCE: NBN Co 2009, *NBN Co consultation paper: Proposed wholesale fibre bitstream services*; Implementation Study

In discussions of the appropriate service offering, it is necessary to address different technology platforms separately. It is possible to offer access at all layers on fibre—including duct access, dark fibre, Ethernet, and IP. However, satellite and wireless wholesale services are typically delivered at Layer 3.

> *Wholesale access can look different on each technology, and models other than wholesale access may be considered for wireless parts of the network.*
>
> Ericsson [52]

Fibre footprint

Within the fibre access network, there are several potential service offerings at different layers. These have natural geographic extents—for example, continuous dark fibre is not typically offered between a metro point of interconnect to premises several hundred kilometres away because of the physical topology of the network. Rather, multiple dark fibre links would be pieced together to enable a connection between those points. Similarly, IP managed bitstream services typically exist between two smart devices so would be offered from a service provider's central facilities to end users' premises.

There are several considerations in determining which layer(s) should be provided to access seekers. The primary trade-off is between enabling greater competition by lowering barriers to entry, which suggests services higher in the stack, and enabling network management and innovation, which requires access lower in the stack. Exhibit 3–11 illustrates these trade-offs.

Access at the passive layer gives service providers the greatest level of control over their service offer. Although the fibre cable itself is standardised across the industry (based most commonly on ITU standard ITU-T G.652), access to the dark fibre allows the provider to control the transmission of signals over it. For a given cable, different methods can be employed to do this using different modulation and optics. Ethernet is emerging as a standard which creates a data link, generally regarded as Layer 2. At Layer 3, IP is a dominant standard for the transmission of data. Although Layers 2 and 3 are mostly standardised, passive access gives service providers opportunities for sophisticated routing and traffic management, including quality of service.

> *Regulators usually favour passive access as it provides CPs (communications providers) with the greatest level of control over the underlying infrastructure. This, in turn, provides the greatest scope for innovation, allowing CPs to reduce costs and prices, and develop new products, bringing real benefits to consumers*
>
> Ofcom[53]

[52] Ericsson 2009, *Ericsson submission to the Department of Broadband Communications and the Digital Economy National Broadband Network legislative framework*

[53] Ofcom 2009, *Ethernet Active Line Access: Updated Technical Requirements*, viewed 8 February 2010, <http://www.ofcom.org.uk/telecoms/discussnga/eala/eal/>

However, one limitation of access at the passive layer is the level of investment required to enter. Service providers must invest in active equipment in any area they want to serve. In the short term, this would increase barriers to entry and limit competition to large, existing network providers (e.g. Telstra, Optus, AAPT). This situation would not meet the NBN requirement for a level competitive playing field at the retail level. In the long-term however, passive access may be needed to introduce competition at lower layers in the stack. We discuss this in Chapter 9.

Access higher up the network stack at Layer 3 significantly lowers the barriers to entry for service providers. Access to the NBN at this layer would allow many service providers to compete, from limited geographic points of interconnect (e.g. only major cities). However, Layer 3 access would require NBN Co to manage all network routing and end-to-end service specification. This requirement would have two impacts. First, NBN Co would need to offer a large range of services to meet the needs of all access seekers. This would increase the risk of the NBN not meeting the needs of some service providers. Second, it would reduce the level of control and scope for innovation of service providers. This would reduce the potential benefits for end users of the network.

We conclude that active services at Layer 2 provide the best means of levelling the retail playing field in the short term without unduly limiting service provider competition and innovation. Layer 2 bitstream services are already implemented in other separated telecommunications industries around the world (Exhibit 3–12). Regulators like Ofcom, have also examined and endorsed the ability of Layer 2 active services to meet the needs of a range of service providers.[54]

We acknowledge the challenges in predicting the evolution of service specifications at Layer 2 (Chapter 4). For example, enabling IPTV services requires Layer 3 awareness, known as IGMP snooping, to responsively present video streams to end users. The possibilities for ambiguity of definitions based on the OSI stack are significant and ongoing monitoring and adjustment will be required.

54 Ibid

Exhibit 3–11. Choice of Layer for NBN services in fibre footprint

Core offer in initial stage of network

OSI layers	Example service offer	Ability of access seekers to… Compete with relatively low barriers to entry	Manage network and QoS	Upgrade optical line electronics
3 Network	IP	✓✓	✗	✗
2 Link	**Ethernet**	✓	✓	✗
1 Physical	Dark fibre	✗	✓✓	✓
0 Medium	Duct	✗	✗	✗

SOURCE: Implementation Study

Exhibit 3–12. Bitstream service examples in other markets

Country (operator)	Type of Service	Stage of development	Support for premium services
New Zealand (Telecom NZ)[a]	Enhanced UBA, over DSL	Offers in market	**Yes.** Voice-ready 40–160 kbps real time bitstreams
UK (BT Wholesale)[b]	Datastream, over DSL	Offers in market	**No.** Best efforts service
UK (BT Openreach)[c]	Generic Ethernet Access, over FTTP	In trials at Ebbsfleet. London launch planned for 2010	**Yes.** CIR, support for Class of Service, multicast, ATA voice
Singapore (Nucleus Connect)[d]	Portfolio of layers and network elements, over FTTP	Launch planned for first half of 2010	**Yes.** Full implementation of carrier Ethernet, wide range of L2 / L3 services, 4 classes of service, multicast.

a. Telecom NZ 2009, Product profile: Enhanced Unbundled Bitstream Access

b. BT, BT to expand footprint for UK's fastest broadband, media release, London, 9 October 2009

c. Infocomm Development Authority of Singapore (IDA) 2009, *Lighthouse series: Active network architecture*, report prepared by Nucleus Connect, Singapore

d. IDA 2009, *About Next Gen NBN OpCo, Nucleus Connect*, viewed 12 December 2009, **http://www.ida.gov.sg/Infrastructure/20090731130844.aspx**

Source: Implementation Study

Recommendation 32. That NBN Co only be permitted to operate at the lowest layer of the network stack that enables sufficient retail competition and diversity of services for end users. Initially, this will translate into Layer 2 bitstream services in the FTTP network, and Layer 3 IP services in the satellite access footprint; that Government request that the ACCC periodically monitor competition, and recommend necessary modifications of the service portfolio to best serve the long term interests of end users; that this include considering the offering of passive services.

Satellite and wireless footprint

For a retailer, interconnection to satellite services at Layer 2 has limited added value because effective management of the access link on modern satellite platforms requires access to Layer 3. This network management is particularly important on satellite given the high latency of the platform, which renders standard transport protocols less effective. The normal model for satellite interconnection is for the satellite operator to perform network management with retailers operating through a Layer 3 (normally IP) connection.

Within the wireless footprint, the successful tenderer(s) for the NBN fixed-wireless service should be required to offer both a wholesale Mobile Virtual Network Operator (MVNO) service as well as a retail offering. Similar to the satellite case, the MVNO service would be provided by default at Layer 3. As part of the tender specification, Government should also consider whether to require the tenderer(s) to offer support for a Layer 2 tunneling protocol (L2TP) to enable Layer 2 data streams to be provided over the network.

Determining the geographic extent of the NBN

As discussed in Chapter 2, NBN Co should focus on non-competitive areas where the market is not delivering outcomes for end users. In practice, this means that the Company should focus on:

- Fibre access to all premises within the coverage objective, except in the few parts of the country where fibre networks of the required specifications exist;
- Satellite where fibre access is not deployed;
- Backhaul where there is no competition.

Delivering services to meet a broad range of needs

Most immediate demand for services will come from carriers, who are focused on voice and best-efforts Internet services, as well as delivering enterprise and mobile services. However, NBN Co should consider the needs of smaller, emerging, or non-traditional providers. These providers will require services which serve specialised needs and are available at a low marginal cost. For example, a smart grid meter may require a low-bandwidth connection, which can be priced very cheaply as it poses no substitution risk to broadband. Conversely, a remote health consultation provider may require high-grade symmetric services, for which a premium can be paid.

A specific dimension of specialist connectivity is quality of service (QoS). QoS is a means of prioritising packet-switched traffic to create different classes of service to suit different application needs. Currently, wholesale bitstream services are mainly used to deliver Internet services—most notably in the UK and NZ, where ISPs leverage bitstream services on DSL platforms. While creating QoS services across network boundaries at Layer 2 is still relatively unproven for mass-market advanced services such as IPTV, it is well established in carrier network management and should be technically feasible within the fibre footprint. For the satellite service, Layer 3 wholesale services can be created to handle voice, the main QoS service likely to be available on that platform.

NBN Co's role here is to offer the range of services and protocols to service providers that enable end-to-end QoS. It remains the responsibility of the service providers to manage the services across network boundaries.

Advice. That the NBN Co Board ensure the NBN supports service providers in the delivery of next-generation services that are specified to conform to international and industry standards, including emerging standards for Quality of service parameters and classes of service; that reference points include principles and standards published by regulators (such as Ofcom); and technical specifications defined by international forums (such as the Metro Ethernet Forum or Broadband Forum).

3.2.2 ENSURING NBN SERVICES MEET FUTURE NEEDS

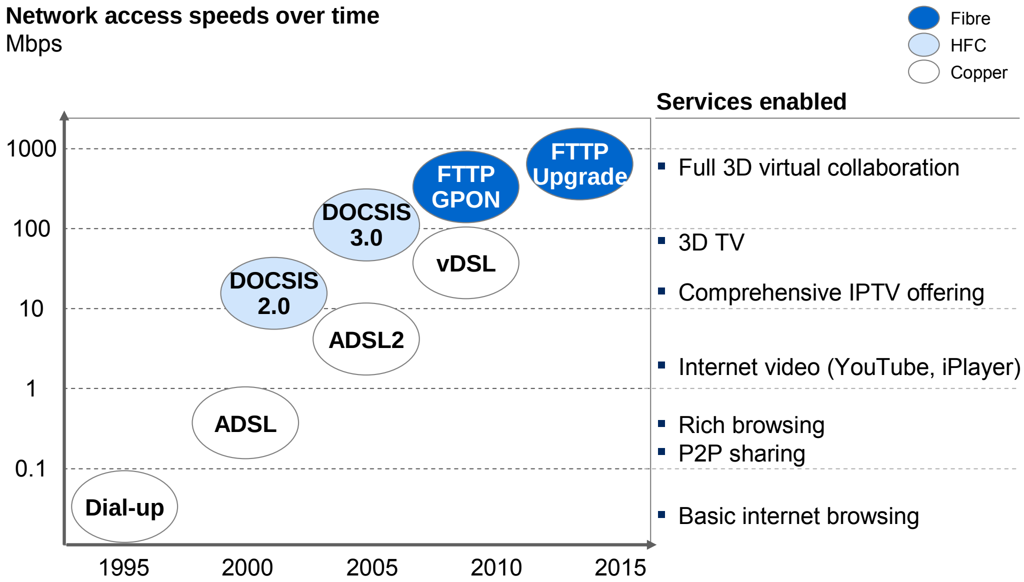
NBN Co's network and service footprint may be required to change over time, as the needs and competitive structure within the industry evolve. These changes could be effected in two ways:

- As upgrades in data rates and performance of the Layer 2 services that form the initial core offering of NBN Co; and/or
- As a shift in NBN Co's service footprint. This shift could be a move up and/or down the network stack (i.e. offering services at Layer 1 or 3); or a geographic shift in where NBN Co offers services.

Ensuring upgrades of active services

As demand for bandwidth and performance continues to grow over time, NBN Co will need to upgrade the specifications of its initial portfolio of active services. Users are likely to demand speeds in excess of current requirements—100 Mbps and 12 Mbps—in the future (Exhibit 3–13). An important question is how to ensure NBN Co, as the only provider of active wholesale services, continues to invest in its network and services to meet such evolving needs.

Exhibit 3–13. Growth in fixed-network access speeds over time



SOURCE: Implementation Study

Referencing international benchmarks prior to active competition

Competition at the active layer of the network provides the most effective way to ensure ongoing innovation and upgrades of services, within the fibre footprint (Chapter 9). However, it may take some time for the market to meet the necessary criteria for the introduction of competition at this layer of the network. NBN Co will therefore need to upgrade its active equipment at some point following the first-generation cycle of 7–10 years.

As its customers demand higher speeds and performance, NBN Co should upgrade its services. These upgrades are likely to require investment in new equipment. In making these upgrades, NBN Co should reference international benchmarks and industry standards, to ensure NBN services continue to offer world-class performance.

> *Although getting fibre deployed into the network is the first and most significant step, we anticipate ongoing reinvestment in equipment [as opposed to the fibre] will be required at least every decade, if not more frequently*
>
> FTTH Council Asia-Pacific[55]

Government will want to ensure that NBN services continue to stay at the forefront of international performance. It is challenging to prescribe an exact mechanism given the dynamic nature of innovation in telecommunications technology. Regulation is one

[55] FTTH Council Asia-Pacific 2009, *Submission to the New Zealand Government Broadband Investment Initiative*

option, but does not guarantee optimal outcomes. We believe competition at the active layer will deliver the best outcomes, as discussed in Chapter 9.

> **Advice.** That the NBN Co Board ensure NBN services are upgraded as the needs of customers and users evolve. Where these upgrades require investment in active equipment, that NBN Co reference international benchmarks (e.g. major network deployments) and best practice (e.g. industry standards) to ensure NBN services continue to deliver world-class performance.

Ensuring national upgrades once active competition is introduced

As competition emerges in the active layer, the services offered by new entrants will form a new benchmark of performance and innovation. However, this competition is unlikely to emerge in all geographies, or at the same time, due to differences in the density of demand (e.g. a metro fibre exchange serving 20,000 subscribers would be a more attractive opportunity for an attacker than a regional fibre exchange serving only 5,000 subscribers).

To ensure that similar levels of performance are available across its network, NBN Co should also reference competitive offers when upgrading its equipment and services. Upgrades of NBN services should therefore be available across all geographies within a particular technology footprint, as demanded by end users.

> **Recommendation 33.** That NBN Co be required to offer services with comparable levels of performance in all geographies within a technology footprint, specifically:
>
> 1. While it is the sole provider of active layer NBN services, NBN Co should upgrade services over time and demonstrate that the functionality and performance of its services are in line with international benchmarks; NBN Co's upgrade plans should be submitted for ACMA's approval that they are sufficient to maintain Australia's broadband position internationally;
> 2. As network elements are upgraded over time, NBN Co should ensure all equipment within an access technology platform is on a similar upgrade path. If active-layer competition is in place, NBN Co's offers in competitive areas should be consistent with NBN services in all areas;
> 3. In the satellite footprint, NBN Co should ensure that CPE upgrades continue to be offered via service providers.

Meeting the needs of new business models

NBN Co's services portfolio may also need to evolve to meet the needs of new business models. In Chapter 9 we acknowledge there is considerable uncertainty in the evolution of broadband technology and applications. For example, it is conceivable to envisage a shift from today's carrier-driven model to a future dominated by devices and/or applications. Apple's iPhone and new iPad provide real examples of this shift—these devices form the primary relationship with end users, while the network connection is a secondary consideration.

While Layer 2 active services currently provide the best means of levelling the retail playing field, this may not always be the case. NBN Co should be willing to flex its service offering if stakeholder needs (including those of Government and regulators) demand a shift. In particular, an optimal long-term competitive structure relies on NBN moving down the stack and providing access to passive services—that is, Layer 1. Chapters 9 and 10 discuss this in detail.

It is also possible that market failures at Layer 3 may result in customer demand for a shift up the stack by NBN Co. This is plausible but should be a last resort. A market exists today for these managed-network-type services, mostly provided by the large carriers and networks. However, as with any concentrated market, there is a risk it fails to serve the long-term interests of end users by preventing the emergence of certain services (for example, application service providers offering low-bandwidth applications, with limited ability to pay). We believe the ACCC should play the primary role in monitoring this market, and consider traditional remedies if failures or bottlenecks become apparent. Those remedies should only involve an extension of NBN Co's mandate with specific Ministerial authorisation.

Advice. That the NBN Co Board consider that NBN's service scope may need to evolve as market conditions shift and new business models emerge. This evolution could involve logical (e.g. up or down the network stack) or geographical changes (e.g. more or less involvement in backhaul); that NBN Co ensure decisions made in the design and deployment of the network can incorporate a range of potential changes in scope.

3.3 Delivering video services over the NBN

The NBN will expand the possibilities for service providers to deliver video services to end users. Three types of video distribution technologies are possible over a fibre network and need to be considered for NBN Co: IPTV, radio frequency (RF) and OTT.

In addition to enabling new distribution technologies, NBN Co will derive revenue from offering a wholesale video service. While in the longer term, a wholesale video service could generate significant revenue for NBN Co, it is not expected to initially. Nevertheless, a wholesale video service will ultimately increase competition and take-up by opening access to service providers and by providing consumers with greater choice of providers, content, and video experiences.

The following recommendations address the role of NBN Co in delivering video services, in the following subsections:

3.3.1 Introducing potential video distribution technologies for the NBN

3.3.2 Identifying competition and commerciality challenges with RF

3.3.3 Enabling new innovation and competition over IPTV

3.3.4 Anticipating video-over-Ethernet business models

3.3.5 Acknowledging video market structure and content bottlenecks.

3.3.1 INTRODUCING POTENTIAL VIDEO DISTRIBUTION TECHNOLOGIES FOR THE NBN

Three types of video distribution technology could be enabled by NBN Co:

1. **Internet Protocol Television (IPTV**) is a method for delivering video-over-Ethernet with defined QoS. This allows a service provider to reserve a consistent amount of bandwidth to guarantee that high quality video is available when the user requires it. IPTV, which is growing in international markets, facilitates interactivity and the convergence of different types of applications, content, and services.
2. **Radio-frequency overlay (RF)** provides a television viewing experience similar to terrestrial broadcast. Video-over-RF works by sending video signals through an HFC or fibre optic network on a different wavelength to data transport. Frequently used to distribute cable television, RF is a well understood and reliable technology. Video quality over RF is high, although the platform offers limited scope for innovation.
3. **Over-the-top (OTT).** OTT video is transmitted directly through a broadband connection without dedicated bandwidth. OTT is an efficient method to deliver video over the best-efforts Internet that will not require NBN Co to provide a reserved wholesale video service. Quality and consistency of sound and picture is not

guaranteed and does not match consumer expectations for broadcast linear television. OTT video will likely be generated and delivered in large volumes over NBN. Traditional media companies have already begun delivering content OTT through joint ventures with online services (e.g. Yahoo! Seven, NineMSN) and through new services like ABC's iView platform. No specific wholesale services need to be offered by NBN Co to support OTT delivery of video. Rather, development of the market will be promoted by fast Internet speeds, affordable data plans with large download limits provided by a competitive ISP market. One potential obstacle that will need to be monitored by the ACCC is the incentive for ISPs to throttle speed and discriminate between publishers, either to promote their own content or receive payment for promoting other providers' content.

3.3.2 IDENTIFYING COMPETITION AND COMMERCIALITY CHALLENGES WITH RF

NBN Co should not install an RF overlay unless it caters to multiple operators. A single-player RF overlay will be inexpensive for NBN Co to provide, but will not conform to the open-access principle and may not attract interest from the market. However, it is questionable whether a multiple-player RF overlay would be commercially attractive—it could add up to $1 billion to the cost of network build and will have its revenue constrained by the low-cost alternative of satellite distribution.

RF may also bring a number of technical challenges as the technology has a lower signal/noise ratio than data. RF could reduce the reach of fibre from the exchange by 2–3 km. Further, it is possible that some existing backhaul will not support RF and would need in some instances to be replicated.[56] This may only be of concern in a national network if signals need to be carried between POIs.

Avoiding simple RF implementation due to competition issues

The NBN could be constructed to support one video provider per point of interconnect using fairly simple technology at relatively low cost.

However, a single-provider RF service will conflict with the open-access principle at the heart of Government's NBN policy. The RF port would need to be sold to one provider who would effectively receive exclusive access to the region. No competition would be possible within that POI.

The cost of providing a simple RF overlay is relatively inexpensive for NBN Co as the retailer would provide active equipment within the POI. NBN Co may only have to provide an ONT which reads an RF signal, and that has an additional port for an RF feed.

[56] Industry interviews

It is estimated that this would add approximately $25 to the cost of each ONT, hence adding less than $250m to the cost of build.[57]

Despite the relatively low cost, the commercial rationale for a simple RF service is uncertain. While the cost for NBN Co is low, the cost for the retailer would be high. The retailer would need to provide active equipment at each POI for which they had the exclusive right to deliver video over RF, as well as video content centres at various points in the network (the number would depend on how many POIs they serve). For a service provider with reasonable scale, active equipment would cost approximately $65 per household served, with video content centres likely to cost around $250,000.[58]

More importantly, the RF service would struggle to earn reasonable revenue competing with the low cost of satellite and the existing long-term contracts. Austar and Foxtel are potential customers. Currently, Foxtel delivers to 800,000 customers via satellite and 640,000 over HFC, and Austar delivers to almost all of its 720,000 customers via satellite.[59] Transitioning existing satellite customers onto the NBN would be a costly exercise for Foxtel and Austar. They would need to visit each customer premises to switch customers without an RF-compliant set-top box (STB) to new CPE.

As the capex and transition costs will be high, RF would need to provide a significantly more efficient carriage platform for Foxtel and Austar to switch. Foxtel and Austar are estimated to pay a satellite carriage cost of $2–3 per customer per month.[60] Even if every existing Pay TV customer was switched to RF annual revenues would be no more than $50m per year[61] if priced to compete with satellite.

There are two further challenges. First, Austar and Foxtel may not be able to transfer their traffic onto NBN as both companies are locked into long-term satellite contracts.[62] Second, they may prioritise migrating customers to IPTV services, in the expectation that IPTV will become the main platform for future competition in pay TV.

Alongside the existing Pay TV providers, new entrants may be interested in an RF service. Delivering pay TV over RF may be more economic for a new entrant than an established provider. Satellite space has a very high upfront cost, but a very low marginal cost. As a result, satellite is an efficient delivery mechanism only if the provider serves a large number of customers. However, the pricing constraint is still relevant, as a new entrant

57 Industry interviews

58 Ibid

59 Austar 2009, *2008 Annual Report*; Buddecomm 2009, *Pay TV – statistics and subscriber overview*; Industry interviews

60 Austar 2008, *2007 Annual Report*; Industry interviews; press reports

61 Calculated based on 2.16 million Pay TV subscribers and a wholesale charge of $2 per subscriber per month

62 Industry interviews; press reports

would struggle to be viable paying a higher per subscriber access charge than established competitors. Furthermore, IPTV will offer new entrants greater ability to differentiate.

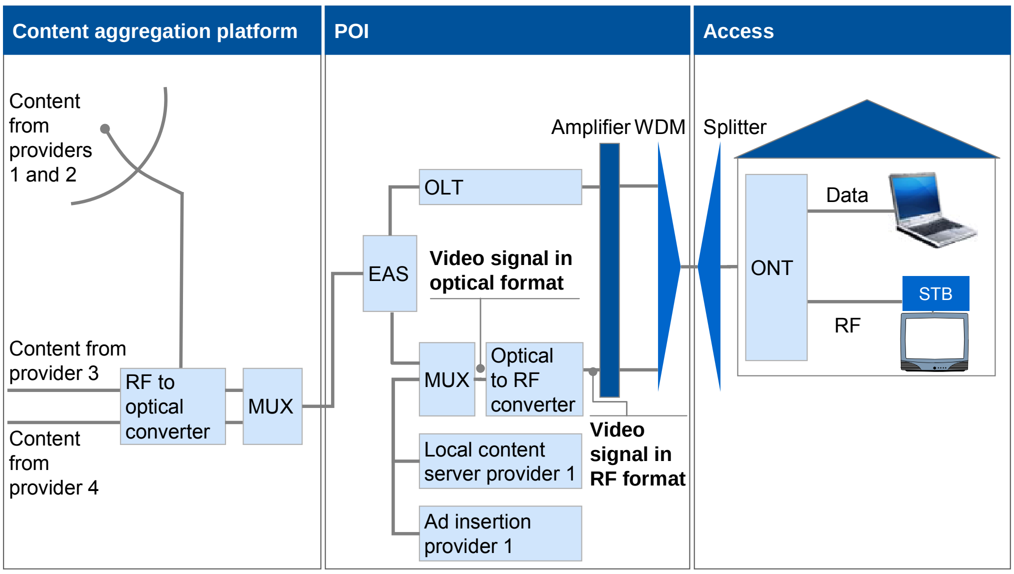
Recognising RF for multiple providers as possible but unlikely

An alternative model for RF would allow for multiple operators. This requires a content aggregator (NBN Co or another intermediary) to operate the RF platform. Retailers would feed their content to the aggregator who would deliver that content to households over the network. Set-top boxes (STBs) would be configured to decode only the signals to which the household subscribes. Exhibit 3–14 illustrates this architecture.

A multiple provider RF overlay allows for competition within the RF service set and would fulfil the open-access principle. However, it is unlikely to be an attractive option because the service lacks innovation potential, duplicates existing technologies and is unlikely to be commercially viable on a standalone basis.

The incremental cost to NBN Co of providing an RF overlay on top of network build is up to $1 billion. Cost is driven by equipment required at three points in the network. First, content aggregation points would need to be constructed. One in each capital city would be required at an approximate cost of $65 per premises covered. Third, NBN Co ONTs will need to have an RF port and a detector capable of reading

Exhibit 3–14. RF architecture for multiple providers



SOURCE: Implementation Study

the varying light intensity of the RF signal. This equipment will cost an additional $25 per premises based on initial cost estimates from equipment vendors.[63]

Revenue potential of RF is low for the same reasons discussed earlier in relation to a simple RF implementation. Even if Pay TV penetration were to double, the total revenue pool would be approximately $100 million, with NBN Co realistically unlikely to gain more than half.

Managing transition from RF in HFC areas

As discussed in Chapter 2, NBN Co’s fibre footprint will include areas where HFC is already deployed. Given RF is already being used to deliver video to about 650,000 HFC subscribers,[64] the decision to provide an RF service within that footprint is more complicated. NBN Co will need to assess the commercial and practical issues at the time of transition, but we do not expect that an exception for providing an RF port would be required. If it is, it should be a multi-operator platform.

The commercial attractiveness stems from the fact that the contract between Telstra and Foxtel for carriage of Foxtel’s signal provides for a very high carrier charge ($10–12 per month for each user) relative to satellite.[65] The contract is expected to expire in 2020. If NBN Co were to acquire an HFC network as an interim solution (Chapter 2), these high carrier fees are a potential revenue stream if the contract survived a change of ownership. In addition, RF may provide continuity for Foxtel’s HFC customers as those customers will not be required to transition to a new platform.

Foxtel would likely prefer to transition customers from HFC to a satellite platform with costs closer to $2–3 per month per user or onto a more functionality-rich IPTV platform. Foxtel would have time to plan for such a transition through the natural cycle of churn and STB upgrade. Alternatively, in an HFC migration agreement, Telstra could transition broadband customers only from its HFC network and continue to deliver Foxtel over HFC.

Recognising practical exception for RF on a user-pays basis in greenfield estates

In addition to providing a premium broadband service to prospective residents, developers install FTTP networks in greenfield estates to deliver free-to-air and pay-TV services. Using RF overlay to deliver television and remove the need for aerials and

[63] Industry interviews

[64] Screen Digest 2009, *Australia: satellite pay TV operator TV subscribers;* Screen Digest 2009, *Australia: cable operator subscribers*; Screen Digest 2009; *Australia: HDTV subscribers by operator (annual total and forecasts)*

[65] Telstra 2009, *Annual Report 2009*; Industry interviews; press reports

satellite dishes is preferred by developers in some estates for aesthetic or planning reasons.

Where greenfield estates demand RFoG as part of their FTTP communications infrastructure, NBN Co should be permitted to enable single-operator RF. This will ensure NBN Co can compete for greenfield FTTP contracts. Over time the demand for RFoG capability from developers is expected to decline as video content providers transition to IP-based platforms.

Recommendation 34. That Government permit NBN Co to offer an RF overlay service on its FTTP network provided it meets these conditions:

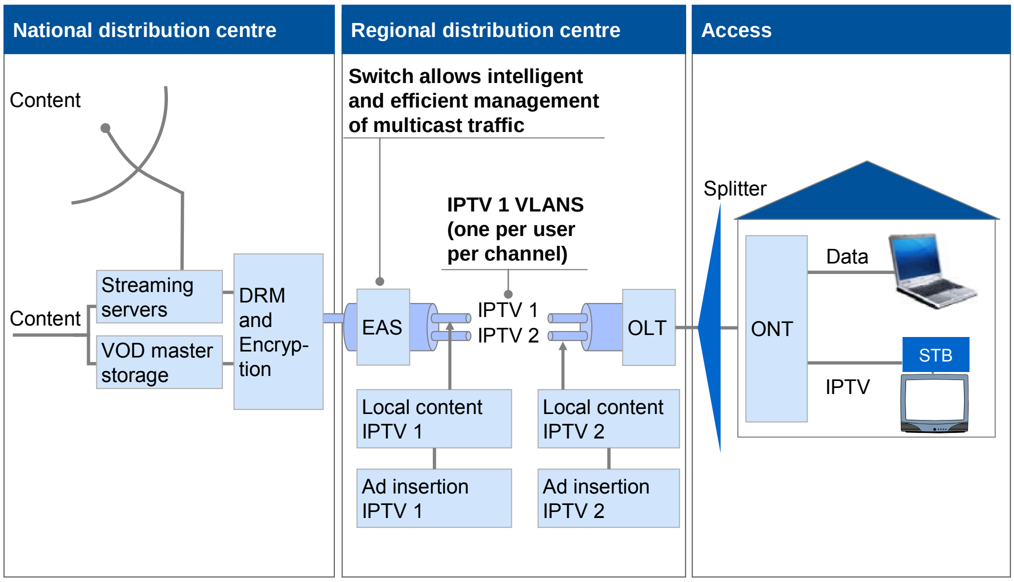
1. Except where necessary to compete for greenfield FTTP contracts, RF overlay supports multiple providers and the RF port on the household ONT is not exclusive to a single provider;
2. The deployment of RF overlay capability is commercially viable for the Company as a standalone service.

3.3.3 ENABLING NEW INNOVATION AND COMPETITION OVER IPTV

IPTV is a video service that can offer a high quality user experience (e.g. high definition, live linear television). IPTV requires that NBN offer a managed wholesale video service and that retail distributors construct a video distribution platform.

IPTV will be an important platform for innovation. It will be low cost for NBN Co to enable and is consistent with Government's open-access philosophy in permitting multiple types of video retail services to serve different consumer needs. However, we believe that revenue potential is limited in the near term (Section 4.5).

Exhibit 3–15. IPTV architecture for multiple providers



SOURCE: Implementation Study

Favouring IPTV as a platform for innovation

IPTV provides a platform for innovation through interactivity and convergence, though retailers are likely to face technological challenges during the early phase of the market. This contrasts to RF which is a mature legacy technology with similar functionality to terrestrial broadcast and satellite, and limited scope for innovation. A typical IPTV architecture is shown in Exhibit 3–15.

IPTV allows interactivity between the service and the user. In its most advanced form, IPTV permits users to personalise their video interface and control what they are watching by adjusting camera angles, watching multiple programs at once, or watching television and channel surfing at the same time. Data can be embedded in video footage so that viewers can click through to view additional details about the content being broadcast, watch features such as in-depth interviews, purchase a relevant product or play an embedded game. Phone and data services can be connected so that a caller's identity is visible on a television screen, or a television program can be recorded by phone. Internet and television convergence allow a user to query a provider's performance statistics while watching a football game, or chat with friends online while watching the same program. IPTV enables different forms of media to converge, by allowing users to store, access and share photos and music.

IPTV is a natural fit with triple-play, as data, phone and TV services can be interconnected. Based on the development of video markets in international settings, and the current plans of a number of local ISPs, IP-based triple-plays enabled by NBN could be available to consumers. IPTV would allow an attacker to differentiate through functionality, but creating a competitive content offering would be more difficult given legacy arrangements for sporting and premium movie content.

Bringing IPTV services to market may not occur smoothly in the early stages of NBN, as retailers are likely to need to resolve technological challenges as well as secure compelling content. IPTV services introduced in international markets have experienced initial challenges with deficient installation methods and service faults being relatively common. IPTV services may face similar challenges in the Australian market before they enjoy widespread success.

Enabling open-access IPTV through QoS and multicast

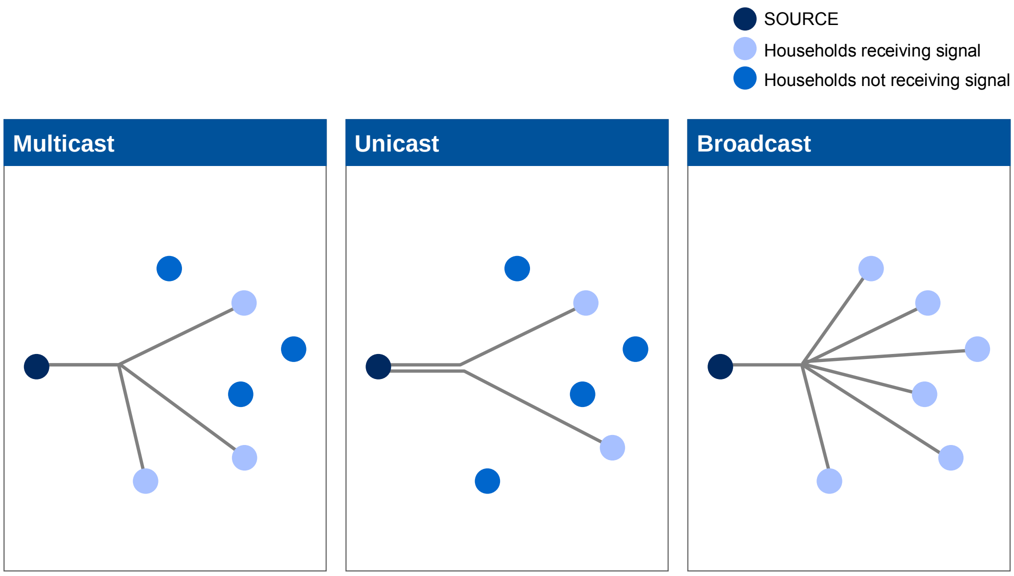
IPTV is relatively inexpensive for the NBN to support. It is unlikely that NBN Co will need to provide any additional equipment, as the equipment required to run an IPTV platform can be provided by the retailer.

However, to ensure the efficient management of IPTV traffic, NBN's standard equipment will need to offer intelligent capabilities. Industry bodies such as the Open IPTV Forum and the Broadband Forum have developed standards to support the necessary technology. The incremental cost to the overall network build will be minimal.

Facilitating IPTV will require the NBN to support IPTV multicast. Multicast is a way of delivering IPTV that minimises data traffic. Data is sent from the source as a single stream which splits and replicates as close as possible to the end users. The result is that when multiple households in a neighbourhood are watching the same channel, the data travels in a single stream over most of the network and may only replicate into multiple streams at the local exchange. This is in contrast to unicast, where one signal is sent to every end user who requests it; and broadcast, where one signal is sent to everyone in the network whether they have requested it or not (Exhibit 3–16).

The NBN may eventually serve millions of users, multiple IPTV operators and thousands of IPTV channels. This could generate complex, high volumes of multicast traffic. Managing that multicast traffic will require additional functionality in the network. While it will probably not entail NBN Co investing in extra equipment, some equipment may require additional processing and memory capabilities to ensure multicast streams are efficiently and effectively managed.

Exhibit 3–16. Methods of video transmission



SOURCE: Implementation Study

IPTV evolved as a telecommunications provider's response to competition from cable. As broadband and telephony began to be offered in addition to video over cable, telecommunications providers developed ways to match the triple-play offering over copper networks, and then over FTTN or FTTP networks. These providers have all been vertically-integrated, often incumbent operators. This has allowed them to manage end-to-end QoS across their own networks. Delivering the necessary QoS across multiple networks is technically possible, but some industry stakeholders are concerned that it will not be straightforward in practice. NBN Co will need to provide the protocols and functionality to enable service providers to deliver QoS across the network boundary to make the sophisticated IPTV functionality possible. This is a specific case example of the broader need for QoS enablement discussed in Section 3.2.2.

Recommendation 35. That NBN Co be required to provide a wholesale Layer 2 bitstream service which enables multi-operator delivery of next-generation video services (e.g. high definition, video-on-demand) that meets industry standards.

Expecting short-term revenues from wholesale IPTV services to be limited

In the short term, IPTV wholesale services may not generate large revenues for NBN Co because IPTV and satellite will compete as video delivery platforms. While satellite has limited potential for future development of services, the functionality of the two technologies will not be dramatically different in the short-term. VoD services can be provided to satellite customers with a data connection at the STB. A similar model is currently being used by Foxtel, as well as DirecTV and Dish Network in the US.

In the longer term, IPTV may be able to capture additional revenue, allowing NBN Co to charge a premium carriage price. The revenue potential of IPTV is uncertain, however, and should not be assumed in the NBN business case. However, it is possible that IPTV could eventually generate higher ARPU through new services or increased functionality of existing services such as VoD and interactive gaming. Advertising revenues could increase as IPTV will offer new opportunities to embed advertising, target advertising to specific users, and use interactive advertising features.

3.3.4 ANTICIPATING VIDEO-OVER-ETHERNET BUSINESS MODELS

Video-over-Ethernet services exist in the current marketplace and the NBN will likely lead to new models. Telstra is testing a set-top box that permits the carrier's customers to download and watch movies and video-over-Ethernet channels from Telstra sites such as BigPond without incurring additional data charges. TPG offers an IPTV service with a limited selection of foreign language channels available without a set-top box. iiNet is preparing an advanced IPTV service that will use a set-top box. Optus has considered offering an IPTV service for several years.

An NBN wholesale video service resolves the structural barriers to providing access to a broad cross-section of subscribers. Retail distributors will now be able to offer a video service directly to consumers without having to enter into an agreement with an infrastructure owner who may lack the incentive for open access (assuming competitive backhaul). The NBN wholesale video service will also give providers the ability to offer a triple-play product suite, which is likely to spur competition between providers.

An NBN wholesale video market will enable different business models to emerge within the current regulatory framework. We anticipate a variety of OTT and video-over-Ethernet competitors to take advantage of the NBN.

Pay-per-view VoD

Pay-per-view VoD is similar to the on-demand model that is present on Foxtel and Austar, although the customer usually purchases content to own. For example, Apple provides on-demand services to PCs, portable media players and STBs via the iTunes Store and is expected to offer a subscription television service in some markets in late 2010. This could be delivered either over-the-top or over IPTV.

Advertising-supported VoD

Advertising-supported VoD is similar to the traditional broadcast model because it generates advertising revenue by broadcasting content to broad audiences. Hulu offers an advertising-supported VoD service in the US that offers free streaming of movies and television episodes. The company is jointly owned by the media conglomerates that control 3 of the 4 major US television networks (NBC Universal, News Corp, the Walt Disney Company) and an investment firm.

The free-to-air broadcast networks in Australia could join together and offer a Hulu-type service. While the major US networks chose to distribute Hulu via OTT to gain independence from the cable distributors, the service could be offered OTT via the NBN or as a dedicated IPTV platform for a better quality experience.

Content aggregation platform

This model offers software that aggregates and organises OTT free content. Boxee is a company that offers customers software and a set-top box to aggregate OTT free content (e.g. Hulu, YouTube, Pandora, Flickr) and certain subscription services (e.g. Netflix). Social networking is integrated into the platform so that users recommend content to friends and can see user’s viewing lists.

To be successful in the Australian market, a content aggregation platform will need access to more free and subscription content than is currently available. In addition, metered data pricing limits the full potential of a content aggregation platform if the platform is independent of an ISP.

Consortium of publishers on IPTV

A consortium of publishers could join to share the expenses of providing an IPTV platform. Because the shared video infrastructure and customer acquisition costs require sufficient subscriber scale to be profitable, publishers without an established video product (e.g. newspapers or magazines) could share those costs and serve niche consumer segments with narrowly tailored television services (e.g. specialty sports or foreign language programming).

IPTV platforms

An existing pay television distributor or a new entrant could provide a basic television service over IPTV with limited interactivity and on demand features. This service would target the customer who is not satisfied with free-to-air offerings but is unwilling to pay for advanced pay television.

Alternatively, existing pay television providers (Foxtel, Austar) or new entrants may choose to transition their customers to a full featured IPTV platform.

In its most advanced form, IPTV is a fully functional video and content services platform. An advanced version of IPTV will require significant investment of up to $70–100 upfront capex per subscriber with a minimum scale of 1 million customers. It is expected that this version of IPTV will be provided either by companies with a strong existing customer base or by new entrants with sufficient capital and appetite for the investment risk associated with bringing a new video platform to market. A current example is AT&T U-verse, which provides a premium IPTV service to parts of the US. U-verse offers more than 110 HD channels, full digital recording, interface customisation, extensive VoD, access to games and data, with continuous improvements expected in the future. U-verse currently serves more than 1 million subscribers.[66]

IPTV can also exist as a more basic service, with channel offerings and quality similar to standard definition, broadcast linear television and basic VoD. This version of IPTV requires platform investment of less than $70 per subscriber with a minimum scale of 30,000 to 40,000 customers.[67] Additional expense may be required for an STB in the home. It is expected that this version of IPTV will be provided by regional distributors or companies focused on niche consumer segments.

3.3.5 ACKNOWLEDGING VIDEO MARKET STRUCTURE AND CONTENT BOTTLENECKS

The structure of the Australian television industry will make it challenging for new entrants to achieve scale with new video services, even with the NBN. While a market will exist for an NBN wholesale video service without changes to the current regulatory framework, it is unlikely that a new pay television provider will invest in a full-featured IPTV platform until current content agreements expire or are renegotiated.

Identifying characteristics of the Australian television market

Free-to-air television continues to be in a relatively strong market position in Australia relative to markets like the US. While more than 80 percent of US households have access to more than 100 channels, low penetration of pay TV in Australia means that most households have typically had access to five main free-to-air channels, expanding to up to 15 free channels with digital television. This difference is a function of historically favourable regulation for free-to-air television including the late entry of Pay-TV and anti-siphoning provisions for major sporting events.

Pay television in Australia is provided mostly by Foxtel and Austar with monopoly-like positions in their respective regions. The two providers share content rights mostly acquired by Foxtel, which also distributes that content to other pay television distributors.

The pay television distributors and telecommunications providers do not compete with the same kind of offers that are typical in many other developed markets. Most obviously, there is limited true triple-play competition—Telstra has focused its video strategy on the

[66] AT&T 2008, *AT&T Inc. 2008 Annual Report*

[67] Industry interviews

PC rather than the television and Foxtel does not offer voice and broadband in competition with Telstra, its 50–percent owner. As a result, consumer prices are high (a basic Digital Video Recording (DVR) package is 1.8 times the comparable US package) and penetration rates remain low at approximately 30 percent of households even accounting for the later introduction of Pay TV.

Recognising content bottlenecks and limitations for new market entrants

We expect that service providers will use the NBN to offer a triple-play suite of voice, data and video services. In other markets, multiple product bundles reduce churn by up to 150 basis points and permit providers to gather and monetise additional information on consumer behaviour.

Notwithstanding these new business models, barriers to success still exist in programming and scale. The free-to-air networks broadcast most preferred video content in Australia. Without carrying free-to-air networks, a distributor is not likely to gain the subscribers necessary to achieve profitability with a full scale television platform.

Content drives consolidation within the Australian television industry. Foxtel acquires a majority of the content distributed on pay television platforms in Australia. Television distributed on the future NBN will most likely develop similarly to the current market. Rights to distribute content on the Internet are already being consolidated in the same way as terrestrial. As a result, the NBN wholesale video service will most likely benefit the existing providers.

In addition, IPTV and online distributors are not currently subject to anti-siphoning restrictions. This leaves open the possibility that an individual distributor could lock up critical sports events and foreclose the retail market.

Foxtel, Austar, Telstra, Optus, iiNet and a few other companies have an existing customer base that gives them the scale necessary to succeed in marketing a television service to Australian consumers. Because most of the value derived from consumers is passed through to the content provider, scale is necessary for distributors to negotiate preferable programming costs. Without access to content, minimal incentive exists for an international or domestic provider to enter the market. Unless the content obstacles change, it is not likely that the NBN will enable another full-scale pay television platform like Foxtel or Austar to enter the market.

3.4 Enabling future e-government capabilities

There is significant potential for the improved delivery of Government and public services over broadband. As a publicly-funded network, the NBN will play a critical role as the connectivity platform to enable these opportunities. However, the scope of e-government is extremely broad, and the deployment of new services relies as much on policy, legislation, and core applications systems as on network components. This section outlines the opportunities for delivery of e-government services and implications for the NBN.

3.4.1 ENVISAGING A RANGE OF E-GOVERNMENT SERVICES

E-government is a term used to describe the use of information and communications technology (ICT) to enable improved delivery and administration of Government services.[68] This definition can apply to a broad range of services and outcomes, many of which are available using existing networks and technology.

This section focuses on some specific areas of Government that stand to benefit particularly from the improved use of ICT in the context of the NBN. It also highlights the other necessary components of e-government capability, outside of the network. We acknowledge the work completed on this topic in the recent Government forum, *Realising our Broadband Future*. This section does not address the wealth of materials published through that process or in other literature on the digital delivery of Government and social services, but rather focuses on the role the NBN may play in enabling these services.

[68] Australian Government Information Management Office 2006, *2006 e-Government Strategy: Responsive Government: A new service agenda*, Canberra

Addressing policy goals through e-government

Government departments are starting to define ways in which e-government can help to deliver their policy goals. We engaged with a range of Government departments and stakeholders on the types of e-government services they expect from the NBN. A number of areas of Government were discussed as priorities for the continued development of e-government services:

- e-education;
- e-health;
- Smart infrastructure;
- Government processes and online services.

Exhibit 3–17 provides examples of e-government services envisaged in each of these areas.

Exhibit 3–17. Examples of priority e-government services

Category	Description	Examples
e-health	A means of delivering health information and services in a secure electronic form for the purpose of optimising the quality and efficiency of health care	■ Remote consultations via video-conference ■ Remote and/or real-time diagnosis of tests and scans ■ High-speed transfer of medical imaging ■ Remote health monitoring
e-education	Ability for educational institutions to publish materials online, students and teachers to collaborate online, students to participate in remote learning and researchers to instantly access information	■ Remote learning ■ Collaboration networks for special-interest/ research groups ■ High-speed transfer of large data files (e.g. space monitoring)
Smart infrastructure	Networked infrastructure that uses sensors and communications technologies to better utilise or sustain resources	■ Smart grids ■ Remote monitoring of dam levels ■ Remote traffic monitoring
Government processes and online services	Use of ICT to enable improved government processes and increased efficiency in the administration of government services	■ E-forms and filing (e.g. online tax submission/ records) ■ Online procurement ■ Networking between Departmental sites

Source: DBCDE 2009, *BroadbandFuture.gov.au*, viewed 1 December 2009, <http://www.broadbandfuture.gov.au>

Identifying the components of e-government capabilities

There are a number of components to e-government capabilities. While network and technology services are an important part of the equation, and have spurred development in markets such as South Korea (Exhibit 3–18), a range of additional components are required to deliver most of the services outlined above. Examples include:

- **Policy and funding.** Broad policy changes may be required to align incentives to shift activities online. For example, widespread implementation of remote medical consultations will require changes to the current funding model. Medicare funding currently discourages remote medicine as practitioners are only funded for actual visits.
- **Regulation.** Legal or regulatory issues can prevent the development of some e-government services. For example, privacy concerns are an obstacle to the collection and use of online health records.
- **Training.** Changing behaviour to adopt new technologies is challenging, and can absorb much time and cost. For example, teachers may require training in how to use video-conferencing or Web-based tutorials if they are to utilise the benefits of e-education. End-users would need training to interact online instead of expecting face-to-face interaction for the delivery of selected Government services.
- **Operations and processes.** Many of the e-government services outlined in Exhibit 3–17 require a fundamental change in the way Government departments operate. For example, real-time remote analysis of medical imaging may require processes to ensure availability of specialists in central locations, whenever demanded from remote locations.
- **Equipment and infrastructure.** New equipment will be needed with the required functionality. For example, remote medical diagnosis may require desktop video-conferencing units in rural doctors' surgeries, with the capability to connect to a network of other doctors or large hospitals.
- **IT platforms.** Real-time access to applications and data will require the upgrade or replacement of IT platforms. For example, online health records require reliable databases with secure interfaces for remote access.

> **Highlight.** Network and technology services are only one component of an e-government capability—other components include policy and funding, regulation, training, operations and processes, equipment and infrastructure, and IT platforms.

Exhibit 3–18. Case study: e-government in South Korea

Fibre for the people: A South Korean success story

A relentless drive to disseminate and push for very high-speed broadband usage across South Korea has reduced the cost of government, while delivering a vast range of online opportunities. Outcomes in South Korea demonstrate the importance of addressing the multiple components of e-government capability. Some examples:

- **E-learning**. 99.6 percent of students use IT for their studies (second highest worldwide). Every primary and high school has free Internet access and PCs; government programs have distributed 96,000 computers to low-income students
- **E-government**. South Korea ranks sixth worldwide in the 2008 UN e-government Readiness Index. Integrated e-government platforms handle 90 percent of public administration documents (e.g. for home taxes, housing registration)
- **E-health**. Almost all medical claims are managed electronically. All medical institutions are linked to the government's high-speed fibre network; remote diagnostics and portals display live medical operations
- **ICT access**. South Korea has 94 percent broadband penetration (highest in the world), 25,000 low-cost Internet cafés, 8,600 information access centres offering used PCs and ICT know-how
- **ICT policies**. The ICT sector employs up to 8 percent of the workforce. R&D centres are subsidised (USD 1.2 billion) to develop a national core network. A public entity has been set up to develop ubiquitous networks with operators. New buildings are certified by connection speed, encouraging ICT investment.

Source: Implementation Study

3.4.2 TRANSLATING NEEDS INTO SERVICE REQUIREMENTS

Developing a set of technical and service requirements for NBN Co with respect to e-government is difficult, as many services are in the early stages of development. It is also likely that the network requirements will vary significantly across different service types. This variety of requirements is shown in Exhibit 3–19.

Smart grid is not an individual application or solution, rather a collection of distinct applications that have varying degrees of latency sensitivity, market availability, interference issues, and power requirements.

Alcatel-Lucent[69]

For many of these services, the network is not the bottleneck, and the services could be delivered over most ADSL2+ and cable connections today. The barriers to implementation are often the systems and processes of the relevant Government entity.

[69] Alcatel-Lucent 2009, *Comments on NBP public notice #2: Implementation of Smart Grid technology,* submission to the Federal Communications Commission, GN Docket Nos. 09-47, 09-51, 09-137

Exhibit 3–19. Network requirements for select e-government services

Service	Description of needs	Network specifications
Healthcare IT services	■ Fast and reliable transmission can literally be a matter of life and death[a] ■ Includes personal healthcare information[a]	■ QoS (i.e. prioritisation) ■ Resilience ■ Security and privacy
Telemedicine	■ A single image can vary from 2 MB to 3 GB or more[b] ■ Common requirements for all clinical applications are the need for guaranteed, continuous connectivity and QoS[b]	■ Variable speed and symmetry depending on application ■ QoS ■ Reliable connectivity
Online voting	■ There are substantial technical challenges to safe and secure online voting today[c]	■ Security and privacy
Educational video-conferencing	■ Videoconferencing requires broadband to avoid pixilation and latency problems with video or audio connections[d]	■ Symmetrical high speeds ■ Latency

a. AT&T 2009, *Comments on NBP public notice #17: Health care delivery elements of national broadband plan*, submission to the Federal Communications Commission, GN Docket Nos. 09-47, 09-51, 09-137

b. American Telemedicine Association 2009, Comments on NBP public notice #17: Health care delivery elements of national broadband plan GN Docket Nos. 09-47, 09-51, 09-137

c. Open Source Digital Voting Foundation 2009, *Comments on NBP public notice #20: Moving toward a digital democracy*, GN Docket Nos. 09-47, 09-51, 09-137

d. California Imperial County Office of Education 2009, *Comments on NBP public notice #15: Broadband needs in education,* GN Docket Nos. 09-47, 09-51, 09-137

Source: Implementation Study

Highlight. e-government services have widely varying requirements at the network level, ranging from basic Internet access to sophisticated managed network functionality.

3.4.3 DELIVERING THE NETWORK CAPABILITIES TO SUPPORT E-GOVERNMENT SERVICES

The NBN will play an important role in enabling an e-government future. By greatly improving the extent and performance of superfast broadband across the country, the NBN will enable widespread delivery of services which are developed for digital delivery.

Determining the ability of wholesale services to meet e-government needs

NBN wholesale services will enable a step change in many e-government services, through ensuring ubiquitous fast access with higher bandwidths. Public agencies will be able to deploy many new services with confidence that they will be available and affordable to all Australians. The diversity of bitstream services to be offered by

NBN Co, and the availability of enterprise-speed point-to-point services, should ensure that connectivity is available to meet most public service requirements.

However, differences in platform capabilities could impact the ability of some e-government services to be delivered in some regions. For example, high-bandwidth services exceeding 12 Mbps are unlikely to be delivered to remote communities, limiting the scope for two-way high-definition services. Even in the fibre footprint, terrestrial wireless access—including wireless connectivity for some services such as smart grids—will continue to be provided by integrated operators. Although the NBN will be a substantial enabler of e-government, other networks will continue to play important roles.

The role for downstream service providers to enable e-government

For those e-government services running over the Internet, service providers will play an obvious role as the provider of Internet connectivity. In addition, some e-government requirements will require Layer 3 functionality to the end-user premises. These services are expected to be provided by managed-network providers, operating on Layer 2 NBN services. It is likely that Layer 3 wholesalers, and integrated resellers, would naturally provide such services as part of their offering—those that did not would lose market share. Nevertheless, there is a possibility that no wholesale service provider emerges which can meet the specifications on a national basis, and for key government services, some further stimulus may be required.

Highlight. If Government departments aim to develop national e-government capabilities that leverage the NBN, they should consider developing or procuring dedicated Layer 3 systems designed specifically to meet their needs. These services would be provided by intermediate wholesalers utilising NBN and other network services. If multiple Departments are pursuing similar objectives there are likely to be synergies from combined efforts.

Ensuring affordability of services for public service needs

To enable the digital delivery of Government services, it is important that the agencies and institutions which require connectivity to deliver the services can afford it. NBN Co will be required to set wholesale prices for its mass-market services at levels which ensure affordability (Section 2.3). As such, NBN Co will be pricing to encourage widespread adoption of broadband by households and businesses.

However many e-government services require broadband services with performance specifications that exceed the mass-market services NBN Co is likely to offer. This is particularly true of larger institutions which require enterprise-grade connectivity to enable large bandwidth transfers or simultaneous video conferencing links. Hospitals, schools and other educational institutions are likely to require enterprise-grade connections. For example, hospitals require enterprise-grade services to enable the transfer of large bandwidth files such as magnetic resonance imaging (MRI) and to allow for high-quality video conferencing for remote consultations.

> *Symmetry is widely required in the contemporary education context to be necessary for adequate real-time communications, such as high-definition video-conferencing as well as end-user-created content and the sharing of multimedia.*
>
> DEEWR[70]

The Department of Education, Employment and Workplace Relations (DEEWR) states that the NBN should be capable of providing point-to-point fibre connections to schools to enable a digital education future. This could include classrooms drawing on a store of educational videos and interactive class materials as well as using video conferencing to create virtual classrooms that bring together remote students and other schools.

NBN Co is likely to price enterprise-grade services for business users at a price premium relative to mass-market services (Section 4.5). However, such prices may prove prohibitive for public institutions delivering Government services over digital platforms, which have significant ongoing needs for connectivity.

Government should aim to work with NBN Co and service providers to develop a special class of wholesale services that can be used by service providers to develop affordable services for institutions delivering Government services. Offering discounted services to these institutions could make commercial sense for NBN Co. There are many examples of the private sector offering discounts to the public-service sector—e.g. education discounts for IT equipment, in recognition that while valuable customers these institutions do not have same financial resources as private sector enterprises.

As described further in Section 4.5.2, defining specific classes of wholesale services for end users does not violate NBN Co’s equivalence obligations as long as those wholesale services are offered on an equivalent basis by NBN Co to retail service providers.

[70] DEEWR 2008, *Towards a National Vision of Connectivity for Australian Schools*, Canberra

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4 Building a fibre access network to 90+ percent of premises

SUMMARY

- NBN Co should build a fibre access network to deliver superfast broadband services to 93 percent of premises in Australia.
- Selecting the fibre topology to deploy in this network is one of the most important implementation decisions facing NBN Co and Government—it will shape the industry landscape for 40 years or more. NBN Co should deploy a topology that facilitates active-layer competition across a substantial portion of the network.
- A home-run topology provides a future-proof solution and delivers competitive benefits by enabling active-layer competition through physical unbundling of fibres. Implementation Study modelling suggests this topology can be deployed across 50 percent of premises in the fibre footprint for an approximately 4 percent increase in the total cost of the fibre access network, relative to a fully-shared topology.
- NBN Co should conduct trials of alternative topology options during its early roll-out to determine the appropriate mix of topologies to deploy, in consultation with Government and the ACCC, and determine its target topology by the earlier of the completion of the roll-out to 15% of premises or the end of 2013.
- Active equipment deployed on top of the fibre is expected to be a mix of GPON and Ethernet point-to-point technologies. 100 Mbps data rates are achievable in the access network using both technologies—20 Mbps is an appropriate speed for an entry-level broadband service. Technical standards for NBN Layer 2 services must support a range of high-bandwidth and next-generation retail services and facilitate entry by Layer 3 service providers.
- The NBN should achieve high penetration in the fixed-line market in the long term—with steady take-up year-on-year of 6-12 percent of homes covered in line with international experience. Mobile substitution is not expected to be a long-term threat to achieving take-up, and service providers will have an economic incentive to migrate customers onto the NBN.
- Pricing for NBN services should evolve over time to balance a range of considerations—take-up, affordability, usage, regulation and commerciality.

Government has set a coverage objective for the fibre solution of delivering 100 Mbps data rates to 90 percent of premises. Government has also set a long-term objective that NBN Co build and operate the fibre network as a commercial entity.

Achieving these outcomes requires a holistic approach to implementing the fibre access network. To deliver on coverage requirements, all network components must be capable of supporting the specified data rates. At the same time, the coverage obligation must be implemented efficiently, within Government's initial expenditure estimate. Once built, the network must attract customers and generate revenues sufficient to enable NBN Co to sustain its business.

This chapter begins with an overview of the FTTP reference model used throughout the Implementation Study, including terminology used for different network elements. Subsequent sections outline our recommended approach to implementing the fibre access network:

4.1 Defining the fibre-to-the-premises reference model

4.2 Establishing network specifications to meet the objectives

4.3 Meeting fibre coverage objectives within Government's initial expenditure estimate

4.4 Achieving take-up of services on fibre

4.5 Creating a robust revenue model for the NBN fibre network.

4.1 Defining the fibre-to-the-premises reference model

In deploying a fibre-to-the-premises (FTTP) network, a wide range of different topology and technology options are available. For the purposes of the Implementation Study, we have developed a 'reference model' FTTP network, which we have used as the basis for our modelling of the potential business case for NBN Co and as a basis for assessing the types of services and the degree of competition that can be enabled over time. As described in Chapter 7, we have also run a variety of sensitivity and scenario analyses.

This reference model was developed through extensive consultations with industry experts and with NBN Co engineers. It is consistent with industry standards and forms an appropriate basis for the work of the Implementation Study. It is not however, intended to be a precise and detailed depiction of the network NBN Co will build, which will be informed further by both additional modelling by NBN Co and input from additional stakeholders including Government, vendors and retail access seekers.

The terms and definitions outlined below are used throughout the report when referring to specific network components. We have not attempted to capture and define each individual component of the NBN. Rather, this reference model aims to assist the reader in understanding the recommendations and discussion contained in this report.

This reference model builds on existing work, industry standards and terminology wherever possible. In particular, we have drawn from published material from NBN Co and the Communications Alliance[71], with a focus on the fibre footprint.

This section covers:

4.1.1 Defining network components

4.1.2 Defining fibre access network architecture.

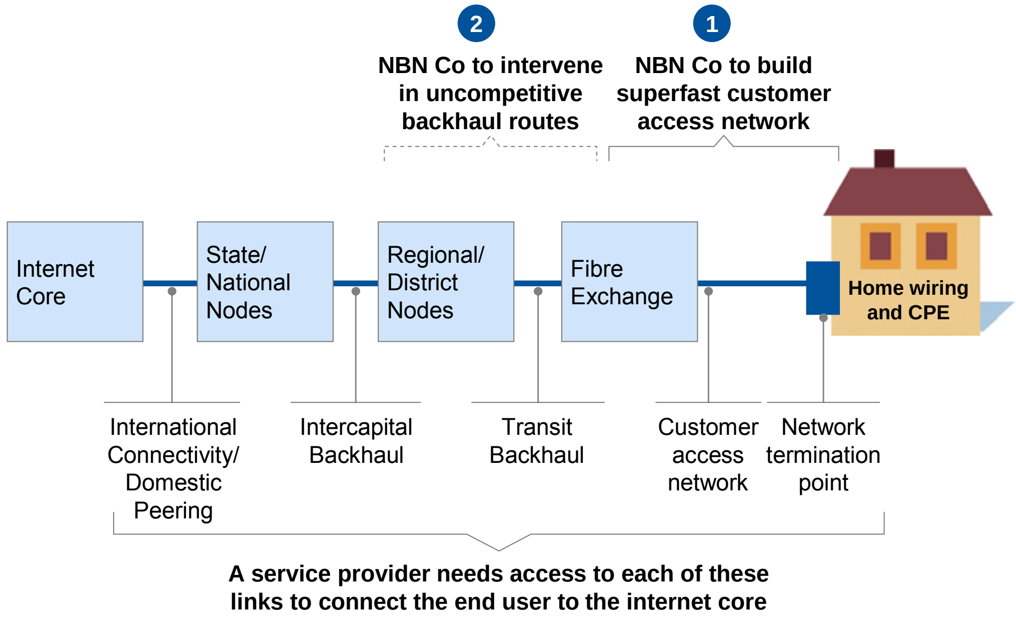
4.1.1 DEFINING NETWORK COMPONENTS

Exhibit 4–1 outlines the network components a service provider uses to link end users to the Internet core. Industry definitions of terms are not fixed, so the Implementation Study uses generic terms to define these network components.

We discuss differences between the types of backhaul in Section 6.1.1, and the rationale for limiting NBN Co's participation to the access network and targeted intervention in the backhaul market shown in Exhibit 4–1 in Section 2.1.1.

[71] Communications Alliance Ltd (2010), *National Broadband Network Reference Architecture: High-level Architecture Options for the NBN,* Release 1, January 2010

Exhibit 4–1. High-level depiction of network components

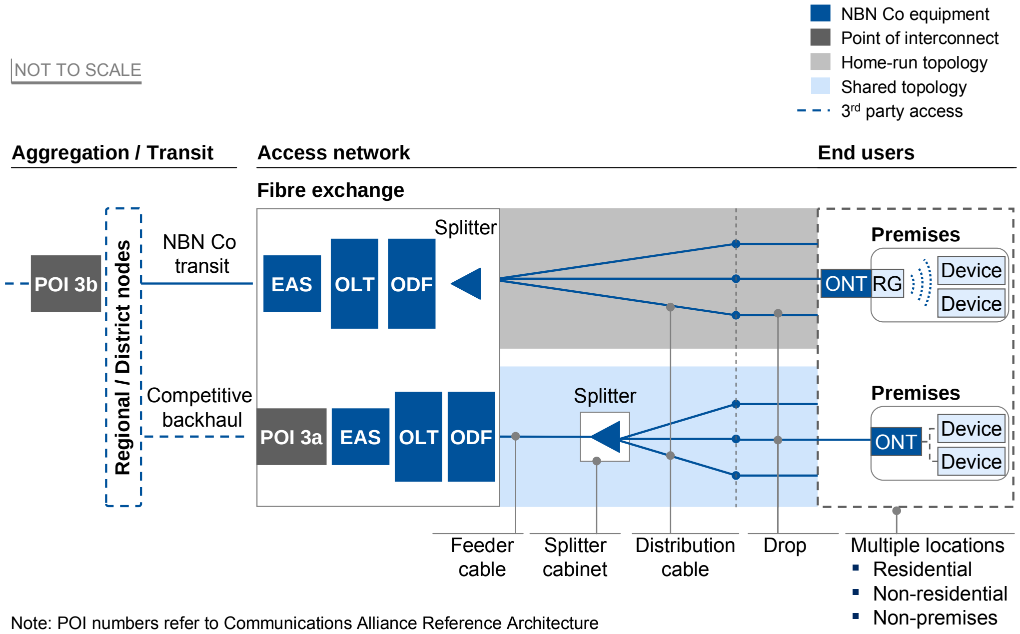


SOURCE: Implementation Study

4.1.2 DEFINING FIBRE ACCESS NETWORK ARCHITECTURE

Most of NBN Co's operations will be in the fibre access network, with targeted intervention in uncompetitive backhaul routes. Exhibit 4–2 outlines the major components of the fibre access network, each of which we describe below.

Exhibit 4–2. Fibre access network reference model



Note: POI numbers refer to Communications Alliance Reference Architecture
SOURCE: Communications Alliance; Implementation Study

Fibre Exchange

The fibre exchange—also commonly known as a Fibre Access Node (FAN)—houses the active equipment. This includes the Optical Line Terminal (OLT) equipment—in this case a gigabit passive optical network (GPON) OLT—and Ethernet aggregation switching devices (EAS), as well as equipment for physical fibre management, such as the Optical-fibre distribution frame (ODF). The fibre exchange is analogous to a copper exchange; however a fibre network typically requires fewer exchanges due to higher premises to exchange ratios.

In some cases, the point of interconnect (POI) where service providers connect to the NBN access network will be directly at the fibre exchange. In other cases where competitive backhaul is not available from the exchange back into the network, the POI is located at an aggregated node higher up in the network.

Passive network components

The passive architecture refers to the overall scheme for fibre cabling and passive (i.e. unpowered) optical plant. Its configuration is frequently referred to throughout this report as the 'network topology'. The choice of network topology influences both the physical deployment of the fibre and the passive equipment employed.

Network Topology

The network topology refers to the physical layout of fibre in the field. There are two main types of fibre topology:

- **Home-run topology**, where a dedicated access fibre connects every individual premises to the fibre exchange. This is analogous to existing copper access networks where premises connect by at least one dedicated line;
- **Shared topology,** where a single fibre runs from the fibre exchange to a passive 'splitter' in the field. This splitter divides the optical signal multiple times, with each split signal travelling down a separate fibre to a customer premises. Splits of 1:32 are common in FTTP systems and reduce the amount of fibre that must be run from an exchange to the point of the splitter.

Because the terms 'topology' and 'technology' (where technology refers to the active layer technologies deployed on the passive fibre) are often confused when referring to fibre architectures, we set out in Exhibit 4–3 how the Implementation Study uses these terms, along with a discussion of the relationship between common topology and technology choices.

Exhibit 4–3. Topology vs. active component technology

Clarifying what is meant by topology vs. active component technology

Our fibre access network reference model assumes a passive optical network is deployed from the fibre exchanges out to customer premises. Consequently no active electronic components are deployed beyond the exchanges (except at the customer premises). Within this architecture it is important to distinguish between the concepts of fibre topology and active layer technologies.

Topology refers to the physical layout of the fibres between the exchange and customer premises: in particular, whether part of this layout is shared (with splitters deployed in the field so that many customer premises can be served by a single fibre running from the exchange) or whether individual fibres run to every premises (home-run topology).

In many cases, specific active layer technologies have been developed to transmit signals down the fibre within a given topology. For example, with shared topologies a popular active layer technology is GPON (Gigabit Passive Optical Network) electronics, since GPON lasers are designed to be compatible with a fibre that is subsequently split into multiple downstream fibres. By contrast, Ethernet Point-to-Point electronics are typically deployed over home-run topologies.

Since GPON electronics are typically associated with a shared fibre topology, the term ‘GPON’ is sometimes taken to mean both use of GPON electronics and use of a shared topology. This does not necessarily have to be the case. Specifically, if a home-run topology is deployed (as is recommended by the Implementation Study for a significant portion of the network), GPON electronics can still be used. This is accomplished by relocating the optical splitters to the fibre exchange (a ‘central split’), so that there is an individual distribution fibre per premises.

An advantage of this model is that it allows the network operator to deploy OLTs with fewer ports (where the number of ports is driven by the number of fibres connected to the OLT).

Source: Implementation Study

While a variety of topologies and active technologies are possible, the Implementation Study reference model is based on GPON active components installed on a combination of home-run and shared topologies, which we expect to comprise the bulk of the fibre access network.

In practice, the network deployed by NBN Co will also contain Ethernet Point-to-Point components deployed over home-run topologies where very high throughput service is required, for example to enterprises, schools, hospitals or government departments .

Fibre access network segments

For the purposes of the Implementation Study, we define three segments of the fibre access network:

- Feeder is the shared fibre that runs from the OLT to the splitter cabinet or pit where it is split. It is only used in a shared topology;
- Distribution is the dedicated fibre for each user that runs from the splitter to the drop point (typically either a pole for an aerial deployment or a pit for an underground deployment);
- Drop is the fibre connection into the premises and includes the physical lead-in cable and the fixed installation (including ONT and wiring).

Passive equipment

- Splitters split the signal travelling over shared feeder fibres into dedicated distribution fibres;
- Splitter cabinets are enclosures that house splitters and enable in-field fibre management;
- Optical distribution frames (ODFs) sit in the exchange to enable efficient fibre management.

Active network components

Active equipment is installed on the passive components to provide active wholesale services. For ease of reference, the reference model outlines GPON components only. However, most fibre exchanges will also contain equipment to provide Ethernet point-to-point services. The active equipment includes:

- Optical line terminals (OLT), which is active equipment that typically sits at the exchange level and controls, allocates, transmits and terminates optical signals;
- Optical network terminations (ONT), which terminate the PON at the customer premises. The ONT can be placed inside or outside the premises, and will connect to residential gateways (RG) or directly to user devices.

Customer premises equipment

NBN Co will not take responsibility for installing customer premises equipment (CPE), which will instead be handled by the retailers providing services into the home. CPE within the fibre footprint will typically consist of one or more residential gateways (RGs)—for example, wireless routers, set top boxes—connected to the ONT, as well as any in-home wiring used to distribute signals around the house. In new developments, this in-home wiring should be of a standard capable of high-speed data transfer, such as CAT 5 or CAT 6 cables (Section 2.1.4).

4.2 Establishing network specifications to meet the objectives

The NBN fibre access network must be capable of delivering at least 100 Mbps. However, there are several network components required to enable the Layer 2 service, and the capabilities of each of these must be fully considered in the specification of the network.

The different layers of the network (shown in Exhibit 4–4) have starkly different life-times and implications for ultimate performance and competitive outcomes. The passive layer has a very long life and will shape the dynamics of the industry for generations. The active layer is expected to be upgraded much more rapidly over time. The services layer will be highly dynamic once a large number of users connect to fibre and an applications ecosystem develops.

As recommended in Chapter 3, NBN Co will operate both the passive layer and active layer (Layer 2) of the fibre network. This section describes the network specifications required to implement the coverage objectives and the minimum level of wholesale service that NBN Co should offer:

Exhibit 4–4. Brief overview of network elements and principal characteristics

Network layer	Description	Lifetime (years)	Principal characteristics
Service (Layer 3+)	Retail services provided to end users (NBN does not specify, but must be cognisant of demand)	n/a	■ Retail demand ■ Innovation of applications and services
Active (Layer 1/2)	Wholesale services offered to service providers	n/a	■ Wholesale inputs required for service providers to meet end-user needs
	Active equipment installed on the network (OLT and EAS switch)	7–10	■ Operational efficiency ■ Upgrade path ■ Cost
Passive (Layer 0/1)	Fibre topology	20–50	■ Desired competitive outcomes ■ Network performance ■ Cost
	Physical deployment: Poles, ducts and trenches	30–60	■ Open access ■ Security ■ Cost

Source: Implementation Study

4.2.1 Designing a passive architecture to deliver enduring performance

4.2.2 Deploying active equipment to deliver 100 Mbps

4.2.3 Specifying wholesale services to substantiate the NBN promise.

4.2.1 DESIGNING A PASSIVE ARCHITECTURE TO DELIVER ENDURING PERFORMANCE

The scalability of fibre provides the capability of delivering speeds in excess of 100 Mbps—more than sufficient to meet the needs of most premises today. However as we discuss in Chapter 9, the specific topology of fibre network selected will be a critical enabler of future competition at an active layer. Such competition is the best means of ensuring innovation and continual upgrades—sufficient to meet the needs of all premises in the future.

The passive architecture refers to the overall scheme for fibre cabling and passive optical plant, its configuration—referred to as ‘topology’—and the ducts and poles that carry the fibre equipment—which we refer to as the ‘physical deployment’. Collectively, these passive elements are the most costly part of the network, comprising about 70 percent of total network investment. They also have the longest life (Exhibit 4–4). The passive network must therefore be designed to deliver enduring performance as a future-proof national platform.

This subsection explains the options and considerations that apply to the three elements of the passive network: fibre as a physical medium; topology; and the physical deployment.

Laying fibre as the enduring physical medium

Fibre is the physical network platform of the future. It has potential to far exceed the short-term performance requirement of 100 Mbps. Already, single fibres can carry over 10,000 times this volume of data traffic. In addition, physical fibre has a very long life, with a low fault rate. Chapter 2 outlines the importance of fibre in creating the national platform for future needs. We now revisit these points in the context of the passive network specifications.

The NBN fibre network will be an enduring national asset, serving the communications needs of consumers, businesses and enterprises for a generation or more. If properly specified and deployed, the physical network should not need revisiting for 40 years and more. The passive network should be designed and deployed with a ‘dig-once’ mindset to ensure future generations receive the benefit of this transformational project.

Selecting a future-proof fibre topology

The decision of which fibre topology to deploy requires careful consideration. Although fibre-to-the-premises delivers a step change over copper performance, fibre topologies can vary significantly. There are three criteria on which different topologies should be assessed:

- Future network performance;
- Support for long-term competitive outcomes;
- Upfront cost.

> *Network design directly influences market outcomes and the nature and effectiveness of competition*
>
> FTTH Council Asia-Pacific (2009)[72]

The major trade-off for Government is cost versus future-proofing performance and long-term competitive outcomes—specifically, the extent to which the fibre topology supports future upgrade scenarios and passive-layer unbundling (the options for which are discussed in Chapter 10). However, making an informed trade-off upfront is challenging due to uncertainties about the magnitude of impact. In this section we assess a range of topology options against these dimensions, and emphasise the need for careful analysis to ensure any trade-offs are fully considered.

Introducing the options for fibre topology

There are two main types of fibre topologies: 'home-run' and 'shared' (or 'split') topology. In home-run, a dedicated access fibre connects individual premises to a fibre exchange. This is analogous to the existing copper access network where premises connect by at least one dedicated line.[73] In a shared network, a single fibre runs from the exchange to a 'splitter', which then distributes the optical signal amongst multiple premises through dedicated fibres. Home-run options are often referred to as 'point-to-point' and shared options as 'GPON' networks. However, those terms are imprecise, as they refer to both the fibre topology and the active electronics commonly employed on those topologies.

It is important to distinguish between the fibre topology and the active electronics when designing the network. Although a shared topology requires PON active technology, such as GPON, a home-run topology will support any optical electronics, including GPON. In addition, the passive and active layers have different life spans. The decisions on topology and active electronics should therefore be driven by different factors (Exhibit 4-4). For example, the permanent nature of the topology means the impact on the long-run network performance and competitive landscape is a primary

[72] FTTH Council Asia-Pacific 2009, *Submission to the New Zealand Government Broadband Investment Initiative*

[73] Except where a pair gain system has been used to extend the reach of a copper line (discussed later in this section)

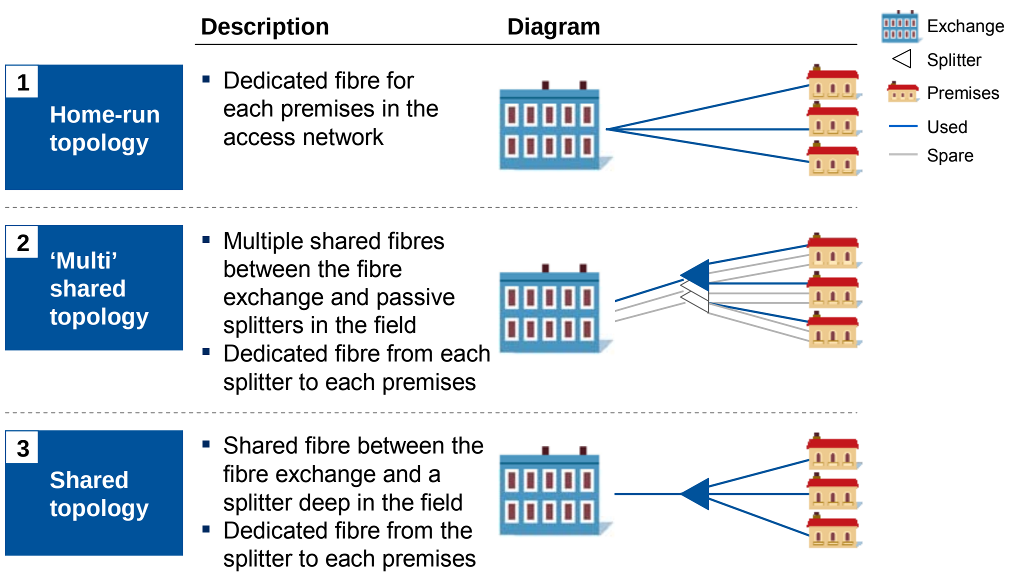
concern. Conversely, the 7–10 year generational lifecycle of active electronics increases the importance of cost and energy efficiency. Topology and technology for the NBN must therefore be treated separately, with careful consideration of the decision criteria, before committing to an investment of this magnitude.

> **Highlight**. The choice of fibre topology for the NBN is a critical decision that should be distinct from the active technology installed on it, despite these choices often being made jointly. The topology will shape the long-term network performance and competitive landscape, whereas the technology will be replaced every 7–10 years.

We have assessed three topology options. The home-run and shared topologies are the most common, and are widely deployed around the world. We also consider a variant of the shared topology that is being deployed in some countries around the world: a 'multi' shared topology, in which multiple fibres from the fibre exchange serve multiple splitters in the field, with multiple distribution links to the premises. Exhibit 4–5 outlines the three options.

Shared and home-run topologies are both capable of enabling short-term performance of 100 Mbps and each is being deployed in other markets (Exhibit 4–7). However, the options differ in performance against the key decision criteria (Exhibit 4–6). From this comparison, it is clear that Government faces a genuine trade-off in selecting the right fibre architecture for the country. We now address the detail of each criterion in turn.

Exhibit 4–5. Fibre topology options



SOURCE: Yankee Group; Implementation Study

Exhibit 4–6. Assessment of fibre topologies

Topology options	Decision criteria: Future network performance	Support for physical unbundling	Upfront cost
1 Home-run topology	✓✓ Full flexibility to upgrade individual premises ✓ Upgrades not restr-icted by technology	✓✓ Fully enables physical unbundling	✘ Likely cost premium ? However, premium depends on duct availability
2 ‘Multi’ shared topology	✓ Upgrades possible on individual fibres	✓ Active competitors can access ‘dark’ fibres; however, competition limited by number fibres	✘ Additional cost driven by spare fibres, splitters and civil works
3 Shared topology	✓ Robust eco-system of active electronics	? Physical unbundling operationally difficult and economically unfeasible ? Technology for wavelength unbundling uncertain	✓ Generally cheapest option to deploy ? Depends on availability of existing ducts

SOURCE: Yankee Group; Implementation Study

Delivering future network performance

Home-run topology offers superior performance and flexibility over the long term. There are no requirements for smart electronics that share signals between connections; a dedicated connection is available to each premises, which can be ‘lit’ by any optical device, from a simple optical Ethernet switch to a GPON OLT. Shared topologies, by contrast, require PON technologies, which are slower and more complex. It is true that today’s GPON services exceed current household needs, so the benefits of the latent potential for higher bandwidth using point-to-point electronics are not immediately obvious.

> *No one will need more than 637 kb of memory for a personal computer—640K ought to be enough for anybody*
>
> Bill Gates, Microsoft (1981)[74]

Home-run networks have the major advantage that upgrades are realisable on a per-line basis. Individual premises can therefore receive improved performance as it is demanded. Shared topologies do not allow the same degree of upgrade flexibility. All premises connected to an optical splitter must be upgraded concurrently (as a feeder fibre is shared).

[74] Crovitz, G 2009, ‘Technology predictions are mostly bunk’, *Wall Street Journal: Asia Edition*, 27 December, p. 14

There are large numbers of PON networks being constructed around the world, so the ecosystem is likely to continue evolving and improving. It is however possible that at some point in time, the cost of meeting market performance demands may be greater on a shared network than a home-run network, due to inherent performance restrictions of PON technologies.

> *Our strong recommendation is that the passive plant is designed to handle either technology*
>
> Ericsson Communications Limited (2009)[75]

> **Highlight**. Home-run topology supports both GPON and Ethernet point-to-point technologies, giving the option of fast speeds with simple electronics; shared topology restricts the network to using PON technology.

Supporting physical unbundling

Physical unbundling is important for future competitive outcomes. It will ensure ongoing investment and innovation on the NBN at an active layer, and mitigate the risk of NBN Co becoming a long-term wholesale monopoly. We detail the rationale for this in Chapters 9 and 10. The ability to physically unbundle the network is determined by the fibre topology.

Home-run topology fully supports physical unbundling, as individual fibres from a fibre exchange can be used by an access seeker to serve any given premises. Unbundling on home-run topologies is analogous to copper networks today.

Shared topologies, on the other hand, do not inherently support physical unbundling. Multiple premises are grouped on a single exchange fibre, so any access seeker would have to acquire the houses served by a single exchange fibre simultaneously. This gives rise to many practical complexities in unbundling end users. An alternative is to physically reconfigure the network, by changing the connections at the splitter. However, this requires the manipulation of fibre connections in-field, disturbing the fibre cabling and risking disruptions to services.

> *If [regulators] are serious about open access, they should impose topology restrictions to at least ensure that passive opening is viable if it is to be enforced in the future*
>
> Yankee Group (2009)[76]

Some shared designs can make physical unbundling prohibitively expensive and operationally difficult. By placing the splitters in pits or inaccessible environments, or limiting the size of cabinets to require prohibitively high market shares for access-seekers or to prevent installation of their splitters, the network owner can render economic reconfiguration of the network impractical.

Intermediate unbundling options do exist. Multi-shared topologies partially overcome the risk by providing multiple fibres and splitters from the fibre exchange. This provides a

[75] Ericsson 2009, *Submission to New Zealand Government Broadband Investment Initiative*

[76] Yankee Group 2009, *GPON or P2P: Choosing an FTTH architecture*

number of dark shared fibres for access seekers. However, the number of access seekers is limited by the number of fibres deployed from the fibre exchange.

Wavelength division multiplexing (WDM) may also emerge as a viable option for unbundling on either topology. This option involves unbundling of wavelengths rather than physical fibres, and is therefore enabled by the technology rather than topology. We advise that Government not rely on it as the only option for unbundling on the NBN, for two reasons. First, the technology to enable wavelength unbundling in access networks is not currently in operation, and its development is uncertain. Second, it would require operation of the active electronics by NBN Co, which partially negates the competitive benefits associated with unbundling. We discuss WDM in more detail in the following subsection.

> *Wavelength unbundling is considered to be on the border of passive and active access. Although standards for 'grooming' the light are being developed, interoperability requirements mean that technology choices at the exchange will influence technology choices at the customer premises.*
>
> Ofcom (2009)[77]

Highlight. Home-run topology is open-access by design and fully supports physical unbundling of individual fibres; Shared topologies do not inherently support physical unbundling, and some designs can make it prohibitively expensive and operationally difficult—e.g. by locating splitters deep in the network (i.e. serving a small number of premises) or installing small cabinets; Uncertainty of technology for wavelength unbundling means Government should not rely on it as the only option for network unbundling.

Estimating upfront cost to deploy

The NBN will create an enduring platform to meet the needs of users and industry for generations. A project of this scale must be resilient to future developments in technology and demand. Home-run topology should therefore be preferred over shared topology, for a reasonable cost premium.

Home-run topology is generally considered to be the more expensive option. However, studies around the world show that a shared configuration may not always generate significant savings. In some circumstances, it saves less than 5 percent relative to home-run topology.[78]

However, accurately estimating the cost difference between home-run and shared topologies is challenging. It is difficult for the Implementation Study to make a blanket statement of the cost premium that may be required, for two reasons:

[77] Ofcom 2009, *Ethernet active line access: Updated technical requirements*

[78] Cisco 2009, *FTTH technology considerations,* viewed 15 December 2010, <http://www.bloobble.com/broadband-presentations/presentations?itemid=2340>

- Costs are difficult to estimate accurately in desk studies or small-scale field trials—the only dependable data is gathered by experience. Desk studies necessarily require some averaging assumptions. Although actual costs should sit within the bounds of these estimates, real costs will inevitably differ in some instances.[79]
- Costs are likely to vary by geography—the cost differential between home-run and shared topologies depends on duct availability, density of premises, and costs of trenching. For example, Cisco estimates that if ducts are unavailable, the premium for home-run may be as low as 2 percent. If ducts availability is limited—the case for most incumbents—the premium may range from 5 to 25 percent.[80]

Implementation Study modelling suggests a fully national home-run topology would require a $2.6 billion investment premium over a shared configuration. This is discussed in more detail in Section 4.3.

There is a policy choice for Government about the level of investment it is prepared to make for a fully future-proof network. In practice, it may not be necessary to deploy home-run topology everywhere to obtain the long-term performance and competitive benefits. We therefore modelled, as our reference case, a mix of 50 percent home-run and 50 percent shared topology within the fibre footprint. This mix represents a $0.9 billion (4 percent) premium over a fully shared access network. The ultimate percentage deployed over a home-run topology should be determined after NBN Co has trialled different architectures as proposed in Chapter 10.

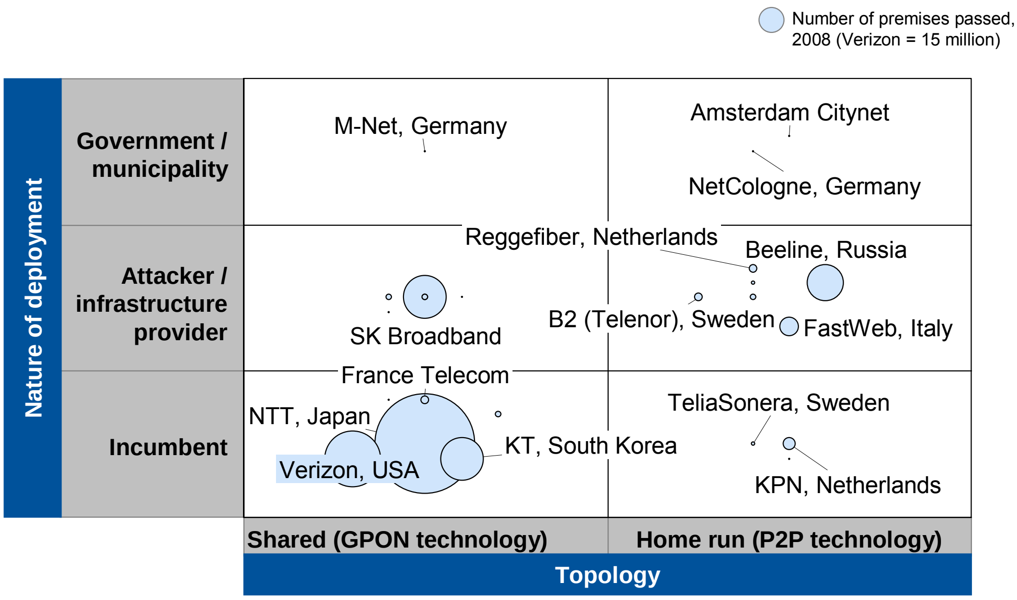
Although it is not a fully future-proof solution, this compromise delivers long-term benefits in the areas most likely to experience future active-layer competition. We consider a premium of this magnitude should be acceptable to Government, given the long-term benefits of home-run topology. A willingness to pay a premium for a future-proof topology is consistent with Government's willingness to pay a premium to deploy fibre-to-the-premises, instead of cheaper but less future-proof solutions such as HFC or FTTN.

> **Highlight**. Geospatial modelling indicates a home-run topology covering 50 percent of the fibre footprint adds approximately 5 percent to the overall fibre access network investment, relative to full shared topology. These costs will need to be refined based on trials to be conducted by NBN Co.

79 New Zealand Treasury 2009, *Fibre-to-the-premises cost study: Prepared for the Treasury*, report prepared by M Milner, Milner Consulting Limited, Wellington

80 Cisco 2009, *FTTH technology considerations*

Exhibit 4–7. Fibre topologies deployed in other countries



SOURCE: Yankee Group; Idate; Japanese Ministry of Internal Affairs; company websites

Assessing precedents and experiences in other network deployments

Australia has the opportunity to learn from the many fibre deployments now underway around the world. Incumbents, infrastructure providers and Governments are funding fibre deployments in many countries. Exhibit 4–7 shows some patterns are emerging.

Shared topologies are usually the first choice for incumbents, for a number of reasons. First, access to their existing ducts is critical for reducing overall costs. Shared topologies employ less fibre in the feeder network and increase the percentage of the physical network that can fit cheaply inside existing infrastructure. Second, commercial incentives can lead some incumbents to limit competition and to avoid physical unbundling. Both these factors favour a shared topology. However, neither of these reasons need apply to NBN co, which owns no ducts and has been established with an open-access mandate. Even if it obtains duct space from Telstra, this will come at a price.

Highlight. Shared topologies are generally favoured by incumbent network owners because they use less duct space and restrict passive-layer unbundling. However, these factors do not apply to NBN Co, which owns no existing ducts and has an open-access mandate.

'Public' networks, including municipalities, and attacker network providers have generally favoured home-run topologies. This trend is driven by the benefits of home-run topology identified above. Most publicly-funded networks require open access at all layers of the network. Home-run topology inherently supports this requirement, including the ability to offer dark fibre to multiple providers. The superior performance of home-run topology makes it more attractive to attackers seeking to compete against incumbent networks, particularly in the enterprise market.

> *Any infrastructure directly or indirectly funded by public money should be designed to withstand the test of time. This points to a home-run solution.*
>
> Yankee Group (2009)[81]

History contains warnings against shared networks, with some being redesigned at significant cost. For example, pair gain systems were installed in many copper networks in the 1990s to extend the reach of copper lines and increase the efficiency of provisioning new telephone services. However, when DSL technology emerged these systems were incapable of transmitting the signal. Pair gain systems consist of active multiplexors that combine multiple voice signals for transmission over a single copper pair, before being split in the field into individual lines for each connection. Telstra installed up to 1.2 million pair gain lines in Australia, which has prevented many homes from receiving broadband.[82] Although some of these lines have since been remediated, pair gains restrict many households to slow dial-up Internet, even in 2010. Telstra has indicated the cost of replacing all pair-gain systems could reach $2 billion.[83]

A second example is provided by the British Telecom deployment of a small shared optical network in Milton Keynes in the 1980s. The deployment comprised shared fibre-to-the-cabinet based on TPON technology. However, the network could not support broadband services or local loop unbundling, and was eventually mostly overlaid with copper.[84] This example is analogous to GPON technology installed on a shared topology, and highlights the risk of shared networks preventing the delivery of new services or technologies.

Investing sensibly to create a future-proof topology

The decision of topology for the NBN requires careful consideration of the trade-offs. Although home-run topology provides the NBN with un-matched performance and competitive benefits in the long term, it will likely require additional investment upfront. However, the magnitude of this investment is uncertain prior to deployment. Adding to

[81] Yankee Group 2009, *GPON or P2P: Choosing an FTTH architecture*

[82] David Quility, quoted in Australia, Senate 2008, *Debates,* 11 November, viewed 18 February 2010, <http://www.aph.gov.au/hansard/senate/commttee/S11509.pdf>

[83] Lundy, K (Senator for Australian Capital Territory) 2003, *$2 billion: The cost of Telstra's neglect,* media release, 27 March, Canberra

[84] Blondeel, Y 2007, 'Prospects for the roll-out of alternative technologies across Europe', presentation to the Ofcom regulatory challenges posed by next-generation access networks seminar, Brussels, 27 March

this uncertainty, the cost premium and competitive benefits of home-run differ by geography. The optimal topology is therefore likely to differ by region.

The amount Government is willing to invest for a future-proof network is a policy decision requiring careful consideration. Given the importance of this decision, it should only be made once a real view of costs is available through initial deployments.

The Implementation Study modelled a mix of 50 percent home-run and 50 percent shared topology with detailed geospatial modelling and network costings. We believe that this mix is achievable within the initial expenditure estimate for the NBN access network.

However, given the limitations of desk-based modelling, we cannot definitively recommend the optimal proportion of home-run deployment. Instead, we propose a review of topology options in the early stages of roll-out to support long-term flexibility and competitive outcomes. We detail this process in Chapter 10. NBN Co should anticipate this review, and plan to deploy a network that supports physical unbundling over a significant proportion of the network.

Recommendation 36. That NBN Co be required to deploy fibre topologies that support the ongoing needs of multiple stakeholders, including:

1. Service providers who may seek access to Layer 1 services, anticipating the likelihood of future unbundling requirements;
2. High bandwidth, dedicated class-of-service requirements for enterprise and government users, and for mobile base-stations and other users.

Advice. That NBN Co Board ensure the company conducts trials, in anticipation of the independent review discussed in Chapter 10 of the Implementation Study report, of options for a fibre topology that will support physical unbundling over a significant proportion of the fibre footprint.

Managing physical deployment of the network

The NBN is likely to require a mixed physical deployment, involving both underground and aerial fibre cabling. The mix of deployment methods is unlikely to impact the ability of the network to meet its performance requirements. However, this is an important issue for many stakeholders—for example, some local councils, given the aesthetic impact of different deployment choices.

The factors influencing the optimal mix of physical deployment are availability and access to existing assets, cost, ongoing maintenance, network redundancy and community impacts. Given the subtle and local nature of these factors, NBN Co is best positioned to balance these factors.

Highlight. The NBN is likely to require a mixed physical deployment with both duct and aerial components. The optimal deployment can only be determined area by area—NBN Co should make its decision based on cost and other factors.

Whichever deployment method is chosen, NBN Co should secure enduring rights of access to required infrastructure.

NBN Co should also ensure the assets used to physically deploy the NBN will support an enduring open-access network. The creation or acquisition of assets which could be shared in future—for example, new ducts—should prepare for growth and the prospect of open access at a future date.

Recommendation 37. That NBN Co be required to ensure that the assets used to physically deploy the network support an enduring open-access network; specifically for:

1. New trenches and ducts: to be over-provisioned to ensure sufficient space for future expansion or alternative use; detailed records of the location of ducts to be maintained;
2. Existing ducts: perpetual or long-term (with firm options to renew) indefeasible rights of use to be sought to ensure renegotiation of leases cannot put the future network, or commerciality of NBN Co, at risk; short-term leases to be avoided;
3. Existing overhead poles: long-term rights of use, ease of access and longevity of assets to be ensured; rights and obligations for future repairs and maintenance to be set out; political and community risks to network security and longevity to be considered.

As the largest cost driver for the NBN, the cost of physical deployment is a critical factor. Low cost options may emerge—for example, deployment in sewers or gas pipes.[85] These options should be assessed on the basis of total lifetime costs and utilised where commercially attractive.

Advice. That NBN Co Board consider the lifetime cost of assets used to physically deploy the network rather than only upfront capital cost.

4.2.2 DEPLOYING ACTIVE EQUIPMENT TO DELIVER 100 MBPS

The actual speed available in the access network will depend on the active components installed to light the fibre. The active technology used for NBN Layer 2 services is likely to combine GPON and Ethernet point-to-point (EP2P). Both are capable of delivering 100 Mbps if properly configured.

Technology decisions should be within the mandate of NBN Co. As we discuss earlier, it is important to clearly distinguish between the choice of topology and technology. While in some cases the topology will define technology choice (e.g. shared topologies require PON technology), the factors influencing each decision should differ due to the

[85] Bingeman, M 2009, 'Sewer skills a fit for cabling', *Australian,* 13 October, p. 33

significant differences in lifespan between active and passive network components (Exhibit 4–4).

Although both GPON and EP2P technologies can meet the performance requirements in the short term, the technologies differ along a number of dimensions. We now focus on the major differences between these technologies, and the implications for the NBN.

Assessing the options for active technologies

Both Ethernet point-to-point and GPON technology can deliver 100 Mbps in the access network, if properly specified. The technologies differ on a number of dimensions (Exhibit 4–8). However, on one key dimension—upfront cost—the technologies do not differ significantly. We discuss capital cost differences in 4.2. The major differences between GPON and EP2P are in performance and ongoing operational cost.

EP2P provides superior speed to GPON technology, due to the dedicated fibre used for each connection. This also allows EP2P to offer full symmetry of speeds (i.e. equivalent download and upload speed), whereas GPON, backed by ITU Standard G.984, is limited

Exhibit 4–8. Assessment of GPON and Ethernet point-to-point technologies

Decision factors	Technology options: GPON		Technology options: Ethernet point-to-point	
Speed	✓	Meets NBN performance requirements, with upgrade path to faster speeds	✓✓	Current and future speeds are superior
Security	?	Potential security issues due to shared medium—upstream traffic is not encrypted	✓	Dedicated fibre provides logical security between fibre exchange and user premises
Exchange operations	✓	Efficient use of exchange space due to fewer fibres	?	Fibre management is more challenging, but standard systems are available
Power consumption	✓	GPON uses less power—passive splitters in field improve power consumption per connection	✘	EP2P is less energy efficient—however, difference is equivalent to each user driving a single commute per year

SOURCE: Implementation Study

to a 2:1 ratio of download to upload speed.[86] This lack of symmetry may impact the ability of GPON to support some services in the future—e.g. multiple high-definition video-conferencing channels. Although current GPON speeds are more than sufficient for current market demand, EP2P will always deliver faster speeds as new services evolve.

A standard GPON configuration (2.5 Gbps over a 32:1 split) will result in slightly lower theoretical dedicated speed for every connection (76 Mbps) than the required 100 Mbps. However, dynamic bandwidth allocation allows some connections to receive greater than 100 Mbps. GPON is therefore capable of delivering 100 Mbps, when it is demanded by end users.

EP2P security is also superior to GPON. The dedicated fibre means data is not shared across any connections in the access network. However, GPON broadcasts bits to every connection below the splitter, where it is then decoded by the appropriate equipment. While downstream traffic is encrypted, upstream traffic is not. A 2007 Stanford University study outlines three potential security concerns: denial of service attacks; eavesdropping; and masquerading of an ONT (e.g. continuously transmitting upstream to block transmission of information from other ONTs).[87] However, GPON vendors downplay the significance of these risks.[88] As GPON deployments become more widespread, standards and technology to ensure the security of these networks are likely to emerge. Outputs from industry conferences and workshops indicate this process is already underway.[89] As we discuss in Chapter 2, NBN Co should coordinate with the major security and law enforcement agencies on issues relating to the security of their data over the NBN.

GPON offers improved efficiency of exchange operations. It requires the management of fewer fibres within the exchange, and therefore requires less exchange space. However, fibre management systems are available for EP2P which assist in the efficient management of multiple fibres in the exchange.[90]

GPON is also a more power-efficient technology. This feature makes it cheaper and more environmentally friendly to operate than EP2P. This aspect of the technology is often referred to as its definitive benefit over EP2P, however, the magnitude of this difference should be qualified. EP2P consumes roughly 12 W per user, compared to approximately 7 W per user for GPON.[91] This difference over 12 months is comparable to the power a user would consume driving a single daily commute.

86 Heavy Reading 2009, *FTTH review & five-year forecast: The road to PON and next-gen PON*

87 Gutierrez, D, Cho, J & Kazovsky, L 2007, 'TDM-PON security issues: Upstream encryption is needed', paper presented to the Optical Fiber Communication and the National Fiber Optic Engineers Conference, Anaheim, CA, 25-29 March

88 Wierand, K 2008, 'EP2P and GPON battle for hearts and minds', *Telecommunications,* 8 January, viewed 12 February 2010, <http://www.telecomengine.com/article.asp?HH_ID=AR_3850>

89 Telecom Italia Group 2009, 'Next generation access network (in-security): Security proposal for NGN standardisation', presentation to the 4th ETSI Security Workshop, Sophia Antipolis, France, 13-14 January

90 Industry interviews

91 Ibid.

Balancing policy objectives and practical constraints

Both GPON and EP2P technologies can meet the requirements of the NBN, despite the differences in performance and efficiency. Although EP2P provides superior performance in terms of speed and security, the operating efficiency of GPON technology makes it an attractive option in the near term.

Three factors should mitigate any government concerns about the potential speed delivered by GPON (in standard configuration):

- GPON is capable of delivering 100 Mbps when demanded by end users. Lower splitter configurations would allow all users to receive dedicated speeds at this level, if required. If only a limited number of users require the top speed, dynamic bandwidth allocation can provide the excess capacity to those users with the highest demand;
- Demand for top speeds on the network is likely to evolve slowly over time. Although trends indicate demand for 100 Mbps and higher will be inevitable, it will take some time for a range of services that consume this level of bandwidth to become widespread;
- GPON has an upgrade path to deliver much higher speeds in the future. 10GPON and WDM PON are forecast to provide higher upload and download speeds within the next few years.[92]

As we discuss in the previous subsection, WDM PON is likely to deliver improvements to GPON performance in addition to speed. For example, it may allow service providers to access ‘unbundled’ wavelengths in the access network. The Implementation Study does not discount the potential for this technology to emerge. However as outlined earlier, we note the uncertainty around its development.

> *The risk of trying to pick WDM-PON technology developments now would be analogous to installing a leading edge ADSL 1 technology that foreclosed a later installation of VDSL2*
>
> Telecom New Zealand Limited[93]

> **Advice.** That the NBN Co Board consider that the NBN is likely to require a mix of Ethernet point-to-point (EP2P) and GPON technology; that EP2P can provide superior performance to GPON in terms of speed and security; and that there is potential for strong demand for EP2P services by SMEs and premium residential users (not just large enterprises) over time, and hence the company should provision sufficient fibre accordingly.

92 Heavy Reading 2009, *FTTH review & five-year forecast: The road to PON and next-gen PON*
93 Telecom New Zealand 2009, *Submission to New Zealand Ultra-Fast Broadband consultation*

4.2.3 SPECIFYING WHOLESALE SERVICES TO SUBSTANTIATE THE NBN PROMISE

Once a network capable of delivering 100 Mbps is in place, the NBN wholesale services will determine the end-user experience. In Chapter 3 we discuss the wholesale service offers at different layers of the network stack. Exhibit 4–9 presents the options for wholesale services within the fibre footprint, and what should be included in the NBN services roadmap over time. In this subsection we discuss the dimensions on which these services must be specified.

Defining service specifications of core NBN Co services

The core offer in the NBN fibre network will be a Layer 2 Ethernet bitstream. This must be defined along 3 dimensions, also discussed in the Reference Architecture:

- **Point of interconnect.** As this is an 'access' product, the default point of interconnect is at the fibre exchange, where the OLT terminates the optical link. Note that in some cases, a transit product may be required to allow retailers to access the service at reasonable cost; this is discussed in Chapter 6.
- **Point of termination.** The NBN fibre network is intended to be open access. It is therefore important that access seekers are able to connect CPE with minimal investment. This is the case today for PSTN and DSL services, where multiple jacks are usually available inside the house. The NBN layer 2 service should provide access at a point inside the house, by means of a patch panel connected to an external or internal ONT.

Exhibit 4–9. Wholesale services to be specified in NBN service roadmap

Core service in initial phases

OSI layer	Service	Timing of offer: During build	Timing of offer: Post roll-out	Criteria for offer
Active L2–3	L3 IP bitstream	✗	?	Failure of Layer 2 market
	RF broadcast	See Chapter 2 for recommendation		
	ATA voice	✓	✓	
	L2 Ethernet bitstream	✓	✓	
Passive L0–1	Dark fibre unbundling	✗	✓	Feasibility of active competition
	Duct/pole access	✗	?	If infrastructure competition necessary

SOURCE: Implementation Study

- **Data link specifications.** Definition of service specifications lies within NBN Co's mandate. We deal with considerations for bitstream services in the following sections. However, it is worth noting that service providers will purchase links on a premises-by-premises basis, but potentially share those links with other operators. NBN Co will need to address the method of bandwidth allocation between operators and services.

> **Recommendation 38.** That the network access point at end-user premises (i.e. the ONT) be required to provide a sufficient number of physical ports to enable multiple providers to offer services to each premises; that NBN Co ensure physical access to this point within the premises, at a location reasonably requested by the user (e.g. within close proximity to existing copper lead-in); this requirement includes: 1. If the ONT is installed externally, an internal patch panel providing open access to service providers on an equivalent basis; or 2. If the ONT is installed internally; that NBN Co be permitted to contract with retail service providers to implement these network access point requirements.

Delivering a superfast experience to all users

Within the portfolio of NBN active bitstream services, there will be some lowest price and performance—or entry-level—services that will be attractive for many consumers. These services are important because they define the minimum service experience. They also form a reference point in the market for performance, pricing, and value of the NBN. If this service offers relatively poor performance, then so will the NBN in the perception of these users. It is therefore imperative that Government provide guidance on the required specifications for these services.

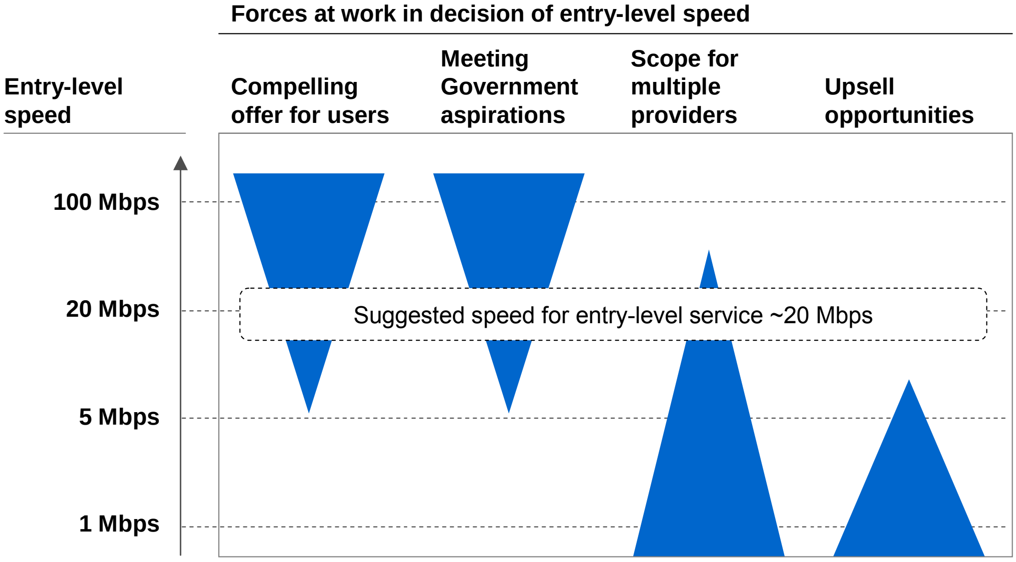
Entry-level services should be defined in two respects:

- What is the required performance of the entry-level bitstream product for broadband use?
- What legacy services should be offered, either as independent pure-play entry-level offers or as a bundle?

> **Highlight.** The performance of the entry-level broadband service will define the initial NBN experience for a majority of end users. It will also form a reference point in the market for performance, pricing and value of the NBN.

We first consider the specifications of the entry-level data product. Several tradeoffs impact this decision, as Exhibit 4–10 shows. We propose that these tradeoffs are best balanced with an entry-level service in the range of 20 Mbps.

Exhibit 4–10. Optimal speed of the entry-level broadband service



SOURCE: Implementation Study

We propose four principles to inform the appropriate performance level of the entry-level product:

- **The entry-level experience must be compelling at copper-substitution prices.** With ADSL2+ now available almost nationally, delivering speeds exceeding 10 Mbps in many areas, a basic offering of 10 Mbps or less is unlikely to gain traction. Some ISPs have average customer speeds today in the order of 12–13 Mbps, with some delivering speeds over 15 Mbps. As a result, we believe 20 Mbps is a minimum to provide a step-change in user experience relative to copper.

> *Our ADSL customers currently receive average speeds of 12–13 Mbps, with some over 15 Mbps*
>
> CEO of Australian ISP

- **The headline offer must substantiate the aspiration.** It is likely that headline entry-level retail offers will be compared against the NBN performance requirement of 100 Mbps. Consultation with industry stakeholders and experts indicates that 10 Mbps would be at the minimum range of an offer befitting Government's objective. By comparison, entry-level fibre offers of providers in other markets are generally at least 15–20 Mbps.[94]

[94] For example, Verizon FiOS offers 15 Mbps download and 5 Mbps upload (Verizon 2010, *Verizon FiOS Internet,* viewed 16 February 2010, <http://www22.verizon.com/Residential/FiOSInternet/Plans/Plans.htm>)

- **There should be scope for multiple service providers in all premises.** Chapter 9 discusses the role of the NBN in levelling the retail playing field. The implication for this section is that meaningful bandwidth should remain for other providers following the purchase of an entry-level product.[95]
- **Upsell based on speed should not be assumed.** Price differentiation is an important mechanism for network businesses to optimise revenues and demand. However, upselling on the basis of speed has proven difficult for ISPs in the DSL market, and it is a source of great market uncertainty. In addition, our revenue modelling (Section 4.5) indicates NBN Co should achieve sustainable long-run revenue with only moderate assumptions about price increases and upsell over time.

Recommendation 39. That an entry-level wholesale bitstream service for NBN Co's fibre network be defined that would be the minimum acceptable service for residential broadband use, specifically:

1. That this bitstream service enable a significant improvement over typical experiences on other fixed networks, and offer at least a 20 Mbps peak download speed within the fibre access network;
2. That this entry-level speed be reviewed over time to ensure it continues to deliver sufficient performance relative to other fixed broadband networks;
3. That exceptions for a lower-speed entry-level service be considered for commercial reasons where most end users will take retail services using at least a 20 Mbps wholesale bitstream service.

In current xDSL broadband networks, speeds are typically quoted as peak data rates. This reflects the effect that the length of the copper loops have on achievable speeds—the further any premises are from an exchange, the lower the experienced speeds. In a fibre access network, the data rates achieved do not decline in proportion to distance from the fibre exchange: all premises within the maximum coverage distance receive identical rates.

For this reason, at least in the early stages of NBN services, the peak data rates offered in the access portion of the network will be equivalent to committed data rates. This means that if a customer purchases a 20 Mbps service, that customer will be able to access sustained data rates of 20 Mbps over their access link.

There are two factors that may cause the data rates actually experienced by the end user to fall below this rate. The first is contention in the backhaul network. Although the access network (from the fibre exchange to the customer premises) is not a contended link, in the backhaul network the data from many end users is combined onto a link which is provisioned at lower capacity than the combination of the individual access

95 While it is true that a 'best efforts', contended product could be defined at full line speed while still accommodating the entry of other service providers, we are assuming that in practice a consumer will seek complementary rather than substitutive experiences.

links. As a result, a user may achieve less than 20 Mbps speeds when downloading data. This issue is particularly prevalent when accessing data from overseas, due to contention on the submarine cables, particularly to the USA.

The second limiting factor is the potential over time for multiple retailers to share the pipe, or for a single retailer to offer multiple services down a given portion of the bandwidth. For example, if a retailer purchases a 20 Mbps connection and offers both an IPTV service requiring a high Quality of service connection, as well as a best-efforts Internet service over the same connection, the actual experience of the end user on the Internet service will vary greatly according to whether the IPTV service is being used.

We therefore recommended specifying offerings over the fibre network in terms of a peak data rate, rather than a committed data rate, even though in the near term a 20 Mbps peak data rate link will offer a similar experience to a committed information rate link of the same specification.

Acknowledging other factors influencing the user experience

We have focused on download speed as the factor that will define the NBN experience for most users, because this is the reference point for average broadband usage. However, additional factors affect end-user experience—in particular, upload speed and network speeds upstream of NBN Co's point of interconnect.

Upload speed can have a significant impact on the user experience. However, for average broadband users, it is less of a defining factor than download speed, once above a reasonable threshold. For example, typical Internet users download (e.g. video) more data and more often than they upload (e.g. email, outbound file sharing). As such, we believe government can afford to be less prescriptive about minimum upload specifications. In addition, upload speeds provide a useful mechanism to differentiate users, as they clearly enable or prevent certain types of services—e.g. video-conferencing requires high upload speeds. Section 4.5 discusses the importance of mechanisms such as these in optimising revenue for the network.

Regardless of the speeds enabled in the access network, performance bottlenecks in other parts of the network affect the speed that end users experience. For example, limited capacity in international links and the speed of the servers hosting the content will affect users' experience with Internet services—for example, YouTube—over the NBN. These bottlenecks are outside the control of NBN Co, but mean that users are unlikely to experience 100 Mbps for most services in the near term. These potential bottlenecks should be resolved adequately by market forces as more users demand superfast speeds.

> **Highlight**. The actual broadband speeds experienced by end users will be impacted by bottlenecks upstream in the network, such as limited capacity in international transport links and the speed of content-hosting servers. These bottlenecks are outside the control of NBN Co, but will be resolved by market forces over time.

Delivering non-Ethernet services

The NBN also has the ability to offer non-Ethernet based services (i.e. no requirement for an Ethernet port at the ONT). The main services for consideration are emulation of PSTN-voice and RF-video overlay. We discuss RF overlay in Section 3.3. We also discuss the continuation of fixed-voice services in Chapter 2.

An important decision for an NBN fixed-voice service is whether it is bundled with the entry-level bitstream service. Double-play (voice and broadband) users are clearly more valuable to the NBN than voice only or broadband only users. However at present, there are significant segments of customers who take only one of those retail products. In the case of broadband-only customers, naked DSL products have grown rapidly in recent years—approximately 80 percent compound annual growth rate between 2006 and 2009.[96]

We therefore propose that NBN voice and data services be sold in a modular fashion. That is, an ATA voice service[97] would be sold separately to data as a pure-play product. The two services could be bundled if requested by an end user, but at the same time could be sold as standalone offers.

> **Advice.** That the NBN Co Board ensure the company offers an ATA voice service as a pure-play service, once access has been purchased, separate to the data service. This would be most relevant if and when the copper network is deactivated, or to do a whole-of-business migration deal with a service provider who has some voice-only customers.

Providing services with sufficient technical specifications

NBN Co should create a broadband platform which anticipates the greatest range of potential services. This is a challenge in the context of the wholesale open-access Layer 2 services being offered on the network, as we describe below. Today, Ethernet bitstream wholesale services are used to deliver best-effort Internet connections, and cater for a range of basic services. NBN Co will have to enable higher levels of performance, through quality of service (QoS) parameters.

The challenge lies in anticipating the implementation of standards. Although protocols for providing end-to-end QoS across multiple networks are well advanced, such protocols have not yet been deployed at scale to support commercial services. Most implementations of QoS-dependent services on telecommunications networks are still reliant on multiprotocol label switching (MPLS), or similar

> *Support for IP multicast within a Layer 2 bitstream wholesale product set is technically feasible*
>
> Juniper Networks[98]

[96] J.P. Morgan 2009, *Australian Telecom Sector in FY09*

[97] Analogue Telephone Adapter

[98] Juniper Networks 2009, *Submission to New Zealand Ultra-Fast Broadband consultation*

solutions which employ control planes within the same Layer 2 environment. However, there is good reason to believe that these carrier-grade Ethernet standards should be widely implemented over coming years.

NBN Co will need to strive to employ the best standards available, and be open to modifying its wholesale services accordingly. Active equipment should be purchased which supports the greatest number of standards paths, and aligns with the largest global ecosystem.

Recommendation 40. That NBN Co be required to offer wholesale services that support the implementation of carrier-grade QoS functionality, allowing retail service providers to deliver premium services from within their network to end users:

1. Initially, this means ensuring that the appropriate specifications are adopted through consultation with industry and potential customers;
2. Over time, this may require offering services that are higher in the network stack, as has already been considered for IPTV, where IGMP functionality is being considered, and/or extending the geographic extent of the Layer 2 network (i.e. further upstream); such decisions to expand the scope of NBN Co operations should not be taken lightly, and should be based on demonstrated inability of NBN wholesale services to enable services that are feasible within other networks internationally and for which there is demand.

Enabling services for enterprise and Government use

Enterprise and Government customers typically purchase point-to-point connections as part of a managed services relationship with a major ICT services provider, or a sophisticated carrier such as Telstra, Optus, or AAPT. The exact specifications vary depending on the solutions being implemented for that customer, but these links typically have a number of requirements.

First, high-end enterprise and Government users generally require very high, symmetrical speeds—at least 1 Gbps. This is 50 times faster than the suggested minimum speed for residential users on the NBN (20 Mbps). Second, they require redundancy via physically diverse paths. Third, the connections must provide security of transmission. Finally, these users need a range of options for class of service.

High-end services to these customers are typically delivered using Ethernet point-to-point technology over dedicated fibres. NBN Co should anticipate this demand in its network design and service specification. Over time, these services are likely to become increasingly attractive to a range of users, due to the ubiquity of the NBN and competitive offers it will enable.

Specifically, the increased availability and affordability of high-bandwidth point-to-point services is likely to increase the demand from small and medium enterprises. These services have typically been out of reach for users of this scale, but it is reasonable to expect some latent demand in the market. One example would be a small graphic design company that requires a high-speed symmetrical service to quickly transfer large data files and images. NBN Co should anticipate increased demand of this nature, and provision its network and services accordingly.

Advice. That NBN Co Board encourage the company to undertake consultation with enterprise service providers to determine the appropriate specifications to serve the enterprise market, including implications for the mix of fibre topology.

4.3 Meeting fibre coverage objectives within Government's expenditure estimate

The Government's stated objective is to deliver a fibre-to-the-premises access network that covers 90 percent of Australian premises. The majority of the $43 billion initial expenditure estimate comprised $23.3 billion plus contingency and out-turning to build the FTTP access network. Under most plausible scenarios, the network can be built to at least 90 percent of premises within that expenditure estimate. Some significant uncertainties remain about the cost of access to existing infrastructure (including deals with existing infrastructure owners), the exact network topology NBN Co will deploy and some of the civil engineering costs. Many of these will not be resolved until NBN Co begins construction.

This section addresses the cost of building a fibre-to-the-premises access network, in three subsections:

4.3.1 Estimating the cost of the 90+ percent fibre access network

4.3.2 Estimating unit costs from prior deployments and industry expertise

4.3.3 Using detailed geospatial modelling.

4.3.1 ESTIMATING THE COST OF THE 90+ PERCENT FIBRE ACCESS NETWORK

We built a detailed model to estimate the cost of building the fibre access network, to inform policy choices such as the extent of the fibre footprint and to build the business case in Chapter 7.

The unit cost assumptions used in the modelling are based on significant consultation with vendors and civil engineers and have been refined based on field surveys with network construction specialists. Distances are based on detailed geospatial modelling taken down to a per premises level. The accuracy of the overall cost analysis will be even greater once deployment commences and better information is available about the state of existing infrastructure, and the actual costs experienced. Further work is required on the part of the NBN Co to test and validate assumed unit costs, particularly once the network architecture and product design is finalised.

We do not assume a deal with network or infrastructure owners in the modelling. Where existing infrastructure is used by the NBN, it is costed on the basis of current commercial rates. There is a compelling economic benefit for NBN Co and Telstra to reach an agreement to reuse existing infrastructure, including ducts and exchange space, and a deal could significantly reduce overall network costs for the NBN Co.

The modelling takes into account the existing stock of premises as well as projected growth. It is expected that the stock of premises will grow at a rate of approximately 1.25 percent p.a. over the life of the network. We break this growth rate down into 0.75 percent for greenfields premises and 0.5 percent for brownfields subdivisions and developments.

Drivers of construction cost for the fibre access network

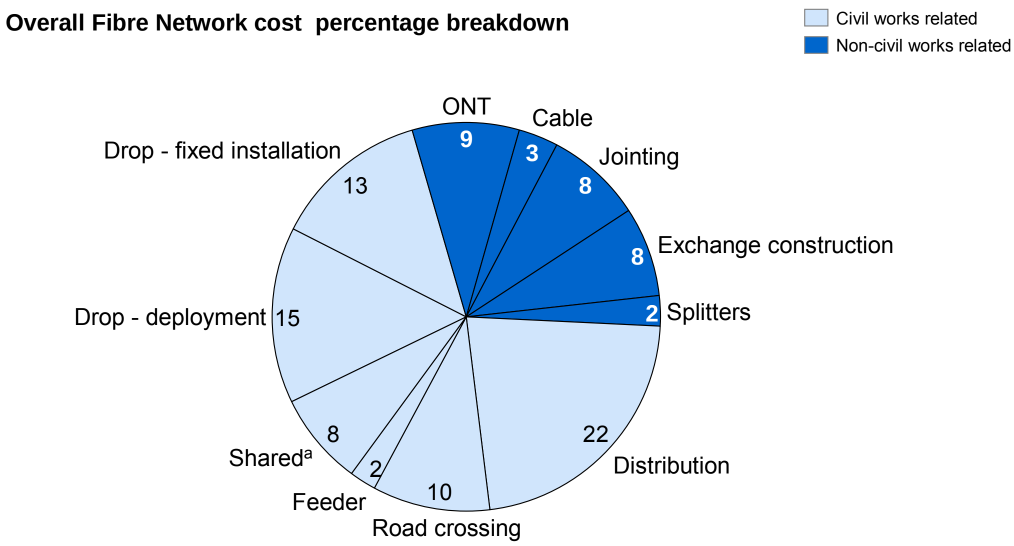
We modelled a GPON network with a home-run fibre topology for fifty percent of the fibre footprint. The network modelled is provisioned to allow redundant home-run fibre links to businesses and high value customers wherever required in the access network. The following are the major elements of the GPON access network:

- **Exchange**—the central office where the active electronics (OLT and other actives) are situated;
- **Feeder network**—the fibre connecting the exchange to the splitter cabinet;
- **Splitter cabinet and splitters—**a cabinet in the field through which the feeder fibre passes and can be split into multiple distribution fibres;
- **Distribution network**—the fibre from the splitter cabinet through to the drop point;
- **Drop and CPE**—the fibre lead-in from the drop point to the ONT in the premises and associated installation activities allowing connectivity to the network

The majority (approximately 70 percent) of the deployment cost is civil works related (Exhibit 4–11). These costs are for deploying the fibre through the distribution and road-crossings, feeder and drop as well as customer premises installation costs. The actual cost of the fibre itself is rather small. If 'pre-connecterised' cabling is used then the cable cost would rise as jointing and splicing costs are transferred from the field to the factory.

As civil works make up the majority of the costs, distance is a critical variable in the overall cost estimation. We describe our approach to distance estimation through geospatial modelling in Section 4.3.3.

Exhibit 4–11. Fibre access network cost breakdown



a. Feeder and distribution share the same trench
SOURCE: Implementation Study

Fibre access network cost curve

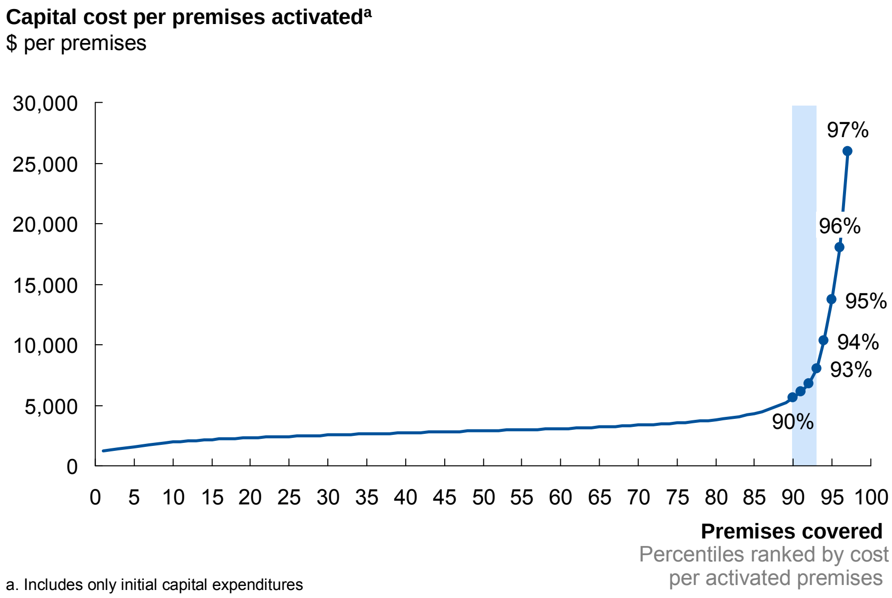
Fibre access network costs can be expressed as a cumulative and marginal cost curve ranging from zero to one hundred percent coverage of premises in Australia. The primary driver of difference in cost-to-serve at the premises level is the required deployment distance per premises. As would be expected, this is highly correlated to density.

The cost curve (Exhibit 4–12), when viewed on a marginal level, allows an understanding of where it becomes dramatically more expensive to serve additional premises and thereby avoid distortion due to the use of average costs. The marginal curve further allows an understanding of policy choices such as uniform pricing and the potential for pre-emptive cherry-picking of areas with attractive economics. On a cumulative level it allows the assessment of how coverage choices translate into overall network costs.

The marginal cost curve:

- Is modelled on the basis of a 100 percent shared deployment;
- Includes all the costs of the fibre access network from the exchange to the premises;
- Excludes costs associated with other elements of the overall project such as backhaul, operating and business support systems and overhead costs. The fibre cost curve provides an indicative only cost of the access network at different coverage levels.

Exhibit 4–12. Fibre-to-the-premises cost curve



a. Includes only initial capital expenditures
SOURCE: Implementation Study

Note that our reference case for the business case modelling assumes a 50% home-run topology which is not included in the above cost curve due to its distortive effect. A marginal cost curve should not be used as a basis for making policy choices concerning fibre topology but only as a guide to where cost to serve begins to accelerate to an unacceptable degree.

The cost curve demonstrates that the incremental cost to connect premises accelerates very sharply after the 93rd percentile. The implication of this spike in cost per premises—particularly for the mix of technologies deployed in the NBN—is discussed in Chapter 5. To give an indication of the acceleration in costs, Exhibit 4–13 shows the cost per percentile beyond 90 percent of premises passed, as a multiple of the 50th percentile costs as well as an acceleration rate, which is the rate of change compared to the previous percentile.

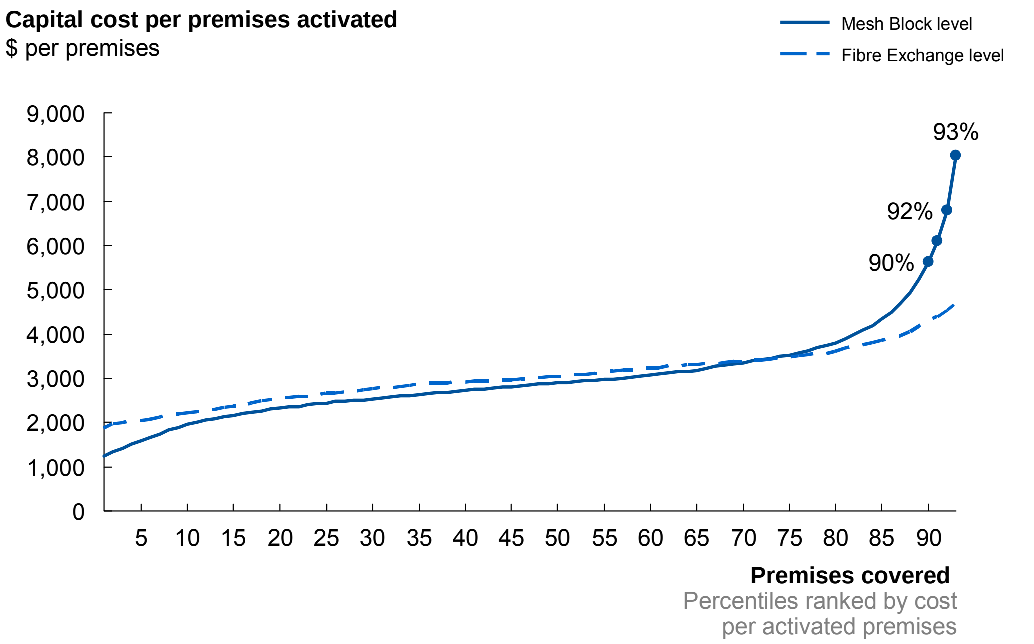
The actual roll-out will not be able to deploy to exactly 90 or 93 percent of the cheapest premises in Australia (as suggested by the above curve) due to the fact that premises of a certain density percentile are not all contiguous. The Mesh Block curve presents marginal costs that are too high and too low at both extremes of the curve. Premises which comprise the first 20 percent of the curve are indeed cheap to connect on an individual basis (they mostly comprise dense MDUs in urban areas). These premises are not contiguous, but rather represent distinct pockets spread across different suburbs and cities. Building a network that covered only the most dense of these premises would incur significantly greater fixed costs per premises (as well as being logistically impractical), so that a cost curve drawn for the first 20 percent of premises alone is considerably more expensive than the above curve suggests.

Exhibit 4–13. Breakdown of upper percentiles from FTTP cost curve

Percentile	Cost as multiple of the 50th percentile	Acceleration rate
90	1.9	7%
91	2.1	8%
92	2.3	11%
93	2.8	19%
94	3.6	28%
95	4.7	33%
96	6.2	31%
97	8.9	44%
Source: Implementation Study		

The cost curve below (Exhibit 4–14) demonstrates the curve on a Mesh Block and fibre exchange level up to the 93rd percentile. The fibre curve (dashed line) produces a much flatter curve and is more representative of marginal roll-out costs incurred in deploying the network to contiguous areas.

Exhibit 4–14. Fibre-to-the-premises cost curve (93 percent coverage)



SOURCE: Implementation Study

Implications of uniform pricing

The slope of the cost curve has important implications for the ability of NBN Co to establish a uniform wholesale price across all areas within the fibre access network. In Chapter 1 we discuss the desirability of geographically uniform prices within (but not across) access technologies, to drive a network effect through widespread take-up of services. The Implementation Study believes that the combination of the slope of the cost curve, ability to price transit backhaul separately and freedom to vary migration incentives is sufficient to enable uniform wholesale access pricing. Major issues concerning uniform pricing are set out in Exhibit 4–15.

Exhibit 4–15. Implications of the fibre access cost curve for uniform pricing

Uniform pricing within the fibre access network

Historically, wholesale fixed-line access prices have been set by the regulator in a band structure, with exchanges falling within a particular band receiving uniform pricing. The Government has expressed its preference for the pricing of the basic NBN access service to reflect principles of geographical uniformity. We anticipate that NBN Co's Special Access Undertaking to the ACCC will reflect this policy aspiration.

The Implementation Study believes establishing affordable, uniform wholesale access prices across the fibre network is desirable for two reasons: first, it can help enable Government's aspiration to deliver affordable broadband to all Australians by reducing the degree of retail price variability in the market. Second, it can help drive take-up of NBN services which is an important driver of commerciality. This uniformity should be limited to the access portion of the network however, and should only apply within—not across—access technologies, due to fundamental differences in performance.

Uniform pricing does present some challenges:

- **Price levels that compromise NBN Co's business case:** If uniform prices are set too low this risks NBN Co capturing insufficient revenue per customer to generate a return on the capital invested over time. If prices are set too high, revenue may also suffer due to low take-up of services.
- **Risk of cherry-picking by competing network operators.** Given the marginal cost to deploy fibre varies by geography, competing network builders have an incentive to enter in only the lowest-cost areas. By contrast, NBN Co is required to deploy in all areas within the fibre footprint. An average national price set by NBN Co could therefore magnify the incentive for competing providers by allowing them to overbuild the NBN at lower cost in targeted areas and offer lower priced services.

Is uniform pricing viable within the fibre access network?

The ability of the NBN to overcome the challenges of uniform pricing depends strongly on the shape of the fibre access cost curve up to the point where fibre deployment ends—which the Implementation Study recommends taking as the point where the curve begins to accelerate dramatically (approximately the 93rd percentile). Exhibit 4–12 demonstrates the way marginal cost to deploy fibre across premises varies by geography. Based on the shape of this curve we believe uniform pricing is viable within the fibre access network, for four reasons discussed below.

1. Ensuring use of a uniform price does not inhibit take-up

Setting a uniform price establishes an implicit cross-subsidy from users in low cost areas (who receive a price higher than they otherwise would) to users in high-cost areas (who receive a price lower than their cost to serve would imply). Essentially, the uniform wholesale price point must be sufficiently high that it generates an acceptable return relative to the *average* cost per premises activated across the curve (assuming take-up rates are roughly uniform across the curve—if take-up is lower in outer areas then this will be a conservative assumption since average cost per premises will be lower).

Therefore, if the cost curve rose very steeply at, say, the 75th percentile, this would present a significant challenge for setting a uniform price, since the average cost of deployment would be very high, leading to an unsustainably high uniform price point.

2. Confronting the risk of cherry-picking low-cost areas

As discussed above, the low end of the cost curve is only accurate in the context of a national deployment, where adjacent, more expensive areas are also served to create a contiguous network. It is not possible to build a network that serves only the lowest-cost percentiles at the costs depicted above. Therefore, for an alternative market entrant targeting the least expensive premises, their cost curve at the low end would reflect higher costs than those represented in Exhibit 4–12. Costs would more closely resemble the flatter fibre-exchange curve in Exhibit 4–14 and consequently the opportunity for 'cherry-picking' is not as great as it may initially appear. For a longer discussion of measures to ensure any overbuilding of the access network is consistent with Government's objectives for the NBN, see Section 10.2.

3. Separating transit and access pricing

The cost curve shown above is for the fibre access network only. In areas that lack competitive providers of backhaul today, NBN Co will also provide transit backhaul to connect Fibre exchanges to the core of the network (see Chapter 6). This transit backhaul will primarily be deployed outside metropolitan areas, which will add cost disproportionately to serving premises on the right hand side of the cost curve shown above.

The Implementation Study believes NBN Co should be permitted to charge separately for this transit backhaul component, which will remove one of the major drivers of cost difference between geographies, and therefore improve the viability of uniform access pricing.

In Chapter 6 we discuss a separate mechanism to ensure the affordability of transit services. It is important to note that this additional cost to serve remote premises may not automatically be passed on to consumers through higher retail prices. If the additional cost is not significant, service providers may cross-subsidise these customers via a uniform retail price structure to allow them the simplicity of a national rate card.

4. Excluding migration incentives from uniformity requirements

Some service providers may require incentives to migrate their customers onto the NBN.

In Section 4.4 we discuss the need for NBN Co to have flexibility regarding the nature and extent of these incentives, as long as they are offered on an equivalent basis. Competitive dynamics and retailer economics are likely to differ between geographies—any migration incentives offered by NBN Co should reflect this reality and have the flexibility to vary by geography and over time, without distorting long-term equivalence or uniformity of access prices.

Source: Implementation Study

We discuss the other considerations for national uniform pricing—within access technologies—in Chapter 2.

4.3.2 ESTIMATING UNIT COSTS FROM PRIOR DEPLOYMENTS AND INDUSTRY EXPERTISE

A bottom-up approach has been used in the modelling which draws on granular estimates of network elements. Estimates are the result of extensive consultation with industry vendors, network operators, technical consultants and internal analysis. Field surveys with two major civil engineering companies have been undertaken to ascertain the likely costs of civil works in the network build across regions with different geographical characteristics. A leading industry contractor was retained to advise on cost assumptions.

The Implementation Study has specifically avoided using high-level benchmarks such as cost/premises from international roll-outs as a basis for calculating overall costs. We avoid this approach because:

- Cost differences between localised (typically urban) and national roll-outs
- Costs faced by incumbents (with significant ability to cheaply re-use existing infrastructure) are different to those faced by over-builders
- Differences in labour prices between countries
- Incentives to over/understate costs in markets where prices are set as a function of the regulated asset base
- Fibre take-up percentages (the driver of headline cost per activated premises numbers) are different

Deployment mix as a driver of network deployment costs

Other than distance, the major driver of overall costs is the mix of deployment methodologies employed in the roll-out.

In the distribution network there is the possibility of pursuing a significant variety of deployment methods due to the reduced the risk of large-scale end-user disconnections if the distribution cable is cut.

The more conventional methods of deployment are underground through a ducted telecommunications conduit (either existing or newly constructed) or aerial deployment. Some less widely used deployment methods include placing fibre through the sewerage network, gas pipelines, electrical ducts or other available infrastructure. Although less conventional, these methods have been used for several international roll-outs.

The possibility of using the sewer network in particular has received significant attention. The Implementation Study has not been able to accurately assess the likely costs involved in such a deployment due to the paucity of available data. On this basis, a sewer based deployment has not been modelled although it is acknowledged that the technology to allow such a fibre deployment is still in its infancy and is rapidly developing.

The use of alternative undergrounded infrastructure such as gas pipelines or electrical conduits, while possible on an ad-hoc basis where available and practical, would be less preferred to form a significant part of a large-scale national roll-out. As such these methods have not been modelled.

The model assumes that the deployment will follow the existing road network and utilise only aerial infrastructure or underground telecommunications conduit (either new conduit built by the NBN Co or existing Telstra ducts). In spite of this assumption, there is the real possibility that alternative deployment methods, where feasible, could reduce the overall costs of the network.

Advice.: That NBN Co Board investigate the appropriateness, feasibility and cost of using alternative passive infrastructure to lay fibre in the network build.

Density as a driver of costs per metre

An important consideration in ascertaining realistic cost inputs is the impact of premises density on unit costs (Exhibit 4–16). As premises density changes the cost to pass premises also changes. High density areas tend to have larger, busier road networks and a higher percentage of concrete between the premises boundary and the road, making trenching more expensive. High density areas also have significant existing infrastructure which often necessitates expensive drilling under the surface of the road, further increasing costs. Several other differences including premises frontage and changing average span between poles contribute to different unit costs in areas with different density characteristics. These differences have been taken into account in the overall cost modelling.

Exhibit 4–16. Impact of density on unit costs

Density and its impact on unit costs

Analysis has shown that the cost per metre in very high density places can be sharply higher than the cost per metre in lower density areas. Our cost modelling includes differential costs/metre for high and low density areas, for both new trenching and aerial deployments.

New trenching. Field surveys conducted in NSW and Victoria establish that the trenching methodology deployed is highly correlated to density. Above a certain threshold the footway at a surface level changes from mostly grass to mostly concrete and becomes sufficiently crowded with other infrastructure so as to rule out a surface trenching method. This step-change in costs is factored into the model.

Aerial. Geospatial analysis based on pole data in NSW reveals that pole distances begin to lengthen as premises density declines. This is consistent with average premises frontage analysis which also increases as density declines. As aerial cost per metre is a function of distance between poles, the change in pole distances has been factored into the model.

Source: Implementation Study

Exhibit 4–17. Trenching techniques

Trenching techniques
Directional Drilling. Uses a machine to bore through the ground at a typical depth of 0.8–1.2 metres. It is most appropriate where there is significant obstruction caused by existing utilities at a surface level, where deployment across a road is required or where council regulations require complete reinstatement of a sidewalk after open trenching.
Open trenching. Uses a chain-digger or other equipment at surface level to trench and then re-compact to fill the trench once the conduit has been laid. Open trenching is most suitable where there is ample room at a surface level to dig without impacting other infrastructure. The costs of open trenching are largely dependent on the level of re-compacting that is required after digging.
Mole-plough trenching. Uses a mechanical digger in soft-soil. It is the cheapest method but is only available in soft-soil in areas that are completely unobstructed.
Micro-trenching. Involves cutting a narrow trench along a street curb or footway. This method is generally considered inappropriate in Australia due to possible water damage to bitumen or asphalt after the micro-trench has been cut.
Other novel methods not commonly used in Australia. Includes micro/open trenching hybrids and mechanised shallow trenching methods using advanced mechanised installation machines from Europe or America.

Source: Implementation Study

Distribution

The distribution network can be deployed aerially or underground and runs from the splitter cabinet to the drop point (either a pole or a pit). If the distribution shares the same route as the feeder then the distribution fibres are placed underground in the same conduit as the feeder.

Where the distribution is deployed underground in a new trench, the overall cost comprises:

- Labour and equipment for the trench—typically a function of the trenching method and soil type;
- Installation of the conduit—typically 50–100 mm in diameter and guard-wire;
- Capital and labour for purchasing and installing a pit system;
- Road crossings to access premises on the other side of the single-sided deployment.

The cost per metre of deploying underground in a new trench depends on the mix of different trenching techniques used (Exhibit 4–17) and ranges from $60–150 per metre.

Advice. That NBN Co Board ensure the company investigates innovative trenching methods not currently used in Australia to assess their potential to bring down the costs of the deployment.

Where distribution is deployed aerially, the cost comprises:

- Pole make-ready including costs associated with load-testing (checking if the pole has the necessary structural integrity to support fibre) and pole framing (clamping, screwing, drilling etc);
- Re-configuration, pole reinforcement or replacement, where needed;
- Hauling for fibre installation.

Aerial is typically a substantially cheaper deployment method than new underground trenching. Although it may have a shorter life than underground cable and involve higher operating costs, aerial deployment is almost always cheaper if good quality pole infrastructure exists. The capital cost of aerial installation is estimated to be in the range of $20–$30 per metre throughout the network.

Cost estimates assume that the deployment will be aerial wherever possible. Detail on the assumed maximum aerial percentage is below (Exhibit 4–18).

Exhibit 4–18. Availability of aerial deployment

55 percent availability of aerial deployment

The estimated maximum extent of an aerial deployment is 55 percent of cumulative total distribution distance, based on:

- A theoretical maximum aerial deployment of 72 percent—which is the number of premises now receiving electricity aerially (according to Electricity Supply Australia)
- A conservative assumption that approximately 7 percent of total poles in Australia are structurally incapable of supporting fibre. This estimate is the result of extensive consultation with utilities. We have not sought independent engineering advice to confirm this or the assertions of different utility companies as to the usability of their pole infrastructure. We assume NBN Co will do so during network planning.
- All other poles are generally available for the fibre deployment, although field trials show approximately 5 percent of poles are likely to be incapable of supporting fibre due to the presence impeding infrastructure. This 5 percent are assumed to be randomly distributed throughout different distribution networks. As a result, the need to deploy underground decreases the aerial percentage by 10 percent (as the loss of one pole requires an underground deployment covering twice the span).

It further assumes:

- Community acceptance of an aerial fibre roll-out
- NBN Co does not deploy any poles of its own. As access to existing poles is mandated, NBN Co deploys fibre on all poles where it is technically feasible

Source: Implementation Study

There remains significant uncertainty as to the 55 percent of the distribution deployment that is assumed to be achievable with aerial fibre due to:

- Community resistance that is inherent in an aerial roll-out;
- Uncertainty as to the proportion of pole network infrastructure that is structurally incapable of supporting fibre (could be less or greater than 7 percent);
- Uncertainty as to the proportion of poles that are unsuitable for deployment due to impeding infrastructure (could be less or greater than 5 percent);
- Some utilities may be unwilling to cooperate with NBN Co and there are the practical challenges of seeking access under the relevant access regime.

Some of this risk can be reduced with appropriate powers and immunities legislation, which is discussed in Chapter 7.

Feeder

The feeder network, due to the risk of large-scale end user disconnections is assumed to be deployed underground to allow greater network security. A large proportion of the total trenched distance of feeder is overlapping with the distribution network and we assume trenches are shared.

The Implementation Study assumes that the most attractive fifty percent of fibre exchange service areas have a home-run fibre topology with a dedicated fibre running from the exchange to the premises. The remainder are served with a shared topology.

Fibre exchanges, street cabinets and splitters

Exchanges are deployed to serve a maximum of 30,000 premises. This assumption is in-keeping with the current number of premises served per Telstra exchange and is not a recommendation as to the actual size per fibre exchange. The modelled network covers a maximum radial distance of 10 km from the exchange.

It is not assumed that the NBN Co utilises existing exchanges. All exchanges, as part of a new build, incorporate costs associated with site acquisition, external structure, electrical and air conditioning, site make-ready, power backup and costs associated with leasing land. To calculate land lease costs and how these vary according to geographic characteristic, exchanges have been divided into high density and low density categories to reflect higher costs per square metre in urban locations. It is assumed that the minimum land areas available for leasing per exchange will significantly exceed the actual space requirement of the NBN and this has been taken into account in the modelling.

All exchanges are equipped with an OLT. The OLT specifications may vary according to the number of premises served at the exchange. We have provisioned with OLT chassis with 2.5 Gbps line cards. On a per premises basis the OLT cost per user is expected to be less than $100. Optical distribution frames to facilitate fibre management are assumed to be deployed at every exchange.

The modelling assumes that where a shared topology is used, the feeder fibres will be split at street cabinets which have been placed in the network to serve 250 premises. The cabinets are capable of supporting nine splitters and a maximum of 288 premises. A cabinet per 250 premises should not be read as a recommendation. It may be preferable to have more aggregated cabinets if a shared topology is to be successfully unbundled at the active layer in the future. Cabinet costs, although significant, equate to approximately $30 per premises. The modelling assumes that 1:32 splitters are employed at the cabinet level.

Drop

The drop incorporates the fibre lead-in to the premises and the fixed installation cost involved in installing the ONT. The Implementation Study assumes that customer premises are activated on a demand driven basis and not when passed. This leads to lower overall costs and greater capital efficiency (Exhibit 4–19).

The deployment costs of the drop vary according to whether the installation is aerial or underground. Typically the drop method will be aligned with the distribution method—i.e. an aerial distribution will lead to an aerial drop and an underground distribution will lead to an underground drop. Exceptions to this are made for premises which are passed by an aerial distribution but have an underground lead-in. This percentage was assessed as roughly 10% of premises.

Exhibit 4–19. Benefits of demand-driven activations

Benefits of demand driven activations
Connecting end users on a demand driven basis reduces capital costs, results in higher capital efficiency and is more practical than a policy of simultaneous ‘pass and connect’ in advance of the customer taking up the service.
Costs are reduced through capital costs forgone for those premises who choose ultimately not to connect to the fibre network due to wireless substitution or use of competing infrastructure. If the premises were activated when passed with an outside ONT deployed, it is estimated that this would result in additional costs exceeding $3 billion. If the drop fibre were only made to the premises and no ONT installation occurred (i.e. the fibre was just curled up) then the additional cost would exceed $1 billion. A policy of pass and connect further increases the operational leverage of the company making its financial performance more sensitive to take-up rates.
Practical legal considerations suggest that issues of consent could be problematic when installing the lead-in to premises when passing.
Based on these factors the Implementation Study has assumed that the drop will be deployed only on a demand driven basis.
Source: Implementation Study

Where the lead-in is deployed underground, the model assesses two different cost segments: pit to property boundary and property boundary to premises boundary. Both segments are assumed to have different unit costs. Within segments costs differ according to high density and low density categorisation. It is assumed that pit to property boundary will typically be deployed in a ducted conduit and property boundary to premises boundary will be direct buried to minimise overall costs. The underground lead-in is assumed to have a fixed cost per premises based on high density or low density categorisation. This approach is consistent with current market practices where lead ins are typically costed on a fixed basis per lead-in.

Aerial lead-ins are significantly cheaper than underground lead-ins. Savings are achieved as the pole from which the cable is deployed has already been made-ready in the course of the distribution deployment. Aerial costs are made up of hauling and cabling.

Collaboration with utilities will be important in achieving a widespread aerial roll-out (Exhibit 4–20).

Exhibit 4–20. Collaborating with Utilities in network roll-out

Collaborating with Utilities

The NBN deployment could benefit from collaboration with electricity distribution network service providers in several ways. Direct cost savings could be derived from coordinating the fibre deployment with utilities' own network upgrades, fibre deployments, undergrounding initiatives or smart-metre roll-outs. Further cost savings could accrue from cooperation with utilities to achieve minimal disruption to existing infrastructure from the distribution roll-out. Finally, collaboration could provide other benefits including premises access rights through shared infrastructure where this may be problematic to achieve, such as for MDUs.

However, several significant hurdles stand in the way of effective collaboration, notably negotiating, contracting and coordinating roll-out schedules with the numerous electricity distributors, each of which has exclusive distribution rights for a franchise area. Therefore the Implementation Study has not assumed any significant savings from coordination with utilities.

Smart meters are currently being installed throughout Australia, driven by a desire to achieve more efficient energy consumption (specifically peak-load management) requiring two-way communication. In 2007, the Council of Australian Governments mandated the deployment of smart meters in areas where the benefits outweigh the costs.[a]

Installing smart meters requires access to customer premises by a skilled electrician. This truck-roll could be coupled with the installation of an ONT to avoid the cost and disturbance of multiple visits. It may also be possible for the ONT and smart meter to collocate which could reduce overall costs. Moreover, in the same enclosure, power could be provided to the ONT directly out of a power outlet adjacent to the smart meter, which would reduce the need to enter the premises. However, there are five main issues that would need to be resolved for the NBN roll-out.

- Timing. The deployment of smart meters and the NBN FTTP network are on different schedules. Smart meters are quicker to install and COAG has mandated smart meter roll-outs where the benefits outweigh the costs. For example, Victoria has already commenced with their deployment of smart meters, which is scheduled to be finished by 2013[b].
- Demand for fibre. Although all distributors expressed interest in fibre as a communications platform, they are already trialling alternatives such as mesh radio and WiMAX[c]. These other

technologies are more than sufficient for the current bandwidth needs of smart meters.

- Acquisition of customers. Smart meters will be deployed to all customer premises in a certain area where benefits outweigh the costs, without customers requesting an upgrade. This is significantly different to the NBN where service providers will have the option to transfer customers to the fibre network. Therefore the deployment of the NBN and smart meters are not aligned well in terms of network cut-over timing.
- Location of ONT. It will be difficult to place the ONT and smart meter in adjacent positions. The positioning of the ONT at the premises will most likely be determined by the easiest path for the drop cable. It will be unlikely that the drop fibre will be easily aligned with the location of the electricity entry point, where the smart meter is located. Furthermore, an outdoor ONT is more expensive than an indoor ONT (~$200 more)[d]. This extra cost combined with the potential extra costs in deploying will likely outweigh the benefit of sharing an enclosure.
- International precedents. There has been no large-scale international FTTP deployment identified in which a network owner has successfully collaborated with electricity utilities during the deployment of smart meters on a large scale.

These hurdles may be overcome in specific situations. NBN Co should investigate collaborating with utilities during smart meter roll-out where commercially attractive to do so.

Fibre deployment may become cheaper if the deployment is coordinated with utilities' own capital works programs and costs are shared. Recently, many electricity utilities have embarked on major network upgrades as their assets are ageing and they strive to cope with increasing demand.[e] This combined with pressure to underground aerial cabling has led to increasing deployment of power cables underground.

Clearly to achieve successful collaboration, timing and deployment issues will need to be resolved. NBN Co and the utilities are typically on different schedules and this makes the resolution of such issues problematic. Moreover, it is typically much slower to deploy underground power cables, which may slow down the deployment of the NBN should the company choose to pursue this path for fibre deployment. Nevertheless, the size of potential cost savings is significant and justifies serious investigation of all possibilities for coordination.

The costs and speed of the aerial build will be influenced significantly by the commercial terms that NBN Co negotiates with utilities for infrastructure access. While access to pole infrastructure is mandated under access regulations, access is expected to be attained through private negotiations. Effective cooperation with utilities will clearly be important.

a. Council of Australian Governments 2007, *Council of Australian Governments' Meeting 13 April 2007*, viewed 8 December 2009 <http://www.coag.gov.au/coag_meeting_outcomes/2007-04-13/index.cfm>

b. Ibid

c. Interviews with Energy Australia

d. Industry interviews

e. Australian Energy Regulator 2009, *State of the Energy Market Report 2009*, Melbourne

Source: Implementation Study

Multi-dwelling Units

We assume that flats or offices are internally wired with fibre when they are passed to allow the customer to connect on demand. Internal wiring includes the lead-in to the building's main distribution frame from the drop point and the installation of the communications riser to each floor in the building. We have also included costs associated with surveying the building, designing the installation and consulting with strata corporations.

Customer premises installation

The installation of the ONT can vary based on various network design choices. We assume the most cost efficient method is employed and the ONTs are installed on the inside of the premises (Exhibit 4–21).

Exhibit 4–21. Location of the ONT

ONT location

It is assumed that the NBN will deploy ONTs on the inside of premises. Indoor ONTs offer significant cost savings over outdoor ONTs. Consequently, the majority of FTTP roll-outs internationally have involved indoor installation.

In addition, indoor placement improves customer experience and accelerates commoditisation of the ONT, thereby providing greater opportunities for future competition at the active layer.

Total cost of an indoor ONT and its installation are significantly lower compared to an outdoor ONT. There are three major cost components which differ between indoor and outdoor ONTs.

- The cost of the device and enclosure is approximately $200 more for an outdoor ONT[a] than an inside one. A strong, sealed, weatherproof enclosure with glands and seals is required for outdoor ONTs to protect them from the elements.
- Providing power to an outdoor ONT is much more complex than an indoor ONT, which plugs directly into a general purpose outlet (GPO). Most premises do not have a free GPO outside. Therefore an electrician would need to enter the premises to run the power cable between the ONT and the closest free power socket. This is a significant cost as it could take well over an hour of skilled labour to run electricity to the ONT.
- The connection between the ONT and CPE also becomes more complicated for an outdoor ONT. CPE can plug directly into an indoor ONT, but an outdoor ONT requires individual cables to be run through the wall for each port on the ONT. Therefore it is possible that four Cat 6 cables may have to be run through the wall for an outdoor ONT as opposed to one 'ruggedised' fibre cable for an indoor ONT, again increasing the installation time and cost.

It is estimated that the overall cost per premises of an outdoor ONT would be approximately $300 higher than an inside one.

Customer experience is typically better during the roll-out. An indoor ONT takes less time to place and less wiring is needed. It requires a customer to be at home during the installation, but an outdoor ONT typically requires internal access as well, so that electrical wiring can be done.

International experience shows most ONT faults can be rectified with remote testing, but outdoor ONTs do have an advantage for future maintenance as technicians can access the unit without entering the building. This advantage is not perceived to be significant as most faults are likely to be caused by CPE and connections within the premises rather than the ONT itself. These faults would require internal access to the building, regardless of location of the ONT.

Competition is more likely to be encouraged at the active layer by deploying indoor ONTs. There is a greater chance that indoor ONTs will be commoditised due to their simpler and cheaper form, making it easier for competitors to compete at an active layer.

Replacing indoor ONTs, which are physically similar to wireless routers today, will be a simple process for customers compared to replacing an outdoor ONT mounted to an external wall. Moreover, indoor ONTs are cheaper, making it easier for the customer to upgrade their ONT if they wish to customise or replace it.

FTTP networks are being deployed throughout the world, but very few deployments involve outdoor ONTs. There are strong reasons to believe that the placement of ONTs on the inside of premises is preferable.

a. Industry interviews

Source: Implementation Study

We assume the installation of a network interface device (NID) which is the termination point for the drop cable at the premises. The NID is a small, weatherproof enclosure, usually mounted on the exterior of the premises. The drop cable enters the NID at one end and a ‘ruggedised’, bendable cable is connected to the other end. The cable must be ‘ruggedised’ to protect the fibre when passing through the wall.

There is an option to either splice at the NID and wall socket or use pre-connectorised cable. Where it is easy to accurately measure the cable distance, pre-connectorised cables should be used to reduce installation times. This can be aided by the use of a ‘library’ of different cable lengths stored in the truck.

After the NID, the ruggedised cable enters the exterior wall of the premises and is run through the wall cavity until it reaches the back of a wall socket within the premises. The length of the cable run between the NID and the wall socket can differ greatly, based on their relative locations and on the structure of the building. Consequently, deploying this cable is typically a complicated and expensive step and may require a team of two.

The wall socket is then installed inside the premises, preferably close to an existing power outlet. A patch cable is used to directly connect the wall socket to the ONT, without any need for splicing. The ONT is then plugged into the existing power outlet in the same room.

The total fixed installation and materials cost (excluding lead-in installation) is estimated to be approximately $500 per premises. The Verizon experience suggests that this cost can be brought down over time with experience and the adoption of best practices.

Some premises will require rewiring or new CPE within the home. Exhibit 4–22 explains these migration costs, which the end user or the retail service provider would bear. We modelled a migration incentive of $300 per premises connected, which NBN Co would provide to the service provider to assist with migration and help drive take-up. This is modelled as an offset against the revenue as NBN Co receives from service providers. It is assumed that apart from the one-off migration payment, the service provider will fully absorb migration costs. The amount of equipment and level of service an individual end-user demands will ultimately determine the precise cost of new CPE or rewiring.

Exhibit 4–22. Migration costs

Migration costs

Migration costs are defined here as the additional network costs on the customer-side, beyond the indoor ONT. The two major components of migration costs are rewiring premises and provisioning and installing new customer-premises equipment (CPE).

Rewiring premises. Most premises are currently wired with a twisted copper pair, which supports both Internet and voice services. This copper network within the premises will need to be connected to the ONT if customers wish to continue using existing devices, such as telephones and fax machines, which are currently connected to a their POTS outlet. This will generally require a copper connection from the ONT to the existing copper wiring. These two points may not be close together and could be as far away as 20m in some MDUs. After rewiring the premises would then be disconnected from Telstra's copper network and the signal to the existing devices would be carried over fibre.

In addition to voice customers, broadband or IPTV subscribers may require premises rewiring to connect the ONT to CPE as the existing copper network cannot be used. For broadband subscribers, rewiring with Cat 6 cable is required if their existing PC or router is not located near the ONT. However, if customers are satisfied with wireless services, no rewiring is required as a wireless router can be plugged directly into an ONT. Likewise, the customer may request IPTV, which would require Cat 6 cable connected between the ONT and each set top box (STB) for each television. Wiring each CPE could range from 5 metres to over 20 metres for larger premises, which would take 0.5–2 hours for a skilled labourer.[a]

Provisioning and installation of CPE. Voice, broadband and IPTV are the three main services likely to be provided over the NBN and each will require different types of CPE. However, if people have a combination of services, devices can be consolidated to a certain extent. For example, some home gateways can support both wireless Internet connectivity and IPTV.

Voice customers have the ability to continue using existing handsets if the POTS port on their ONT is connected to the existing copper network within the premises. Also, VoIP handsets, which are becoming more common, can be plugged directly into the ONT.[b] Therefore no CPE should need to be replaced for voice subscribers.

Broadband subscribers, however, will need a router to connect their ONT to a computer. Alternatively, a wireless router can also be plugged into the ONT to support several computers and WiFi-capable devices throughout the premises. Current prices for basic routers or wireless routers are approximately $100[c].

IPTV also requires distinct CPE, typically in the form of a stand alone STB for each television. Some existing STBs, including in-built STBs, may be capable of supporting IPTV. But in general, users will need a new STB which currently cost approximately $100[d].

a. Industry interviews

b. Pyramid Research 2009, APAC fixed communications demand

c. Based on CNET Australia reviews of various routers. CNET Australia 2010, *CNET,* viewed 1 February 2010, <http://www.cnet.com.au>

d. Based on a CNET Australia review of various set-top boxes. CNET Australia 2010, *CNET,* viewed 1 February 2010, http://www.cnet.com.au

Source: Implementation Study

4.3.3 USING DETAILED GEOSPATIAL MODELLING

Ensuring a high level of accuracy with granular geospatial modelling

Distances and density of premises are the primary drivers of civil works costs, which comprise 70 percent of overall costs. We have used detailed geospatial modelling to accurately measure these factors. The importance of geospatial modelling is summarised in Exhibit 4–23.

Defining and aggregating premises

Understanding the extent to which fibre can be economically deployed across Australia requires detailed, granular analysis. We use the Geocoded National Address File (G-NAF) which has spatial information (latitudes and longitudes) for every premises in Australia. We used, on the advice of DBCDE, premises which either Australia Post or the Australian Electoral Commission recognise as a current address. The approach we used to filter the G-NAF dataset is described in Exhibit 4–24.

Exhibit 4–23. Importance of geospatial monitoring

The importance of geospatial modelling

Geospatial modelling applies spatial analysis tools and techniques to spatial information, including the latitude and longitude of individual premises, the location of the road network, and the location of existing infrastructure especially Telstra exchanges.[a]

Geospatial modelling is required to avoid using radial distances, which in some cases are a good approximation, but do not accurately reflect the likely path a network would use. It is best illustrated with examples of the algorithms used in our modelling:

- **Clustering algorithms and implicit Voronoi.** These algorithms are used to group large numbers of objects together in a logical group to minimise overall distance. This has been used to group premises which are served by a street cabinet and to group Mesh Blocks which are served by an exchange.
- **Dijkstra algorithm.** This algorithm calculates the lowest cost to travel over a road network. This has been used to estimate the deployment of the feeder and distribution network, and to optimise reuse of the same route to reduce trenching costs wherever possible.
- **Travelling salesman.** This calculates the optimal sequence to visit a number of locations to minimise overall cost. This has been used to estimate the distance required to build a backhaul network featuring fully redundant rings.

The geospatial modelling is detailed and rigorous. We modelled every address and street in Australia, down to the level of counting the number of fibres that pass through each street.

a. We used commercially available datasets, including the Geocoded National Address File (G-NAFs) for the location of premises, StreetPro for the road network, Exchange Info for the Telstra Exchanges and existing exchange boundaries, and ABS Mesh Blocks.

Source: Implementation Study

Analysing 10.7 million premises requires some aggregation into logical groups. We do not use Exchange Service Areas (ESAs), which are the premises served by an existing copper exchange, because:

- The exchange area boundaries were drawn a long time ago, and in many areas population densities have changed; and
- We are conscious of the 'tyranny of averages'. There are many ESAs where the average density is too low to justify a fibre roll-out, but taking a more granular approach with smaller units of analysis reveals a town with sufficient density and scale to support a fibre roll-out, and outlying areas which will be served with an alternative technology.

We have used the Australian Bureau of Statistics (ABS) Mesh Blocks as our basic unit of analysis. The Mesh Blocks are based on the 2006 Census of Population and Housing, and group residential dwellings using street boundaries. Mesh Blocks, except for empty ones, contain relatively uniform numbers of premises and therefore help in understanding how population density varies across Australia. Mesh Blocks contain additional information including a categorisation by type of use (residential, commercial, agricultural, etc).

> *The ABS has developed Mesh Blocks as a new micro-level geographical unit for statistics. There are 314,369 spatial Mesh Blocks covering Australia with most residential Mesh Blocks containing approximately 30 to 60 dwellings. Mesh Blocks have been designed to be small enough to aggregate accurately to a wide range of spatial units and thus enable a ready comparison of statistics between geographical areas, and large enough to protect against accidental disclosure.*
>
> Australian Bureau of Statistics (2008)

Mesh Blocks only contain residential dwellings, not business addresses. Therefore we used G-NAF addresses to locate premises, and map these to Mesh Blocks in order to group premises into granular units for analysis.

Modelling a realistic fibre network

To estimate the distances involved in an FTTP deployment, the Implementation Study modelled a realistic, but theoretical network. Network design and the specific premises to be served with different technologies is a decision for NBN Co. Our modelling is for the purposes of cost estimation. NBN Co will no doubt make different decisions about its deployment as it plans its roll-out, and surveys street by street. Nonetheless, our modelling provides a strong platform for cost estimates and the business case.

Exhibit 4–24. Applying a filter to national address files to calculate total premises

Premises filtering

G-NAF is the authoritative Geocoded National Address File that combines address data contributed by a number of sources. According to the G-NAF product description supplied by the PSMA:

> *G-NAF uses existing and recognised address sources including the state and territory Government land records, as well as address data from Australia Post and the Australian Electoral Commission. Through a rigorous process involving textual address comparison, matching and geospatial validation, both national consistency and national coverage are achieved at levels not previously obtainable.*
>
> *G-NAF is an exercise in collaboration. The concept of a national index of addresses has been evolving since 1995. Some 15 significant organisations have and continue to contribute and support the initiative. The G-NAF data contributors include:*
>
> – *The mapping agencies and land registries of each of the Commonwealth, state and territory governments;*
> – *Australia Post; and*
> – *The Electoral Council of Australia and the Australian Electoral Commission.*

For many addresses, the 3 different sources are not completely aligned. PSMA provides a Reliability field for each record which indicates to what degree the sources are aligned. The Implementation Study has filtered the addresses by :

1. Removing jurisdiction only addresses (retaining AusPost and AEC records);
2. Removing retired addresses;
3. Removing alias addresses;
4. Removing parent records where there are three or more premises at a single location; and
5. Removing data error duplicates.

Based on the November 2009 G-NAF data, the filtering results in 10.7 million addresses

Source: PSMA Australia Limited; DBCDE; Implementation Study

Our modelling has passed through two iterations.

Determining the fibre footprint

An initial round of modelling was conducted to place exchanges, street cabinets, feeder and distribution. Two fibre footprints, covering 90 percent and 93 percent of premises respectively, were created using:

- The total road distance, premises density and the number of MDUs (which were calculated for every Mesh Block) and
- Deployed road distance, which we calculated for more than 20,000 Mesh Blocks (around 10 percent of non-empty Mesh Blocks).

Deployed road distances were estimated (as a ratio of total road distance controlling for premises density) and combined with the proportion of MDUs and the premises density to rank each Mesh Block into percentiles.

Calculating distances and the number of exchanges

Once the footprints were established, we clustered the Mesh Blocks within a fibre footprint to place exchanges subject to three rules:

- Fibre exchanges typically do not serve more than 30,000 premises. This is a conservative assumption we adopted, to ensure network integrity and to enable modelling of a home-run as well as a shared topology. Many international FTTP networks have used the new deployment as an opportunity to reduce the number of exchanges relative to a copper network, and NBN Co may wish to do so;
- The radial distance from OLT to ONT cannot exceed 10 km, based on industry conventions for GPON with a 1:32 split to guarantee against performance degradation;
- Where a fibre exchange can collocate with an existing copper exchange, this location is preferred.

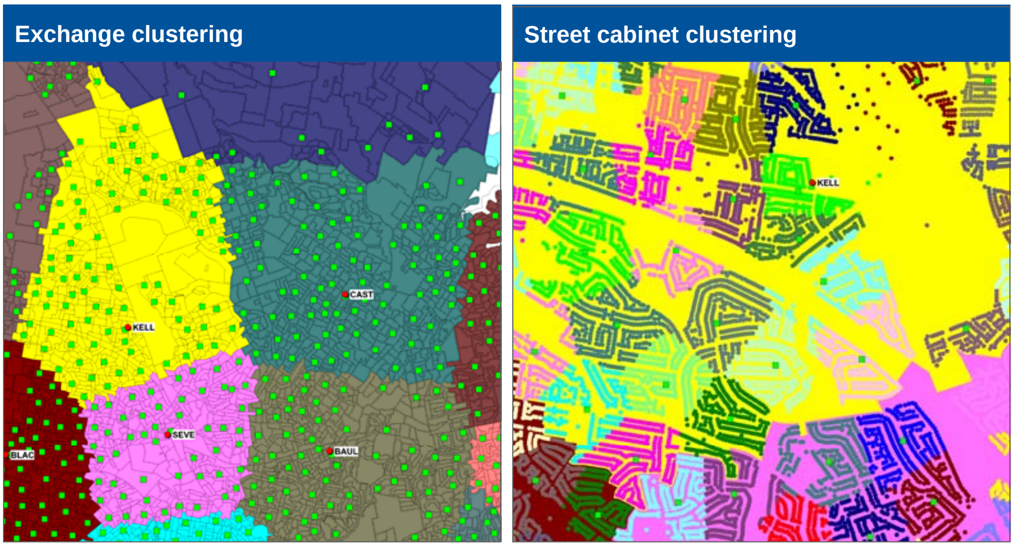
Once exchanges are created, premises are clustered around splitter cabinets to form cabinet zones with a maximum 250 premises per cabinet. Again, this is a conservative assumption as splitter cabinets are available in larger sizes which may reduce costs and facilitate unbundling.

The left hand side of Exhibit 4–25 shows the exchanges (red dots) and the bright colours show which Mesh Blocks are clustered to each exchange. The right hand side zooms in to show the street cabinets (green squares) and the individual premises (coloured dots) which cluster to each street cabinet.

Finally, we modelled the feeder network (from exchange to street cabinet), using a lowest cost algorithm and the distribution network (vertex to vertex) for every street and premises within each of the two fibre footprints.

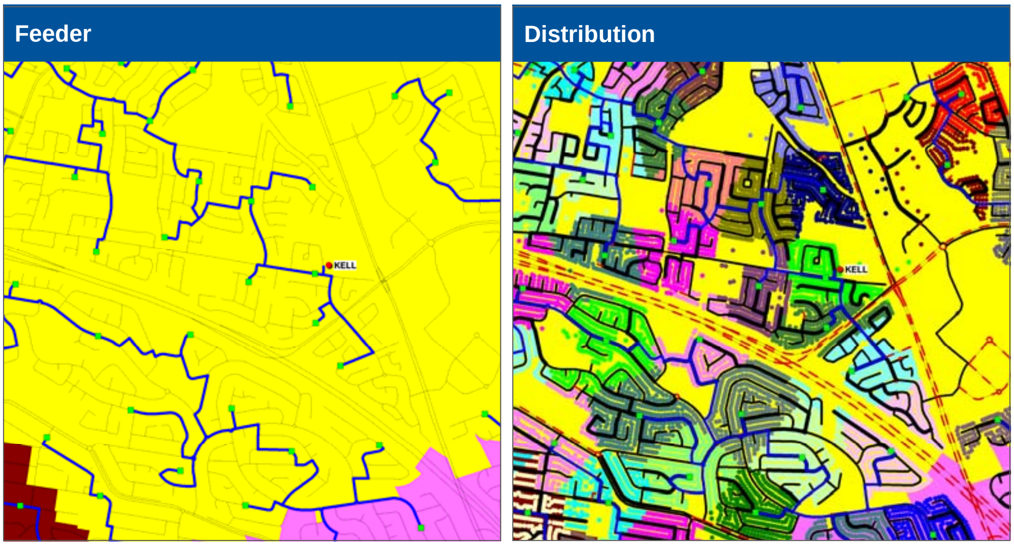
The left hand side of Exhibit 4–26 shows the feeder network, in blue, connecting the exchanges (red dots) to street cabinets (green dots), and shows the way the feeder network minimises total cost by sharing the same trenches where possible. The road network is represented by pale grey lines. The right hand side shows the distribution cable in black—the thinnest lines represent 1–12 distributions fibres; the medium lines represent 12–48 fibres and the thickest lines represent 48–312 fibres. Roads with red dashed lines do not have any distribution fibre.

Exhibit 4–25. Clustering premises to form cabinet zones



SOURCE: Implementation Study

Exhibit 4–26. Modelling the feeder and distribution network



SOURCE: Implementation Study

Combining sophisticated algorithms with practical overlays

Using Mesh Blocks overcomes the 'tyranny of averages', but some practical overlays are required to ensure the fibre footprint generated represents a realistic network design. The first potential issue is a 'Swiss cheese' network, where the road distance per premises for a Mesh Block is just above the cut-off used for the fibre footprint (e.g. it lies in the 94th percentile) but it is adjacent to Mesh Blocks which are attractive to serve. In this case, the cost to serve with fibre may actually be relatively low, especially if a Mesh Block has a relatively large geographic area, but most of the premises are adjacent to the fibre network boundary.

The second potential issue is the minimum scale required for a fibre exchange and the distance of that exchange to backhaul. Mesh Blocks can have a low road distance per premises (de-facto qualifying them for fibre) and be located far away from other premises that fall within the fibre footprint or from other exchanges for backhaul purposes. Both these facts can make the premises unsuitable for fibre coverage on the basis of cost to serve.

These potential issues have been addressed with the practical overlays described in Exhibit 4–27 below. It is important to highlight that while these overlays alter the fibre footprint, none affect more than 1.5 percent of premises.

Exhibit 4–27. Practical overlays applied to geospatial modelling

Possible issue	Overlay	Description
Swiss Cheese	Smoothing algorithm	A weighted average covered road distance is calculated for all Mesh Blocks. The weighted average is based on the average percentile of all adjacent Mesh Blocks. Any Mesh Block which previously would have fallen out of the fibre footprint, but would now fall within based on its weighted average is included in the fibre network.
	Hole filtering	Any Mesh Block not included in the initial fibre footprint, but wholly contained with a contiguous fibre footprint, is also included in the fibre network. These Mesh Blocks typically do not contain premises (e.g. parkland, cemeteries), but some have 1-2 premises (e.g. a caretaker's office).
Isolated Mesh Blocks	Crossing holes	If the network needs to cross an empty Mesh Block to connect premises to their exchange then this distance is included within the overall network.
Isolated exchanges	Shaving algorithm	Fibre exchanges that are not proximate to other fibre exchanges within the fibre footprint, so the cost of providing backhaul is absolutely prohibitive, are removed from the fibre footprint.

Source: Implementation Study

Clearly, the company has significant degrees of freedom to optimise its network relative to our modeling:

- Our modeling leaves approximately 100,000 premises within 100m of a fibre coverage zone and 200,000 premises within 500m. Often this is a result of Mesh Block boundaries being drawn down the middle of a street, leaving the ‘last good street in town’ outside the fibre footprint. In practice some of these will be included in the footprint, and potentially some premises within our footprint will be excluded for practical reasons or to strike a different balance between the cost of backhaul and the cost of the access network.
- NBN Co’s network design could have fewer exchanges serving more premises per exchange and larger street cabinets serving more premises per cabinet, both of which have the potential to reduce overall costs.

4.4 Achieving take-up of services on fibre

The NBN will deliver a step-change improvement in fixed-line performance capability for households, businesses, and institutions. Understanding how quickly users respond to this improvement by adopting fibre services requires evaluation of four factors. We address these factors in turn:

4.4.1 Understanding the shift from fixed lines

4.4.2 Understanding demand for superfast fixed-line broadband services

4.4.3 Establishing the case for RSPs to migrate traffic to the NBN

4.4.4 Expecting fibre to emerge as the predominant fixed-line infrastructure.

Each of these subsections describe the elements of the Implementation Study's approach to modelling take-up of fibre services, a summary of which is provided at the end of this section in Exhibit 4–40. The approach to revenue modelling is described in Section 4.5.

4.4.1 UNDERSTANDING THE SHIFT FROM FIXED LINES

Although a ubiquitous part of the communications landscape over the 20th century, fixed-line markets are in decline. Customers worldwide are leaving their copper-enabled PSTN services in favour of mobile and VoIP services, and DSL take-up is not yet sufficient to maintain fixed-line penetration. However, this trend of fixed-line abandonment is not yet severe in Australia when compared to other developed countries. Fixed-voice penetration in Australia stood at 87 percent of households in 2009,[99] compared to US and European figures in the range of 50 to 60 percent.[100] From this high starting point, significant declines in fixed-line penetration are likely on the existing copper network, irrespective of a fibre overbuild.

The NBN will be Australia's future fixed-line network and will offer a step-change in performance relative to copper. In assessing the likely future demand for fixed-line products, it is helpful to examine the major drivers of fixed-line penetration and how demand dynamics will be altered by the NBN.

The Implementation Study believes that fixed-line demand for NBN services is likely to be strong and will underpin a revival in fixed-line demand across Australia. This review of the market is laid out in three parts:

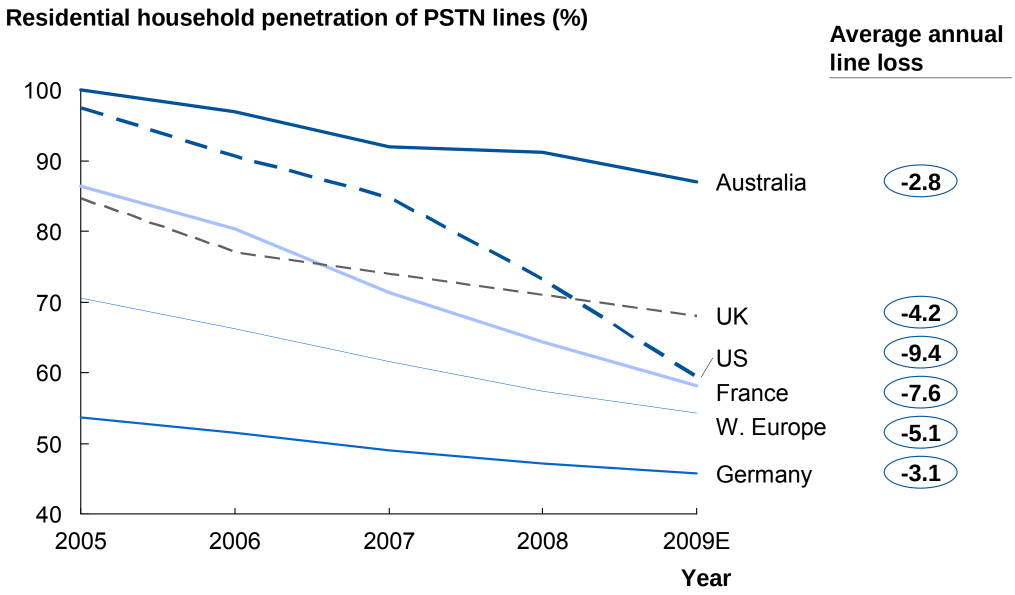
- Transition to a broadband-centric fixed-line market

99 Telsyte 2009, *Home Speed Home: Australian Consumer Digital Home Study;* Note that ACMA figures put this number as high as 90 percent based on Roy Morgan data (ACMA 2009, *Communications report 2008-9*)

100 Pyramid Research 2009, *Residential and business fixed forecasting database*

- Increasing role of mobile broadband
- Continued strength of fixed broadband over time

Exhibit 4–28. Fixed-voice line loss in major markets



SOURCE: ACMA; Pyramid Research; Telsyte Research; Implementation Study

Broadband replacing voice as anchor fixed-line service

The fixed-line relationship will soon be based primarily on broadband services, as fixed-voice services decline in relevance. Historically, voice has been the anchor product for the fixed-line. PSTN penetration stood above 90 percent at its peak, with Internet penetration growing from nothing to over 70 percent today. Broadband customers are still largely a subset of voice customers, but PSTN voice penetration is falling while broadband penetration continues to grow.

Global trends show the decreasing relevance of PSTN. Fixed-voice line loss averaged over 5 percent per year in Western European countries since 2005 and over 9 percent in the US market (Exhibit 4–28).[101] This has been driven largely by substitution to mobile as attacker brands capture share. This trend is now gathering pace in the Australian market, where fixed-voice penetration has declined an average of nearly 3 percent per year since 2005.[102]

101 Ibid

102 Ibid; ACMA 2009, *Communications report 2008-09;* ACMA 2008; *Communications infrastructure services and availability in Australia 2008*; ACMA 2007; *Communications infrastructure services and availability in Australia 2006-7*

There is reason to believe that an increasing number of Australians are poised to leave their fixed-voice lines:

- **Increasingly attractive mobile pricing.** Australians cite price as the most important reason they prefer their fixed line to a mobile phone,[103] with 37 percent saying they would consider replacing their fixed-line if mobile prices were lower.[104] Current mobile prices are declining, particularly as attacker brands (e.g. Vodafone, Virgin) gain share. The price of a mobile call has fallen over 10 percent per year on average since 2005.[105] Mobile calls are also becoming less expensive relative to fixed lines. The mobile price premium, on a per-minute basis, fell from 50 percent premium to approximately 5 percent between 2005 and 2007.[106] As mobile voice prices continue to decline, fixed-voice line loss is likely to accelerate.
- **Mobile 'network effect' and high fixed-to-mobile rates.** Fixed-to-mobile calling rates—increasingly important in a mobile world—are also high in Australia. Major carriers charge up to 80 cents per minute for a fixed-to-mobile call,[107] compared to a small flat fee for fixed-to-fixed calls.[108] As more calls are made to mobiles, customers will have an added incentive to leave their fixed-voice lines for less expensive mobile-to-mobile calling.
- **Widespread acceptance of VoIP as a substitute.** VoIP has a growing presence in Australia, particularly among SMEs. In 2009, an estimated 2.5 million Australians used VoIP at home, up from 1.8 million in 2008. Twenty percent of SMEs report using VoIP, up from 17 percent the year prior.[109] This is good news for fixed-broadband penetration—these services will likely be an important part of the fixed-line relationship and even more so as niche technologies move into the mainstream (e.g. video conferencing). However, as these services will increasingly run 'over the top' of fast broadband connections, rather than on a dedicated managed carrier network, they are hard for carriers to monetise.

Customers who have abandoned PSTN services are unlikely to re-subscribe to a PSTN service. Unlike broadband—where a fixed-line product may offer a noticeably different quality of service to mobile—mobile voice services are effective substitutes for fixed-voice lines. Only 20 percent of customers surveyed felt their fixed-voice lines offered a

103 ACMA, *Telecommunications today report*, vol. 5, *Consumer choice and preference in adopting services*, Canberra

104 Ibid

105 Merrill Lynch 2009, *Global wireless matrix*

106 ACMA 2008, *Fixed-mobile convergence and fixed-mobile substitution in Australia*, Canberra

107 Telstra 2010, *Home phones & plans*, viewed 1 February 2010, <http://www.telstra.com.au/homephone/>; Optus 2010, *Personal plans*, viewed 1 February 2010 <http://personal.optus.com.au/>

108 Ibid

109 ACMA 2009, *Communications report: 2008-09*

more reliable service or a better connection than their mobile phones.[110] Moreover, the services offered on fixed-voice lines are unlikely to evolve over time, creating limited opportunity to win back lost customers.

It is clear that broadband will be the core of a compelling fixed-line proposition in the future even as fixed-voice declines.

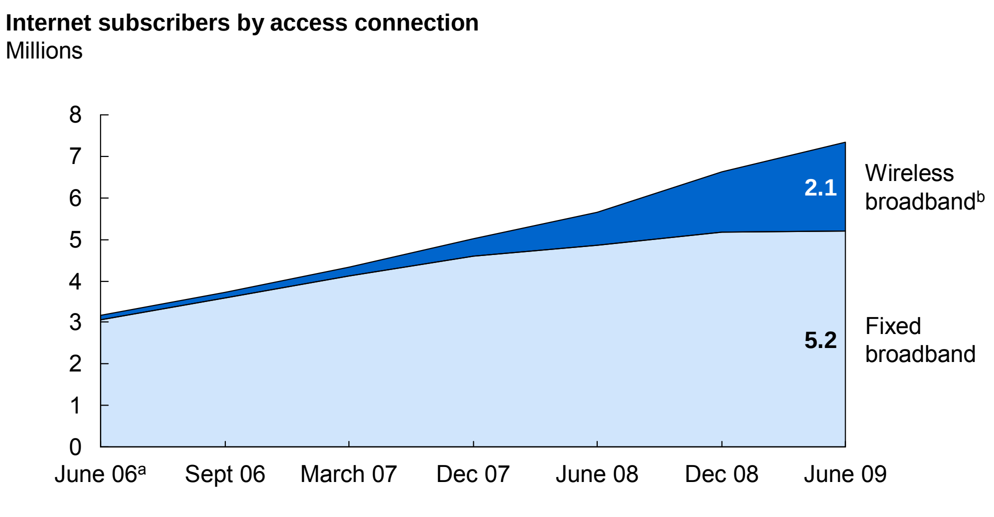
Increasing role of mobile broadband

Mobile broadband has grown dramatically over the past three years (Exhibit 4–29). The market added 664,000 mobile broadband subscribers in the six months to June 2009. Over this same period, the fixed broadband market grew by only 80,000 lines, leading to widespread concern over the future prospects for the fixed-line broadband market.[111]

It is likely that the market momentum and investment by carriers in advertising will result in continued strong mobile share of broadband growth in the short-term. However, this growth is not as threatening to the fixed-line market over the medium to long-term as headline statistics suggest.

The Implementation Study believes that the confluence of several unique and temporary factors has resulted in the rapid growth of wireless broadband that can be seen in

Exhibit 4–29. Growth in wireless broadband accounts over time



a. ABS data reported for all available periods
b. Wireless data includes both mobile broadband and fixed wireless, as ABS did not split data prior to 2009. In June 2009 fixed wireless accounted for 160,000 of the 2.1 million subscribers. Fixed broadband included 90,000 satellite subscribers
SOURCE: ABS

110 ACMA 2007, *Telecommunications today,* vol. 1, *Consumer attitudes to take-up and use*, Canberra
111 White, D 2010, 'Mobile may challenge NBN', *Australian Financial Review*, 11 January, p. 48

Exhibit 4–29. The drivers of this growth are likely to weaken over the medium to long term as fibre connectivity becomes ubiquitous.

Coexistence of mobile and fixed broadband

Rather than substituting for fixed-line broadband connections, as has been widely assumed have assumed, most mobile broadband connections are for users who also have a fixed-line connection at home. This suggests that mobile broadband is a complement rather than just a substitute for fixed broadband.

Moreover, research in multiple markets consistently suggests that between 70 and 90 percent of mobile subscriptions are not substitutive. Less than a third of Australian broadband households today are mobile only, according to Telsyte research.[112] That number is estimated at between 20[113] and 25[114] percent in the US, 24 percent in the UK,[115] and 9 percent in France.[116]

This suggests that less than 200,000 of the nearly 664,000 mobile broadband accounts added in the six months to June 2009 were added by mobile-only users. The 470,000 remaining were complementary—purchased not by people replacing their fixed broadband accounts but supplementing them.

> **Highlight.** Mobile broadband growth does not directly substitute fixed-line services; they are complementary in many cases, and address different user bases.

Weakening drivers of mobile broadband growth

These effects together mean that mobile and fixed broadband services can coexist. There is good reason to believe that mobile broadband growth will slow, as recent growth has been supported by a number of temporary factors (Exhibit 4–30):

[112] Telsyte 2009, *Home speed home: Australian consumer digital home study*

[113] McKinsey & Company 2009, *North American Wireless Panel Survey*; the Wireless Panel is a proprietary McKinsey survey of mobile phone subscribers conducted annually since 2003. It includes more than 30,000 responses from all North American wireless carriers from postpaid and prepaid customer segments and from business and consumer users

[114] Centers for Disease Control 2009, *Wireless substitution: Early release of estimates from the National Health Interview Survey, January – June 2009*, report prepared by S Blumbert and J Luke, National Center for Health Statistics, Hyattsville, MD

[115] McKinsey & Company 2008, *European Telecom Consumer Insights Survey;* European equivalent of the North American Wireless Panel, surveying over 30,000 European mobile phone users

[116] Ibid

Exhibit 4–30. Drivers of mobile growth that are likely to weaken

Current growth drivers	Factors that suggest a future slowdown
Recent drops in mobile broadband pricing	Mobile broadband pricing fell significantly in the past year.[a] For the first time, mobile broadband is competitive with comparable DSL offers on price.[a] For example, Telstra recently dropped the price on its 3 GB per month bundled mobile broadband plan by 40 percent, to $30—less than many entry-level DSL plans.[b] Growth in mobile broadband subscriptions corresponds directly with these price drops. Telstra's first major mobile broadband price cut in November 2007 coincided with a doubling in net adds, from under 100,000 in the period prior to the cut to more than 200,000 in the period following. Telstra did not sustain that growth during a period of stable pricing: net adds dropped to under 150,000 in second-half 2008—a period in which it offered no major price cuts. When Telstra cut prices again in first-half 2009, net adds spiked, to just under 250,000[c]. As the market matures, continuing dramatic price reductions are unlikely and mobile broadband growth rates will likely moderate.
Poor fixed broadband offers	Australian fixed-line broadband services are slow, expensive and usage-constrained when compared with international peers. Among OECD countries, services are third slowest, prices seventh highest and usage 'caps' are the norm.[d] Usage caps are standard for fixed-line connections in only four other OECD countries. The quality of fixed-line broadband offers is set to improve dramatically once fibre is introduced. The NBN roll-out, combined with increased competition amongst service providers, will deliver significantly better fixed broadband services. Mobile broadband is likely to look much less attractive compared to fixed-broadband as applications requiring high-bandwidth became more widely used.
Strong adoption of remote working in business market	International data suggests that a large percentage of mobile broadband subscriptions are held by business customers, for whom connectivity is highly valuable and mobility commands a premium.[e] As the business market reaches saturation, overall growth will slow.

a. For example, Internode's introductory $30 per month 5 GB bundled plan (Whirlpool 2010, *Internode*, viewed 30 January 2010, <http://bc.whirlpool.net.au/bc/isp-9/internode.htm>)

b. Telstra 2010, *Wireless Broadband: Latest Offer*, viewed 15 February 2010, <http://www.bigpond.com/Internet/plans/wireless/latest-offer/?cid=bph-access-3>

c. Goldman Sachs JB Were 2009, *Telecommunications Services*

d. OECD 2010, *Broadband Portal,* viewed 20 January 2010, <http://www.oecd.org/sti/ict/broadband>

e. IDC 2007, Australia wireless and mobile broadband 2006–2010 Forecast and Analysis: Two Princes

Source: Implementation Study

Taken together, these factors suggest that mobile growth should moderate once fibre services become ubiquitous.

Continued strength of fixed broadband over time

Fixed broadband is likely to enjoy significant market share in the long-term. The major factor supporting fixed broadband will be an increasing performance advantage over wireless broadband platforms which will only widen as bandwidth hungry applications emerge.

There are several reasons why this advantage will be significant in the future:

- **Fibre offers higher performance through intrinsic physical properties.** Fibre offers end users an uncontended physical platform for the transmission of bandwidth that is only constrained by the power of the active electronics employed. Wireless services are contended and users' rates of speed are affected by the number of other users competing for available bandwidth. Overall wireless capacity is constrained by available spectrum.
- **Mobile will have trouble meeting increased demand.** AT&T's difficulty in delivering mobile data over its 3G network is instructive. AT&T's mobile network has struggled to meet rapidly increasing demand for data and has led to the company encouraging customers to switch their iPhones to WiFi wherever possible (Exhibit 4–31).[118] Increasingly fixed-line Internet is becoming an enabler of wireless data.

At the end of the day from a physics perspective, you're just not going to be able to beat a fixed-line connection when you're comparing it to fibre-to-the-home solutions. … The bandwidth requirements are going to exceed that of what mobile is going to be able to deliver.

Chris Chapman, ACMA Chairman[117]

- **Users will require fixed-line connections to support emerging services.** Proposed products such as 3D HDTV require sustained data rates of up to 60 Mbps. While next-generation wireless technologies such as LTE are theoretically capable of delivering peak speeds in this range to some subscribers, they cannot deliver these speeds during busy hours or over sustained periods. Therefore very high bandwidth applications will not work on wireless products. Further, LTE will likely continue to face serious contention issues, although it represents a significant improvement over today's 3G HSPA technologies.

117 Ramli, D 2010, 'IDC, ACMA: Wireless broadband won't hurt NBN', *ARN*, 13 January, viewed 30 January 2010, <http://www.arnnet.com.au/article/332325/idc_acma_wireless_broadband_won_t_hurt_nbn/>

118 Wortham, J 2009, 'AT&T to Urge Customers to Use Less Wireless Data', *New York Times,* 9 December, p. B6

Exhibit 4–31. AT&T's challenge in meeting increased demand for mobile data

Case study: AT&T mobile network challenge	
New devices driving increased data usage	■ In the second quarter of 2009 nearly 60 percent of AT&T's wireless subscribers bought an integrated device ■ Wireless packet data over their network has increased more than 18 times in the last two and a half years driven by customers taking unlimited data packages.[a]
Customer dissatisfaction due to poor network performance	■ The result is dropped calls, spotty service, delayed text and voice messages and glacial download speeds as AT&T's cellular network has strained to meet the demand[b] ■ Customers are beginning to express dissatisfaction over dropped calls and the inability to connect to the 3G network[c]
AT&T encouraging use of Wi-Fi networks	■ AT&T encourages users to switch iPhones to Wi-Fi networks wherever possible, signing deals with retailers (e.g. McDonalds) for free access ■ Significant amounts of mobile data are being transitioned to fixed-line networks with traffic backhauled this way rising from 8 percent to 24 percent of total traffic in the year to November (2009) [d]

a. AT&T CTO John Donovan, quoted in Reardon, M 2009, 'AT&T's CTO defends wireless network', *CNET*, 8 October, viewed 15 February 2010 <http://reviews.cnet.com/8301-12261_7-10371298-10356022.html>

b. Wortham 2009, 'Customers angered as iPhones overload AT&T', *New York Times,* 2 September, p. B1

c. Reardon 2009, 'Is the iPhone hurting AT&T's brand?', *CNET,* 2 October, viewed 15 February 2010, <http://news.cnet.com/8301-30686_3-10365952-266.html>

d. Burrows 2009, 'AT&T mulls plans to deal with iPhone data demand', *BusinessWeek*, 21 December

Source: Implementation Study

- **For comparable prices, mobile operators are unlikely to deliver competitive products with current network constructs.** The recent pattern of providing mobile broadband to a greater number of customers at increasingly lower prices has been driven by temporary forces which are likely unsustainable going forward. Excess capacity in recently expanded networks (e.g. Telstra's GigE investments to 85 percent of base stations) has allowed Telstra and Optus to offer highly competitive pricing over expanded capacity.[119] Similar excess capacity among major telecommunications provider in Europe (e.g. Telekom Austria) led to comparable price cuts and corresponding high take-up of mobile broadband.[120] This will likely not be possible in the future as adding excess capacity will be difficult and expensive as the demands for mobile capacity per subscriber continues to increase. LTE will not solve this problem, as investment needs are similar to those of current mobile solutions. The current attractive pricing structures are unlikely to

119 Goldman Sachs JB Were 2009, *Telecommunication services*

120 J.P. Morgan 2008, *The power of mobile broadband;* Note that data are for the European market, and based on the expected cost of future investment, not historical capex

be able to move much lower while sustaining the continued investment that is required to satisfy user demands.

There is potential for the NBN to enable improved wireless speeds as mobile providers install micro or picocells. New retail offers may lead customers to use their FTTP service as 'household backhaul' when in the home—as AT&T encourages iPhone users to do today. Mobile operators are also likely to NBN backhaul services from the NBN to increase their cell density. Although these outcomes would improve the performance of mobile broadband, they increase usage of the network and revenue, respectively, for NBN Co.

4.4.2 UNDERSTANDING DEMAND FOR SUPERFAST FIXED-LINE BROADBAND SERVICES

As explained above, demand for fixed-line services is expected to remain strong with mobile services being complementary rather than substituting for fixed-line demand over time. A key question is then how fast mass-market consumers will shift their fixed services across to fibre from their existing copper or HFC based services. Predicting this is difficult: take-up rates of previous Internet technologies have traditionally been hard to estimate prospectively and there are no domestic examples of widespread fibre deployments from which to learn.

There is no single method to predict how end-user take-up of fibre services will progress in Australia—the best method is to triangulate from different sets of observations. At the same time, care must be taken in understanding the applicability of each of these given the array of unseen factors that influence take-up. This section will look at three sets of observations: historical rates of technology adoption in Australia, international fibre roll-outs and market research.

Using analogies from the adoption of other technology platforms in Australia

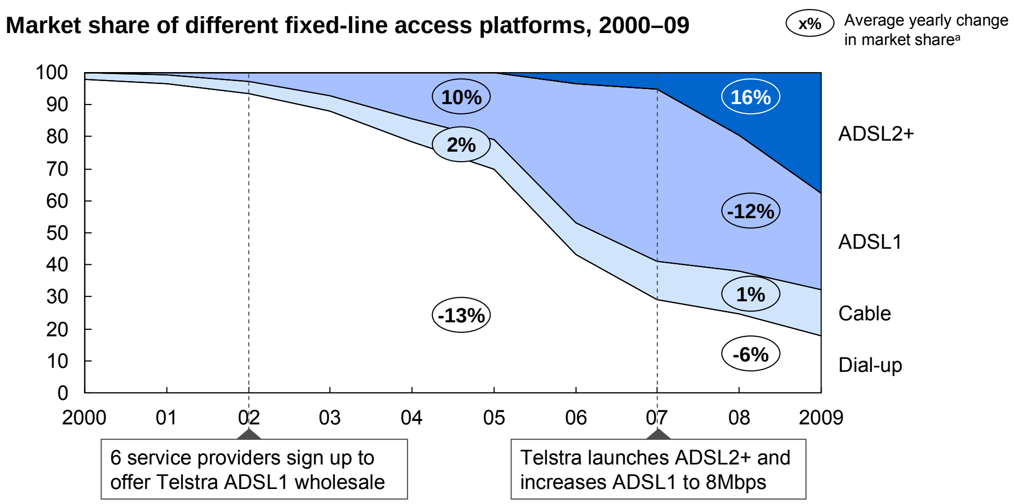
Previous transitions between technologies demonstrate that, with the right incentives, rates of take-up can be very high. For example, in 2005 2G phones were 96 percent of the total mobile phone market, while 3G phones comprised 4 percent. Since then, the market share of 3G phones has increased at 13 percent per annum on average, reaching a market share of 57 percent in 2009.[121] This has been heavily driven by the improved value proposition of 3G phones to end users and the incentive of mobile operators to move users to higher revenue 3G products.

[121] World Cellular Information Service 2010, *Annual total subscriptions Jan 1995 to Jan 2010*

Another recent technology transition in Australia is the migration of broadband customers from 'off-net' to 'on-net'. In this transition, retail service providers moved customers from resale products using Telstra DSLAM to services using their own DSLAM infrastructure. Retailers were incentivised to migrate customers to capture greater retail margins for these products. As a result, migration has been fast. Optus, for example, moved approximately 26 percent of its 'off-net' customers per annum to 'on-net'.[122] Prior to its acquisition of WestNet, iiNet transferred over 15 percent of its 'off-net' customers per year to 'on-net'.[123] Like migration to fibre, the 'off-net' to 'on-net' transition involved choices by retailers. However, unlike fibre, there was relatively limited customer interaction in the move to 'on-net'.

A more directly comparable case to the roll-out of fibre is the adoption of broadband in Australia (Exhibit 4–32). Market share losses for dial-up averaged 13 percent per annum between 2002 and 2007, while the market share increase for ADSL1 was 10 percent per annum over the same period, recently surpassed by the market share increase for ADSL2+ of 16 percent per annum between 2007 and 2009.

Exhibit 4–32. Transitions between fixed-line Internet technologies in Australia



a. Yearly market share calculated as subscribers for specific platform divided by total market subscribers; Yearly change in market share calculated as market share minus previous yearly market share; Calculations are done for years 2002–07, and 2007–09

SOURCE: ABS 2009, *Internet Activity, Australia, June 2009;* cat. no. 8153.0; Screen Digest 2009, *Australia: Broadband Connections by Technology (Annual and Forecast)*; BuddeComm 2009, *Australia – Broadband – ADSL2+ Providers*, ZDNet 2002, 'Telstra downplays broadband demand', *ZDNet,* 25 November; Telstra, *Six Customers Sign Up To Wholesale ADSL Offering,* media release, Sydney, 6 December 2001; Telstra, *BigPond marks 10th Anniversary with launch of national High Speed Broadband*, media release,10 November 2006

122 Screen Digest 2010, *Internet Service Providers (ISPs): quarterly & annual subscribers*

123 Ibid

Learning about take-up from overseas fibre deployments

Many other countries are currently rolling out fibre to meet the growing demands for speed and content (Exhibit 4–33). A good way to compare take-up across markets is to measure new connections as a percentage of homes passed. Since many countries are still only part way through their fibre deployments, only a small percentage of a country's population may be able to connect to fibre at any given time. Overall connections to fibre will therefore under-represent actual take-up and should be read very carefully in making comparisons across markets at different stages of roll-out.

The nine countries for which we present data are at varying stages of roll-out. As would be expected, penetration (the percentage of homes activated as a percentage of those passed) varies significantly. The take-up rate of premises connecting to the network (Exhibit 4–34) shows a significant range across countries. Values range from 2 percent per annum in Italy to 28 percent per annum in Norway. Most countries experience growth between 6 and 12 percent per annum. These countries can be divided into two broad groups. Japan, South Korea and the United States which represent well established, major roll-outs with more than 10 million homes passed. The others (Italy, France, Denmark, Sweden, the Netherlands and Norway) are less well advanced with fewer overall premises passed and are therefore less reliable for forecasting likely take-up in Australia.

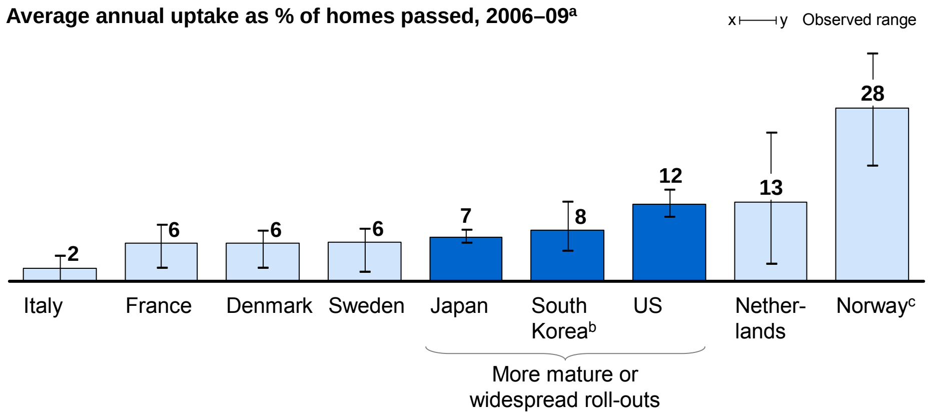
Exhibit 4–33. Fibre roll-outs in selected countries, 2009

Country	Type	Homes activated Millions	Homes passed Millions	Penetration % homes passed	Homes passed % total homes	Penetration % all homes
Japan	FTTH	15.0s	46.8	32	93	30
South Korea	FTTB/N	7.3	~18.0	39	92	36
US	FTTH	4.4	15.2	29	15	4
Sweden	FTTH	0.4	1.0	43	23	10
Italy	FTTB	0.3	2.2	15	10	2
Netherlands	FTTH	0.2	0.8	28	8	2
Norway	FTTH	0.2	0.3	68	13	9
France	FTTH	0.2	~5.5	4	18	1
Denmark	FTTH	0.1	0.7	15	20	3

Note: All figures are for June 2009, except Japan and US. Japan homes passed figure is from September 2008 (most recent available). Other Japan and US figures are from March 2009

Source: Japanese Ministry of Internal Affairs and Communications, IDATE, RVA LLC, Analysys Mason

Exhibit 4–34. Recent average annual fibre take-up rates in other countries



a. Calculated as incremental new activations for the year, divided by average cumulative number of homes passed for the year. For Italy, France, Denmark, Sweden, the Netherlands and Norway, numbers are based on Australian financial years. Numbers for FY09 for these countries are extrapolated by doubling first half numbers for homes activated and homes passed
b. Average incremental uptake as a percent of household sites (a conservative estimate) because homes passed data not available
c. Norway data from 2007 only once >100,000 homes passed

SOURCE: IDATE *"FTTH European Panorama"* December 2008; RVA LLC *"Fibre to the Home: North American Market Update for the FTTH Council"* April 2009; Japanese Ministry of Internal Affairs and Communications *"Japan Monthly Statistics: Information and Communication Service Subscribers and Contracts"*; Analysys Mason *"Fixed broadband: connections and penetration"* October 2009

The less widespread roll-outs show considerable variability. Norway has had a high take-up rate because of a very selective roll-out where fibre is only built to communities where take-up is guaranteed to be high.[124] By contrast, Italy has had low take-up due in part to legal issues over churning customers between Fastweb (an attacker retail service provider which led fibre deployment in Italy) and the incumbent Telecom Italia.[125] France's take-up is diluted by a rapid build-out of nearly 4.5 million premises between June 2007 and December 2008.[126]

The more well established or widespread roll-outs show a more consistent picture. Japan, South Korea and the US had average annual take-up rates of 7–12 percent of homes passed over the last four years. In the United States, fibre penetration, as a percent of homes passed, increased from 16 percent in 2006 to 29 percent in 2009. This was despite competition from cable and price premiums for fibre compared to cable and DSL. In Japan and South Korea, fibre is now available to more than 85 percent of premises and penetration of fibre has grown at a consistent rate over the past five years.

There are three important lessons from these widespread roll-outs for the Australian context:

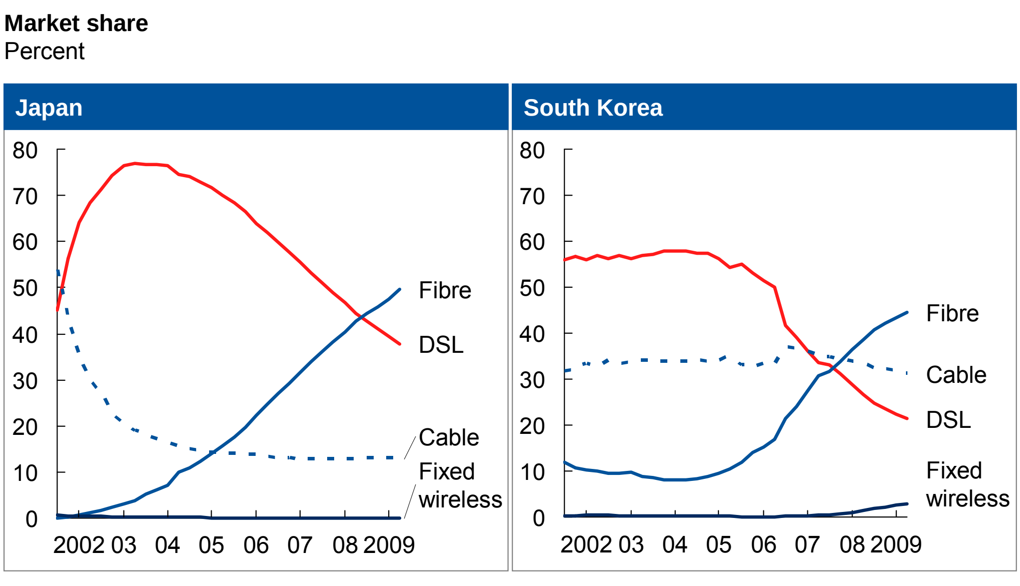
124 Anderson, N 2009, 'Norwegian ISP: dig your own fiber trench, save $400', *Ars Technica*, 11 May, viewed 8 December 2009, <http://arstechnica.com/tech-policy/news/2009/05/norwegian-isp-dig-your-own-fiber-trench-save-400.ars>

125 Reuters 2008, 'T.Italia, Fastweb agree to settle disputes', *Reuters*, 21 June, viewed 13 December 2009,<http://www.reuters.com/article/idUSL214039720080621>

126 iDATE 2009, 'FTTH European Panorama', presentation to the FTTH Council Europe Conference, Copenhagen, 11 February

- **Fibre can displace DSL.** Japan and South Korea have both shown that fibre can take significant share off DSL (Exhibit 4-35). Fibre penetration has reached between 30 and 40 percent of premises passed and now accounts for almost 50 percent of the broadband market in both countries. Fibre has displaced DSL as the most popular broadband access platform and its number of users is rising;
- **Fibre take-up has not yet reached a plateau.** Despite moderately high levels of penetration in countries like Japan and South Korea, fibre take-up rates have been fairly consistent in recent years and overall market share is continuing its upward trajectory in both countries;
- **Cable can maintain share.** In some countries, cable has managed to hold share against fibre (Exhibit 4–35). In these countries, incumbents deployed fibre to counter the threat of triple-play services on cable. Many cable operators have since responded by upgrading their networks to a new standard (DOCSIS 3.0) that can deliver higher broadband speeds with a relatively small capital outlay. In Australia, both Telstra and Optus have announced upgrades to their cable networks to DOCSIS 3.0, with Telstra's cable users in Melbourne being the first to be offered higher speeds. It is reasonable to assume, then, that in the absence of any agreements with current providers, the main source of fixed-line competition for fibre will be cable networks.

Exhibit 4–35. HFC, DSL and fibre broadband market shares in Japan and South Korea



SOURCE: Analysys Mason 2009, *Fixed broadband: connections and penetration*

Exhibit 4–36. Comparison of Australian NBN roll-out with other geographies

Network	Non-incum-bent led	Open access	Wholesale-only	Selective roll-out	Governme-nt support	Lack of strong cable/ VDSL competition[a]
NBN	✓	✓	✓	✗	✓	✓
Japan	✗	✓	✗	✗	✓	✗
South Korea	✗	✓	✗	✗	✓	✗
Norway	✓	✗	✗	✓	✗	✗
Sweden	✓	✓	✓	✓	✓	✓
Netherlands	✗	✓	✗	✓	✓	✗
US (Verizon)	✗	✗	✗	✓	✗	✗
Denmark	✗	✓	✗	✗	✗	✗
Italy (Fastweb)	✗	✗	✗	✓	✗	✓
France	✓	✗	✗	✓	✗	✗

Other factors that will influence relative uptake rates

- Relative prices
- Enabling of competition in uncontested exchanges
- Degree of backhaul constraints
- Competitive-ness of wireless offering

a. In Australia, cable covers <25% of premises and is not presently fully DOCSIS 3.0 capable

SOURCE: IDATE 2008, *FTTH European Panorama: Detailed FTTx Projects*; Verizon 2009, *FiOS website*; OECD 2009, *Broadband Portal*; Japanese Ministry of Internal Affairs and Communications 2008, *ICT Policy in Japan*; IDATE 2009, *FTTx Watch*; National IT and Telecom Agency 2009, *FTTH the situation in Denmark from a regulatory perspective*; Fastweb 2009, 'Fastweb FTTH: A 10-years success story', market presentation

Projected demand for fibre services in Australia can be informed by international comparisons. However, Australia's starting point and context are different in important ways (Exhibit 4–36).

In reviewing these differences, there are several characteristics of the Australian situation which will favour rapid take-up:

- **Lack of high-speed competition in Australia**. In most other countries, fibre has been rolled out to compete with cable operators who own networks spanning a larger proportion of the population. In Australia, only about 25 percent of premises have access to cable infrastructure and the speeds that will be available on fibre are a step-change from ADSL speeds. Furthermore, approximately 40 percent of premises are in non-competitive exchange areas where there is no DSLAM infrastructure owned by a party other than Telstra.
- **Wholesale-only, open-access rather than built by the incumbent**. Incumbent-led programs encounter conflicting incentives. Incumbents incur capital costs to build a fibre network and connect customers from which they hope to benefit from new customers added to the network and from higher ARPUs as well as reduced attrition of their existing customer base and operating cost savings from transitioning existing customers off expensive legacy networks to fibre. In practice it is difficult to realise the benefits from all of these objectives simultaneously. This typically leads incumbents to introduce fibre as an initial premium product to their highest value customers and to manage the transition of lower value customers more slowly.

The exception is in markets like the US where cable operators have competed aggressively by offering integrated triple-play offers. Such competition accelerates the rate at which customers churn off legacy networks and increases the incentive to pre-emptively transfer customers to fibre. With the NBN as a wholesale-only and open-access network, carriers will compete aggressively to win customers on fibre.

- **Priced for affordability and take-up, not as a premium product.** NBN Co should have an obligation to price for affordability and take-up in the near term. The lack of consumer willingness to pay premiums for higher speeds before the widespread emergence of applications to take advantage of this capacity has been correctly identified as a concern by analysts and stakeholders. On the NBN, wholesale prices should be set so that consumers can be offered superior speeds at comparable prices to current plans and this should facilitate the development of the aforementioned applications ecosystem.
- **The ability of NBN Co to offer financial incentives to retailers.** Incentives, if offered by NBN Co, will help drive take-up. Subject to regulatory restrictions, these could take a number of forms—e.g. introductory offers or term discounts—and are discussed later in this section.
- **Further evolution of services and content.** As bandwidth-hungry content and applications become more prevalent every year, it makes the proposition of superfast broadband more compelling to end users. This suggests that the NBN can expect stronger fundamental consumer demand than earlier roll-outs in other markets many of which faced a less bandwidth-hungry set of end users.
- **Community support and awareness.** NBN will be perceived by Australians as a large-scale, nation-building program. Its high profile and the pride associated with this build are not present to the same degree in many other countries. This may help with awareness and take-up in early years.

The main disadvantage NBN will face compared to many other countries is the ubiquity of roll-out. NBN is committed to delivering broadband to all Australian premises, a constraint that does not allow a selective, commercially-targeted roll-out like the one in Norway.

There are also several execution risks which may affect fibre take-up. Smooth migration and effective marketing are critical to the success of fibre. Take-up will also depend on having a desirable product, which requires users recognising the value of higher speeds. This will depend on the availability of quality video content and other bandwidth hungry applications. With the major pay TV operator half-owned by Telstra, a lack of competing video content over fibre is a particular risk for NBN take-up. Effective management of download caps will also be critical to consumers' perception of value.

Competition with other fixed-line technologies like VDSL may also affect NBN take-up. Currently, TransACT offers VDSL in medium-density areas in Canberra. It is possible that other Internet service providers could invest in the infrastructure required to roll out similar services in other parts of the country. Uniform pricing for NBN Co may give these Internet service providers the opportunity to do so.

Highlight. Observations of fibre take-up rates in other countries, as well as comparisons with the adoption of new technologies in Australia, suggest that take-up rates in the range of approximately 6-12 percent of homes passed per annum can be achieved and sustained.

Deriving insights from market research

To enable applications like streaming video, consumers will require higher download speeds. The speeds required for these services to operate effectively are at the limits of what ADSL technologies can currently deliver. Coupled with the fact (discussed in Section 3.1) that speed deteriorates rapidly with distance from the exchange for ADSL, it is clear that current technology is inadequate in meeting projected levels of demand for streaming video.

Market research shows that most Australians value access to a superfast broadband service. A recent Telsyte study[127] reports that approximately 80 percent of Australians are willing to pay more for a superfast broadband service. The study notes that Government services and high-definition video-on-demand are the primary reasons for this interest.

While there are potential pitfalls in relying on today's consumer preferences expressed through market research, there can be little doubt that consumers value a physical platform that is future proof and facilitative of both existing and new multi-media services. Market research confirms the overall conclusion of the Implementation Study that there is strong demand for superfast broadband services which will increase as an applications ecosystem emerges to take advantage of the high available bandwidth per user.

4.4.3 ESTABLISHING THE CASE FOR RSPS TO MIGRATE TRAFFIC TO THE NBN

As a wholesale-only company, NBN Co will have no direct relationships with end users—retailers will act as intermediaries, purchasing products from the NBN and selling them directly to end users. Therefore, while end-user demand will be essential in creating a pull for fibre, take-up will also depend on retailers seeing an economic reason to push fibre products. This section looks at how NBN Co can effectively incentivise retailers to move to fibre.

127 Telsyte 2009, *Home speed home: Australian consumer digital home study*

Economic rationale for retailers

In choosing an access platform with which to serve customers, retailers will look to maximise profitability. Five factors will influence a retailer's decision to migrate customers. The importance of each factor for retailers will differ between fibre and copper.

- **Average revenue per user.** It is expected that fibre based services will command a price premium over DSL based on perceived value to users. In Japan, the United States and the Netherlands, fibre has managed to maintain a consistently higher price than DSL. Furthermore, it is reasonable to expect that the emergence of a newer, faster technology will lead to price declines on services offered over legacy platforms—reducing margins for existing providers using ULL.
- **Wholesale access price.** Obviously, retailers will compare copper and fibre wholesale costs. The cost of Telstra's ULL and wholesale offers will become critical inputs into any decision, although there are uncertainties around those prices. The ACCC may not decide to raise prices on ULL, although price rises are possible if fixed network costs were to be spread over fewer users. Equally, Telstra may choose to price under the regulated price cap for ULL services. Despite the uncertainties around the relevant copper prices, it is likely that fibre will have a higher wholesale access price compared to the ULL price on copper.
- **Retailer cost to serve.** These costs may include billing, customer service and marketing. Together with the first two factors, this determines the margin for a retail product. A fibre offer will require lower investment by a retailer in active equipment and may incur lower backhaul charges (if the retailer is using NBN's transit backhaul) and exchange access fees compared to DSL. It is reasonable to expect that NBN Co services will reduce retailers' physical costs to serve.
- **Churn.** With the introduction of a new technology, the churn rate on copper should increase to take into account the additional churn of customers switching to fibre. The additional churn decreases the lifetime value of a customer on copper and increases the relative value of a customer on fibre.[128]
- **Set-up or acquisition costs.** The retailer may incur costs of changes to internal wiring at a customer's house. This is likely to be a significant upfront capital expenditure which may be offset by migration payments from the NBN Co. Leaving the customer on the legacy network incurs zero costs for the retailer.

NBN Co will be responsible for setting wholesale access prices for its products within the policy and regulatory framework specified by Government. For the purposes of modelling, the Implementation Study has calculated that many retailers will have a

128 Gupta, S. et al. 2006, 'Modelling Customer Lifetime Value', *Journal of Service Research*, vol. 9, no. 2, pp. 139-155

positive business case for using fibre at a wholesale price of approximately $30-35 per month.

We illustrate some indicative pricing scenarios in Exhibit 4–37. These scenarios show the range of prices at which retailers should be indifferent between their legacy copper platforms and the fibre platform. They show that the margin impacts from an increase in wholesale prices for fibre can be more than offset by lower churn, higher ARPU and the lower retailer costs to serve. Some of the factors involved in this modelling may only become apparent to retailers over the longer term (e.g. churn).

The other benefit of a retailer choosing fibre is that it will open up infrastructure based competition for premises that are in non-competitive exchange areas.

Creating the right incentives for migration

To encourage migration to fibre, NBN Co can provide targeted incentives over and above the implicit incentive found in the positive business case for retailers. Effective migration incentives would increase the rates of migration and provide higher early cash flow to NBN Co.

Exhibit 4–37. Price scenarios at which retailers will be indifferent between copper and fibre

	Retailers offering a resale product[a]	Retailers offering broadband on a ULL platform @ $16 per month[b]	Retailers offering broadband on a ULL platform @ $23.60 per month[b]
Wholesale access price on copper	$30–35	$16	$23.60
Indicative benefits from using fibre (retailer cost to serve savings, avoidance of copper ARPU erosion, avoidance of additional churn on copper)	$2–14	$12–24	$12–24
Indifference price for retailers to switch to fibre[c]	**$32–49**	**$28–40**	**$36–48**

a. Although retailers offer ADSL using their own DSLAMs, some retailers resell a Telstra wholesale product

b. Current ULL price in Band 2 is $16 per month. ACCC is considering increasing prices in areas deemed to be part of Zone A to $23.60 per month

c. Price at which fibre becomes at least as attractive to a retailer as copper long-term

Source: Implementation Study

Exhibit 4–38. Typical telecommunications market incentives

Incentive	Description
Cash transfers	Cash transaction for each customer migrated to fibre
Installation	Installation provided for each customer migrated to fibre. This could include, for example, basic internal wiring
Discounts	Price discounts based on volume of connections transferred
Term Contracts	Contract arrangements that lock in price levels for given time horizons
Custom products	Provide unique solutions through product mix
Expiring offers	Incentive offers that expire at set dates in the future
Introductory offers	Special offers for new customers, for example 50 Mbps for the price of 20 Mbps for the first year

Source: Implementation Study

Exhibit 4–38 shows typical incentive mechanisms. Government should allow NBN Co broad flexibility to employ such incentives to encourage take-up through service providers, within the constraints of equivalence. These incentive mechanisms could include one-off fibre connection cash transfers, free installation or discounts on price over set terms.

NBN Co should consider the following when determining incentive schemes:

- **Broad Equivalence.** NBN Co’s value transfer should not distort the power of retailers within the market. Its incentive schemes should provide broad equivalence on price and terms.
- **Economic efficiency.** NBN Co should use cost-impact analysis to construct economically efficient incentive schemes.
- **Transparency.** NBN Co’s incentive arrangements with service providers should be transparent, with all providers able to understand the types of incentives offered to them, and others.

Recommendation 41. That NBN Co be permitted to provide one-off incentives to service providers to encourage migration of their customers onto the network; that these incentives be transparent and offered on a broadly equivalent basis within geographic areas at a point in time; that uniformity of incentives across geographic areas or time not be required.

4.4.4 EXPECTING FIBRE TO EMERGE AS THE PREDOMINANT FIXED-LINE INFRASTRUCTURE

A major factor which will influence the ultimate degree of fibre penetration is the economic viability of legacy networks, particularly copper, as user numbers decrease. Although there is significant uncertainty surrounding future regulatory changes and the long term economics of the copper network, the Implementation Study believes that as fibre penetration increases, the economics of Telstra's copper network will deteriorate. This could eventually lead to an economically-rational decision to shut down the copper and migrate the remaining customers to fibre, absent of any agreement upfront.

Copper network economics

Understanding the future of Telstra's copper network requires examining its economics as its users and revenues decline. Generally, an owner of an asset will shut down that asset if cash flows are expected to be negative. Historical costs, while influencing the depreciation schedule, are sunk and largely irrelevant for any such decision-making. Direct cash costs include maintenance, power and utilities, other network support costs and should include any realisable opportunity costs of keeping legacy infrastructure.

Highlight. Direct cash costs, rather than sunk costs, is the appropriate measure of costs to consider in any future shutdown decisions for legacy networks.

Assessing the copper network's direct cash costs is difficult. Most telecommunications operators are integrated companies that do not report the costs of operating only the copper network, and it is difficult to analyse Telstra's cost structure outside-in. Even in countries that have undertaken functional separation (e.g. the UK with BT Openreach), it is not entirely clear how much of the network support costs are directly borne by the separated entity as opposed to an accounting allocation of group-level costs.

Evidence suggests, however, that a meaningful proportion of the costs of operating the network are fixed and that, as a result, the average unit costs of operating a line will increase as the number of subscribers decrease. AT&T in a submission to the FCC states that customers who leave their network raise the average unit costs for their other customers.[130]

Due to the high fixed costs of providing POTS, every customer who abandons this service raises the average cost-per-line to serve the remaining customers.

AT&T[129]

129 AT&T 2009, *Comments on NBP public notice #25: AT&T Inc. comments on the transition from the legacy circuit-switched network to broadband,* submission to the FCC, GN Docket No. 09-47; GN Docket No. 09-51; GN Docket No. 09-137

130 Ibid

Highlight. The copper network's costs have a fixed component. As a result, the average cost of operating the network per user will increase as the number of users falls.

Deterioration of copper economics with the introduction of fibre

As users move off copper onto fibre the average costs per subscriber left on the copper will increase and Telstra's overall economics will deteriorate. For many exchange areas, once the user base falls below a threshold, it may be economically rational to shut down the network in that area.

A separated Telstra will behave differently to an integrated company. An integrated Telstra will optimise across the entire business, which could involve absorbing losses in its wholesale units to retain higher profits in its retail unit. However, if Telstra were separated and faced an 'equivalence of inputs' condition, then Telstra's retail division would face the same economic choices as other retailers. It would evaluate the relative merits of the copper and fibre networks and consider the migration incentives on offer from NBN Co.

In either case, Telstra may choose to migrate customers who value high speed to ensure their retention. In addition, the wholesale network division will face a difficult predicament as volume falls and unit costs rise—leading to an uncomfortable choice between reducing price to stem share losses despite rising costs, or raising prices to maintain profitability on shrinking volume.

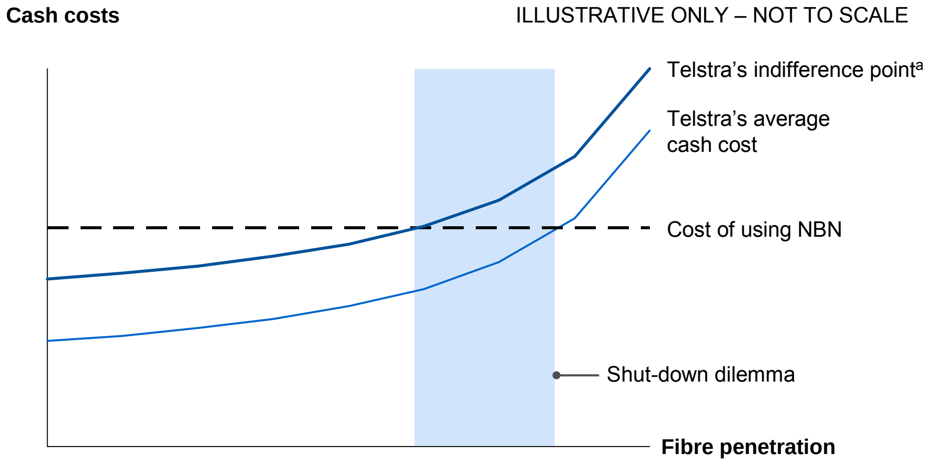
Exhibit 4–39 shows the economic choices for Telstra's retail unit (or an integrated entity) if a proportion of Telstra's copper operating costs are fixed. As fibre penetration increases, the costs to Telstra will increase. As is the case with other retailers, Telstra's retail division will have an indifference point that is higher than the pure cash cost analysis would otherwise indicate because of the differences between fibre and copper in average revenues per user, churn and retailer costs to serve (discussed above). The indifference point line determines when the retail division would choose to move its customers to fibre, assuming copper access prices increase as network costs increase.

Highlight. As users move off copper onto fibre, any fixed costs on copper will be spread over fewer users, increasing the average cost per user and, at some point, potentially making the copper uneconomic to run. This effect will be more pronounced if Telstra's wholesale and retail divisions are separated and make decisions independently.

Several countries have started thinking about closing portions of legacy infrastructure due to the roll-out of next-generation access.[131] In recent years, Telstra shut down its CDMA network and migrated all its traffic to other technologies. Other industries also exhibit deteriorating economics when the number of customers decreases.

131 European Regulators Group 2009, *Report on Next Generation Access – Economic Analysis and Regulatory Principles*, Brussels

Exhibit 4–39. Deterioration of copper's economics as fibre penetration increases



a. Assumes there are churn, ARPU and retailer costs to serve differences between copper and fibre once fibre is rolled out
SOURCE: Implementation Study

There is, however, considerable uncertainty in predicting the long-term economics of copper and Telstra's decisions about its future. After all, no country has yet closed down its copper infrastructure due to the roll-out of a fibre network. The main uncertainties are:

- **Total cost per user.** The higher the overall costs on copper, the more likely the network is to become uneconomic to run. Conversely, if costs are low per user, then the network is less likely to be shut down.
- **Long term variability of costs.** The greater the percentage of overall costs that are variable over the medium to long-term, the less the average cost per user will increase as user volumes decline.
- **Actions Telstra could take.** For example, an integrated company may decide to suffer losses on the copper network to preserve retail market share.
- **Take-up of fibre.** Take-up of fibre may plateau before the costs have deteriorated enough to warrant shutdown. However, experiences in countries with high penetration of fibre, such as Japan and South Korea, suggest that this plateau may not in fact occur.

Nevertheless, on balance, it is likely the economics of copper will deteriorate over the long term, making it more probable fibre will emerge as the predominant fixed-line infrastructure.

Exhibit 4–40. Fibre take-up modelling in the business case

Approach to modelling take-up of fibre

The take-up modelling is based on a combination of the level of consumer 'pull' for fibre-based services and a compelling business case existing for a retailer to migrate services to copper (through a combination of wholesale pricing and one-off migration incentives). The modelling is based on individual activation curves for cohorts that are aggregated into an overall activation profile.

Activation curves by cohort

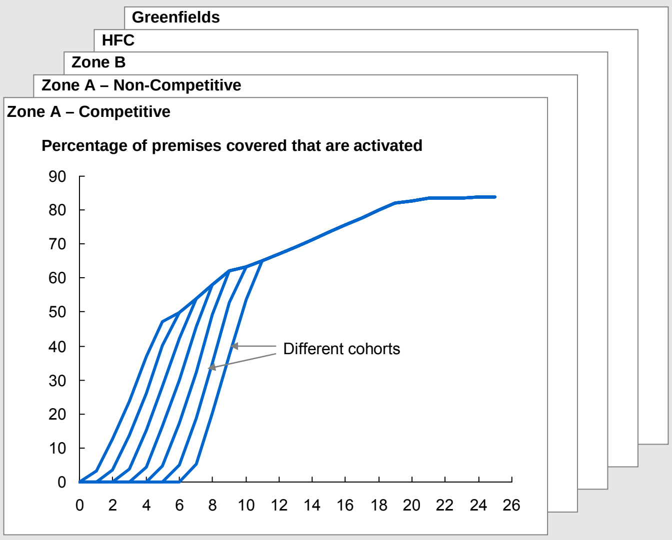
Take-up in the fibre footprint is based on cohorts. A cohort is defined by two characteristics:

- **Geography.** The fibre footprint is split into 4 broad regions for the purposes of modelling: areas with HFC, Zone A competitive, Zone A non-competitive, Zone B. Greenfields premises across each region are modelled as a separate category. The zones correspond to ACCC definitions[a]. A particular area is considered competitive if there are retailers other than Telstra with DSLAM infrastructure in that area. The modelling treats these regions differently. In HFC cohorts, a greater ability of HFC to hold share relative to fibre is modelled. A user in a Zone A non-competitive region is expected to move to fibre more quickly than a customer in a Zone A competitive region due to strong expected activity from ISP attackers. Greenfields premises are treated as a specific case with much faster activation and higher than average penetration. By 2018, Greenfields will account for 11 percent of premises and by 2035, they will account for 28 percent.
- **Year covered.** The take-up effect starts only when a home is covered, and premises covered in later years are expected to move to fibre faster than those covered at the beginning of the rollout.

Within a cohort, take-up is differentiated by two factors:

- **Product.** A voice-only customer is less likely to want to move to fibre in the early years;
- **Retail Service Provider.** Consistent with the modelling assuming no deal for migration of customers, Telstra customers are modelled as moving more slowly to fibre.

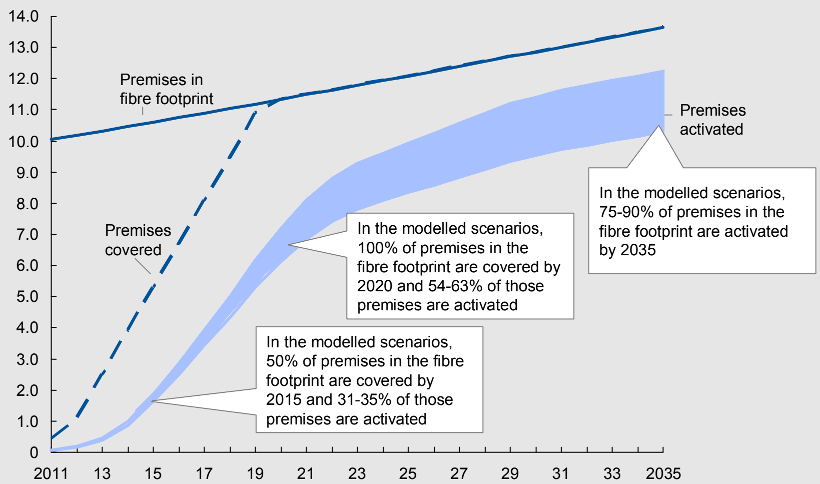
Activation curves by cohort



SOURCE: Implementation Study

Aggregate fibre take-up scenarios

Premises, Millions



SOURCE: Implementation Study

The activation curve is then built up for each cohort. In general, take-up in the early years after an area is covered is modelled to be at the higher end of the 6 to 12 percent range observed in other fibre deployments. This slows, however, once penetration exceeds approximately 60 percent of the cohort. If, however, the copper network were shut down earlier, then there could be an uplift in penetration. The tail of the activation curve is based on the terminal penetration of fibre, which is driven by the combined demand for services over fibre (e.g. 70 to 90 percent for fixed-line broadband).

Aggregate modelling of take-up

Activations for each cohort are aggregated to yield overall coverage and activation (see Chart below), which then drive revenues. There are three features to note in the scenarios represented by the chart:

- Total premises to be covered by fibre in 2018/19 is modelled to be 93 percent of 12.1 million, including 1.3 million new premises from 2010. New premises growth is modelled at 1.25 percent of existing premises;
- All premises are covered by 2018/19. After that, all growth in premises covered is from new premises;
- Activation is shown as a range based on the market demand scenarios of 70 to 90 percent penetration of fixed-line broadband.

a. ACCC, *Draft pricing principles and indicative prices for LCS, WLR, PSTN OTA, ULLS, LSS*, August 2009

4.5 Creating a robust revenue model for the NBN fibre network

One of the most important commercial decisions facing a network operator such as NBN Co is setting price. This will require balancing a range of considerations—take-up, other objectives such as usage, regulation, and financial performance—in a constantly evolving landscape. Although pricing is a matter for NBN Co subject to the applicable regulatory regime, this section provides guidance on major issues to be considered in setting price, now and in the future, and how revenue scenarios may play out for the business.

Three subsections follow:

4.5.1 Managing pricing over time

4.5.2 Implementing a price architecture consistent with policy objectives

4.5.3 Achieving a sustainable revenue profile within the fibre footprint.

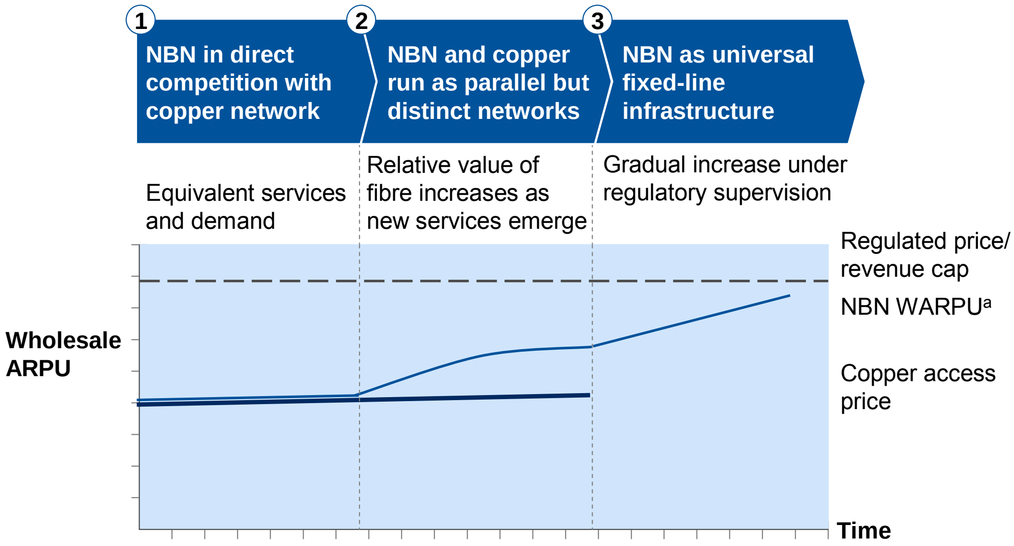
4.5.1 MANAGING PRICING OVER TIME

Pricing of NBN services must reflect the needs of numerous stakeholder groups: Government, the ACCC (on behalf of end users) and customers. These groups have a range of objectives. Government has objectives of take-up and long-term commercial viability of NBN Co, amongst others. The ACCC is concerned with the long-term interests of end users. Customers of the NBN currently operate on a separate platform and will need incentives to move onto the NBN.

Pricing is likely to evolve over a number of phases to balance the needs of these stakeholders. Exhibit 4–41 presents one view of this evolution. The timing of these phases is uncertain. However, this framework highlights the changes that are likely to occur over the life of the NBN. We discuss these phases in three parts:

- Setting initial price levels;
- Pragmatically increasing average prices over time;
- Managing pricing within a regulated revenue cap.

Exhibit 4–41. Conceptual phases of pricing for NBN services



a. Wholesale average revenue per user
SOURCE: Implementation Study

Setting initial price levels

The objective of pricing in the initial phases of the NBN is to drive take-up on the network. Prices for NBN services will therefore be initially constrained by offers on competing networks—in particular, the copper network.

The previous section outlined a methodology to estimate the indifference price for service providers. Indifference pricing refers to the level at which NBN wholesale prices represent parity with copper access prices in terms of customer lifetime value. At these prices, service providers have equal incentive to offer services on either network. The Implementation Study has modelled initial prices for NBN services referencing this methodology. The findings of our revenue modelling are presented later in this Section.

Gradually increasing prices over time

The relative value of fibre is likely to increase over time as new services and uses emerge. As it does, NBN revenues should increase to provide a fair return on the network investment. An increase in revenues over time would likely correspond to an increase in user value. A plausible revenue trajectory over time is presented in Exhibit 4–41. This trajectory could be achieved in two ways: a change in demand for new or higher-priced services; or a price increase on basic services (within the ongoing affordability requirement).

First, changes in demand could drive increased revenue on the NBN. The emergence of new or improved retail services could require users to upgrade to higher speed and/or quality services. These services will likely command higher prices. Demand for higher-priced services will drive an increase in average revenue per user. However, the extent of this revenue opportunity is uncertain.

Second, prices could improve returns over time via regulatory review. There are precedents for this approach in other countries. Singapore, for example, has scheduled a number of pricing review points, at which wholesale prices can be altered, depending on demand.[132]

However, any price increases should not come at the expense of network penetration, given the ongoing requirement for affordability and take-up of NBN services.

Advice. That NBN Co Board consider real price increases for NBN services to achieve reasonable return; that any price increases should ensure entry-level services continue to uphold the NBN requirement for take-up and affordability.

The revenue trajectory has implications for NBN Co and any pricing agreed with the ACCC. Given the uncertainty of future demand, NBN Co may need flexibility to introduce price increases to achieve an adequate return on investment over time. Price increases should be negotiated between NBN Co and the ACCC as part of the special access undertaking, to ensure entry-level prices continue to uphold the affordability requirement outlined in Chapter 2. NBN Co should ensure that its special access undertaking specifies a mechanism and timing for reviewing and setting prices, with a view to long-term cost recovery.

Advice. That NBN Co Board establish a mechanism and timing for reviewing and setting prices of NBN Co services as part of the pricing regime negotiated with the ACCC.

Pricing over the long-run within a regulatory framework

The NBN will eventually emerge as a monopoly provider of some network services. As it does, its revenue and prices may face increased regulatory scrutiny. The ACCC is charged with regulating industries and providers to ensure the long-term interests of end users. Subject to any negotiated pricing regime such as a special access undertaking, regulation of NBN prices and services could occur in a number of ways—e.g. price caps for specific services or an overall regulated return.

[132] Infocomm Development Authority of Singapore 2009, *Industry briefing to FBOs*, Singapore

The ACCC and other national regulators typically regulate prices on the basis of cost. However, it is difficult to reasonably allocate the cost of individual services offered on next-generation networks. This is because a high proportion of cost is fixed upfront, and there is little or no marginal cost of providing different or additional services.

> *With next-generation access a greater proportion of costs will be fixed upfront capital costs which are common across shared services…There will be no sound cost-oriented basis for allocating overall access costs across services.*
>
> Brian Williamson, Director Plum Consulting (2009)[133]

Regulation of NBN services is likely, but the nature and timing of that regulation is uncertain. Successful navigation of the path to regulation has two requirements. First, Government, ACCC and NBN Co must constructively engage on areas likely to be regulated. Second, NBN Co should ensure the costs of building and operating the network are recorded transparently at a sufficient level of granularity (Chapter 10). Government and the ACCC should clearly state to NBN Co their expectations in this regard.

Advice. That NBN Co Board consult with the ACCC and Government on current and likely future pricing regulation; that NBN Co Board ensure costs of building and operating the network are recorded at a level of granularity consistent with likely regulatory requirements.

4.5.2 IMPLEMENTING A PRICE ARCHITECTURE CONSISTENT WITH POLICY OBJECTIVES

Price architecture refers to the components and features of pricing for NBN services and how they come together. NBN Co must be allowed flexibility to develop this architecture to achieve commercial success. Pricing decisions are dynamic and challenging. They are best left to the company, within its regulatory and policy constraints.

To balance these obligations and constraints, the NBN price architecture should:

- Provide commercial flexibility to NBN Co;
- Encourage use of the network;
- Permit multiple retailers to deliver services to premises;
- Anticipate the possibility of future separation.

133 Williamson, B 2009, 'The regulation of next-generation access networks and the draft Commission Recommendation', paper presented to the Network for Economic Research on Electronic Communications conference, Madrid, 11-12 September

Providing commercial flexibility to NBN Co

Pricing flexibility is important to network and telecommunications companies. It allows them to adapt to market conditions, create new revenue streams, even spur demand. Such pricing decisions are challenging and dynamic—prescriptive advice today will not serve NBN Co as conditions change.

Telecommunication companies use a range of pricing mechanisms to optimise revenue. Typical elements of a commercial price architecture include:

- **Price differentiation** that involves varying prices by type or quantity of service or user;
- **Commercial terms and charges,** including contractual terms, volume discounts and operational charges (e.g. connection fees);
- **Bundling of services** that involves grouping services (e.g. voice and data services) at a discount to the sum of their individual prices;
- **Fixed access charges** for every connection to the NBN, similar to existing PSTN line rental charges.

NBN Co should have flexibility to adopt commercial pricing mechanisms, within the constraints of its other policy objectives. The remainder of this subsection highlights the policy objectives that will restrict the flexibility of NBN Co to use some of these mechanisms.

> **Recommendation 42.** That Government not constrain the commercial flexibility of NBN Co to design and update a price architecture, within the requirements of regulation and its obligations for affordability and take-up of services; that Government support NBN Co's adoption of price mechanisms such as price differentiation (except where it is based on geographic location) and differentiated commercial terms and charges that are consistent with equivalence

Price differentiation

A considerable body of literature exists regarding price differentiation of services on communications networks. There is broad agreement that some level of price differentiation in telecommunication and other high-fixed-cost industries (e.g. airlines) is appropriate to achieve social benefits, while helping in the pursuit of a commercial return.

> *Price discrimination by firms with market power is often viewed as unfair. From the point of view of social surplus, however, the judgement… may be quite different. Roughly speaking, welfare goes up if total output is increased.*
>
> Mitchell and Vogelsang (1991)[134]

The alternative to differential pricing—in other words, to price all NBN connections at a single price—would be inefficient. A single price that provides a fair return on investment would be too

[134] Mitchell, B and Vogelsang, E 1991, *Telecommunications Pricing: Theory and Practice,* University of Cambridge Press, Cambridge

high for many users, and therefore constrain take-up and usage. On the other hand, a single price that maximised take-up would be unlikely to provide the NBN with any reasonable return.

Some price differentiation of NBN services is therefore appropriate. Exhibit 4–42 outlines the options for differentiating prices of NBN services. NBN Co should consider the use of these options where commercially viable, within the policy mandate outlined in this report. Price differentiation levers that should be constrained in the context of policy objectives are addressed further below in this subsection. It is important to distinguish between price differentiation for services and NBN Co's equivalence obligation. NBN Co should be permitted to define services that are specific to categories of end users such as businesses, schools and mobile transmission sites. Equivalence demands that each of these services, with the same conditions, be available on a wholesale basis to retail service providers. Therefore, differentiating wholesale services by end-user category for retailers to use to deliver services to end users does not contravene equivalence.

Advice. That NBN Co Board consider reasonable differentiation of prices between discrete categories of end users and customer types:

1. Categories of end users. Different prices could apply between business users (i.e. those with an ABN) and residential users;
2. Customer types. Different price levels or structures could apply between retail service providers, e.g. ISPs serving individual premises, and commercial operators, e.g. mobile carriers serving multiple users from a single connection.

Commercial terms

Commercial terms typically include volume-based discounts, long-term contracts and revenue-sharing. There are also a number of one-off or ancillary charges that may be associated with NBN services—e.g. connection fees, port charges, exchange racks.

As a commercial company with an objective to eventually attract private funding, NBN Co should be permitted to pursue a range of actions that improve return on investment by providing revenue assurance and/or a reduction of risk. It should also have flexibility to charge for ancillary services, so long as these charges transparently reflect costs and are in line with industry practice.

Commercial charges levied by NBN Co should only be limited where they violate principles of equivalence, or other requirements within the NBN wholesale mandate (e.g. driving take-up of NBN services). For example, discounted rates for a long-term contract that guarantees a large volume of customers each year would favour bigger retailers. These terms would in effect violate the principle of equivalence, even if it were offered on the same terms to all providers. Many providers do not have the scale to take-up such an offer.

Exhibit 4–42. Options for price differentiation of NBN services

Options for price differentiation	Examples
Service specifications	■ **Download speed**. Prices increase with download speed. This is a primary mechanism of differentiation in most markets ■ **Upload speed**. Prices increase with upload speed. It is useful to differentiate services that have symmetrical bandwidth requirements, e.g. video-conference services ■ **Quality of service**. Prices vary depending on QoS or Class of Service, to differentiate premium products (e.g. IPTV) ■ **Multicast capability**. Premium charge if capability is required. Useful to capture additional revenue from video providers ■ **Contention**. Prices vary with contention ratio in aggregated bitstream. Not relevant for uncontended last-mile NBN service, but appropriate to differentiate backhaul and other aggregated services
Usage characteristics	■ **Total usage**. Wholesale charge per unit of data used at retail level. Can be difficult to measure ■ **Usage tiers**. Wholesale prices vary by download cap ■ **Peak/off-peak usage**. Wholesale prices vary by time of day ■ **Source of usage**. Usage charges depend on origin of data (e.g. higher price for data routed from international vs. domestic servers)
Characteristics of end user or customer	■ **Type of end user**. Different price for business versus residential end users. Singapore's NBN provides a precedent ■ **Type of customer.** Different prices for single-premises service providers (e.g. ISPs) versus multi-user network providers (e.g. mobile carriers)

Source: Implementation Study

Advice. That NBN Co Board offer a range of commercial terms and additional charges, as long as the offers are:

1. Equivalent and do not distort competitive outcomes;
2. Transparently calculated and reflect reasonable recovery of costs for providing that service, e.g. cost of connecting customers.

Encouraging use of the network

NBN Co should set prices to maximise take-up of network services. While an important attraction of the network will be the superfast speeds it offers, the issue of whether NBN Co should employ download caps has been a subject of debate.

The Implementation study believes that usage-based wholesale pricing that replicates Australia's existing retail download caps risks constraining use of NBN services. One could legitimately question the value of superfast speeds if download caps remain. Current caps are outliers in the developed world and have kept Australia's broadband penetration lower than their potential. Moreover, for retail providers to maintain today's margins, they would likely pass on usage-based wholesale charges to customers. Both caps and higher prices per unit of data would constrain growth in data demand and undermine NBN take-up objectives.

Charging higher prices for usage will hamper the growth of services which demonstrate the NBN's superiority over other networks. Releasing usage constraints will allow service providers to offer high-bandwidth services (e.g. e-health, IPTV) which will provide much better experiences than either slower fixed broadband solutions (e.g. DSL) or mobile broadband. However, at current usage caps, use of these services will be constrained. The equivalent of one hour of television usage every day via IPTV will result in monthly downloads of approximately 150 gigabytes, compared with today's high-end retail DSL plans which typically offer no more than 80 GB per month at best.

The differentiation with respect to mobile broadband is even more stark. Due to capacity constraints, mobile broadband is likely to require download caps for the majority of users in the future.

Advice. That NBN Co Board avoid usage-based wholesale pricing for uncontended services in the long term, once the network is profitable and/or cost recovery is assured; that if usage-based pricing mechanisms are implemented for a transition period, they should:

1. Not constrain reasonable use of cloud-based services;
2. Only differentiate between consumption of sufficiently distinct products or services—e.g. at a level corresponding to considerable usage of IPTV per day;
3. Be of a similar magnitude to those implemented in comparable economies around the world.

Ensuring sufficient competition in the home

Government seeks to stimulate competition in fixed-line products through the NBN. This goal is explicitly non-revenue maximising for NBN Co. A purely commercial approach would attempt to diminish competition in services provided to the home, by extracting maximum value from a single service provider that could 'lock up' an entire connection. To ensure this competition exists, NBN Co should not bundle its wholesale services, at a discount to the sum of individual price points. This mechanism would favour larger providers, and prevent the emergence of a level retail playing field.

Bundling should be avoided by NBN Co in its wholesale pricing. There are about 5.5 million voice-only connections in Australia, and 0.7 million broadband-only DSL connections. This latter figure increased by 30 percent between 2008 and 2009.[135] Bundling voice and data products together limits the ability of these consumers to choose the service that best meets their needs.

Pricing a bundle of wholesale services (e.g. voice and data) at a discount to the price charged for each service creates an advantage for large retailers. It reduces competition after the first service provider has secured access to a household. It also limits the flexibility of customers to choose only the retail products that suit their needs and to diversify these purchases across retailers.

We also recommend against two other types of bundling. First, bundling could occur across services—for example, a last-mile bitstream service bundled with backhaul. This could also reduce retail competition, by reducing both pricing transparency as well as the flexibility of service providers to specify products that suit their needs. Second, physical components of the wholesale services necessary to reach end users could be bundled. For example, if individual charges are levied for access to the ports of the ONT, service providers should not be able to acquire multiple ports at a discount.

Advice. That NBN Co Board ensures general pricing for NBN services is transparent and modular—e.g. bundling services at a discount should be avoided, unless a discount is applied to certain legacy services or an entry-level offer.

Adjusting in future given the possibility of future separation

Elements of NBN Co price architecture implemented in the short term can assist the long-term development of the industry. In Chapters 9 and 10 we discuss the importance of active-layer competition and the possibility of longer-term separation of NBN Co into passive and active network providers. The pricing of NBN services can smooth the transition to both of these end-states.

Separation of active and passive network services would require a division of revenue into these components. Should Government seek separation in the future, NBN would need to adapt its price architecture to facilitate the separation and maximise value from it at the appropriate time.

In future, there is no reason why the cost of line maintenance need not be apportioned more equally between voice (and) data…Alternatively, consumers could pay separately for their connectivity and for their applications

Cable and Wireless (2009)[136]

A fixed access charge for NBN services would provide a simple and transparent means of separating price into active and passive components. This access charge serves a dual purpose for an eventual transition. First, it is transparent, signalling to retailers a base price which helps them price their own products efficiently. It also allows future NBN investors

135 J.P. Morgan 2009, *Australian Telecom Sector in FY09*

136 Cable&Wireless 2009, *Response to Ofcom's consultation document: Next generation networks*

greater transparency about post-separation cash flows. Second, it provides NBN Co with anchor point for an eventual passive access price that would likely be negotiated with the ACCC once active competition is introduced.

Levying a fixed access charge also has an ancillary benefit. A fixed monthly charge would provide an efficient way to recover a portion of the fixed investment, while allowing flexibility for some value-based, variable pricing.

> **Advice.** That NBN Co Board consider that a fixed access charge is appropriate to ease future separation on the condition that it:
>
> 1. Is set at a level that does not constrain take-up of NBN services;
>
> 2. Does not bundle additional services.

Illustrating a price architecture consistent with policy objectives

For the purpose of the business case modelling, we have developed a proposed price architecture that balances NBN Co's objectives and stated policies. Details of the actual price architecture is a matter for the NBN Co and will likely be the subject of a Special Access Undertaking to the ACCC. The illustrative price architecture is shown in Exhibit 4–43 below.

4.5.3 ACHIEVING A SUSTAINABLE REVENUE PROFILE WITHIN THE FIBRE FOOTPRINT

The revenue profile from the NBN fibre network is inherently uncertain. Different revenue profiles, combined with different roll-out cost scenarios, create different rates of return. In Chapter 7 we bring cost and revenue for the NBN together to present an integrated business case. However, under all scenarios, NBN Co is expected to achieve significant operating margins due to its low operating cost profile.

NBN Co should have a commercial mandate to set prices to drive take-up. Prices have yet to be determined by the company. For the purposes of developing a business case for the NBN, we have estimated a range of revenue outcomes. This subsection outlines the approach to estimating revenue in the fibre access network, and discusses a range of potential revenue outcomes.

Estimating revenue in the fibre access network

We have taken a conservative approach to modelling NBN fibre-access revenue, given the challenge of estimating the number of variables at play. The scope of our modelling comprises:

Exhibit 4–43. Illustrative price architecture

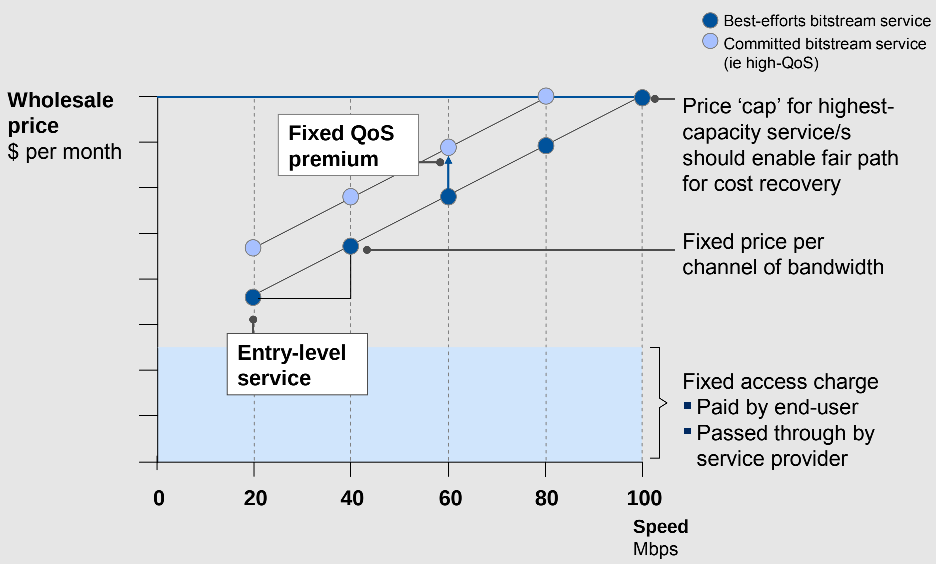
Example price architecture that balances commercial and policy objectives

Here we illustrate a price architecture that balances the objectives and constraints outlined in this section. It provides context for the recommendations and advice outlined in this section. This architecture would apply to a Layer 2 bitstream service in the access network only (i.e. any transit service would be priced separately); and contains some specific assumptions:

- A fixed access charge is levied to end users for connection to the network, and is passed through by the first service provider
- Bandwidth is the scarce resource that, once at capacity, will drive the requirement for network upgrades. Therefore, speed is used as the primary discrimination lever
- The price of the entry-level broadband service (20 Mbps in this example) would be referenced to copper access prices to drive migration
- The price point for the top-speed/capacity service (i.e. 100 Mbps) is set to ensure average wholesale revenue per user provides a fair return on network investment
- Straight-line discrimination between speed channels is used to avoid arbitrage (with no bundling of channels)—i.e. every subsequent channel is sold to providers on an equivalent basis
- Fixed premium for QoS grades within each speed band; providing a linear approach consistent with best-efforts service

Illustrative price architecture: Layer 2 bitstream

ILLUSTRATIVE



SOURCE: Implementation Study

Source: Implementation Study

- A focus on mass-market services—i.e. broadband and voice (PSTN emulation). High-bandwidth and non-premises services such as enterprise-grade point-to-point and backhaul to mobile base-stations, are not included;

- Conservative assumptions regarding new services—i.e. the only non-Internet services assumed to be adopted by service providers are voice and IPTV. Any additional wholesale services purchased by ASPs will therefore be upside to the business case detailed in this report;
- Awareness of practical challenges of mass-migration—i.e. the migration of users onto the network, even once demand for services delivered on fibre exists, will not happen immediately.

For the avoidance of doubt, this section focuses on the fibre access network only. Revenue from transit or non-fibre services is not included.

Drivers of revenue

Revenue is a product of the number of fibre connections (or penetration) and the average wholesale revenue per connection (WARPU). Penetration depends on:

- **Fixed-to-mobile substitution.** The addressable market for NBN services is determined by the number of premises willing to take a fixed-line connection. Loss of fixed-voice lines and rapid growth of mobile broadband have raised concerns this market is contracting. Although these effects are likely to continue in the short term, the performance of fibre will drive a resurgence in fixed-line broadband. We discuss these trends are discussed in detail earlier in this chapter.
- **Demand for services delivered on fibre.** Take-up of fibre is driven by the demand for services delivered over it. Predicting user demand is difficult given the lack of fast alternatives in Australia. We discuss relevant analogies earlier in this section and note the range of likely take-up rates based on international experience.
- **Speed of migration.** Underlying demand for services delivered on fibre does not translate immediately into take-up. Migration onto the network takes some time once fibre is made available to a given 'cohort' of users. This delay is driven by two factors: inertia of end users, and operational limitations associated with migrating large numbers of users onto a new network. For the NBN, the need for installation of equipment at end-user premises affects both factors through inconveniencing end users and presenting operational challenges. The combination of the demand for services and the speed of migration provide the rate of take-up, referred to earlier in this section.

The average wholesale revenue per connection is driven by:

- **Initial price levels.** NBN Co should price to maximise affordability and take-up. Given conservative assumptions of minimal upfront fibre premium, wholesale prices should encourage service providers to generate adequate margins while pricing for mass-market adoption. We outline a methodology to estimate the 'indifference price' earlier in this section; and apply this methodology to model prices of NBN Co services.

- **Price growth over time.** Real prices of NBN Co services may need to increase over time to allow a fair return on network investment. We assume real growth of between 0 and 2 percent per year across the range of services modelled—lower for voice, higher for services such as IPTV.
- **Changes to product mix.** Demand for services will change over time, driving a change in the average revenue per connection. For example, the gradual emergence of IPTV as a service would increase average revenue. Alternatively, once passive-layer unbundling is introduced, NBN Co will only receive passive revenue from lines that are unbundled by access seekers. We assume modest penetration of IPTV—10 percent of connections by 2022. We also model the introduction of active competition in 2022—capturing 20 percent share of lines within four years.

Once these factors are estimated, total revenue within the fibre access network is driven by the number of premises within the footprint. When the fibre roll-out is complete, growth in premises will drive continued growth in revenue.

Price levels and approach

NBN Co has a mandate to set prices for its services within the applicable regulatory regime. The Implementation Study is not recommending prices that should be set for services. However, assumptions have been made to construct the revenue component of the overall business case. These assumptions are outlined below.

The modelled price architecture is similar to the example presented in Exhibit 4–43. It has a fixed component and modular add-ons for individual services. That is, an access charge applies to every connection. Individual charges for broadband, voice and other services (e.g. IPTV) are applied on top of that charge, depending on demand.

Wholesale prices modelled are consistent with the ‘indifference’ pricing approach discussed earlier in this section. This methodology estimates the wholesale prices that give service providers an equivalent customer lifetime value compared to the copper network. It indicates blended average wholesale prices in the range of $30–$40 per month, depending on the wholesale access (ULL) price on the copper network.

We also assume that price differentiation allows NBN Co to charge some users higher prices. For example, some users are likely to pay more for higher speeds (Exhibit 4–43). However, NBN Co could achieve this upsell in a number of ways. Our focus is on the revenue impact rather than a particular method of service differentiation (e.g. download versus upload speeds). We assume an average upsell of $5 per month per connection, in addition to the charge for basic broadband access. This would represent ‘premium’ segments paying more—e.g. $15 extra across one-third of the user base.

Major sensitivities

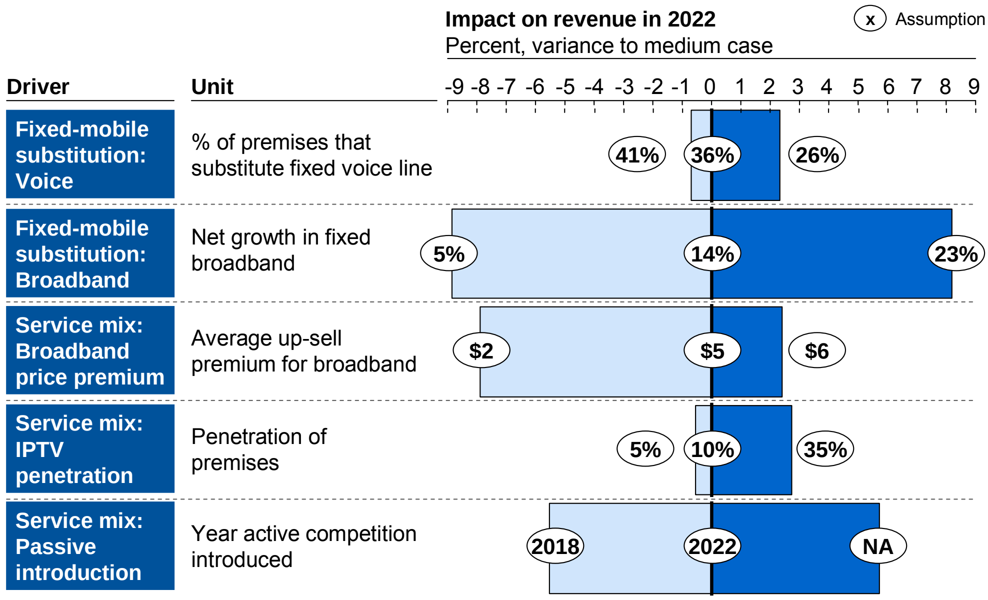
Estimating revenue on the NBN requires consideration of each of the factors discussed in this section. Exhibit 4–44 demonstrates the sensitivity of revenue to these variables, in percentage terms. Fixed broadband penetration and pricing have the biggest revenue impact.

Preparing for a range of revenue outcomes

Given the degree of uncertainty and number of variables at play, a range of revenue scenarios is analysed. Exhibit 4–45 outlines these scenarios, which are integrated with cost scenarios in Chapter 7 to inform the overall business case. We focus on four scenarios that differ along the two dimensions with greatest revenue impact: fixed-broadband penetration and wholesale pricing.

The ULL price affects the wholesale fibre prices that will encourage service providers to switch to the NBN. There is uncertainty regarding the ULL price that will be charged in the market going forward. The current price is $16 per month in Band 2 locations (the de-facto reference point for ULL pricing), but the ACCC has published a position paper stating its intention to raise the price to $23.60 in Zone A locations.[137] As discussed in Section 4.5, this directly impacts service providers' cost-to-serve, and therefore the price at which they would be willing to switch to the NBN.

Exhibit 4–44. Revenue sensitivity of major variables



SOURCE: Implementation Study

137 Australian Competition and Consumer Commission 2009, *Draft pricing principles and indicative prices for LCS, WLR, PSTN OTA, ULLS and LSS*, Canberra

Exhibit 4–45. Revenue sensitivities modelled for business case

Revenue scenario	Fixed broadband demand (percent)	Reference price[a]	Revenue 2022, $b[b]
■ Higher demand	90	$23.60	4.8
■ Mid-case demand, higher price	80	$23.60	4.4
■ Mid-case demand, lower price[c]	80	$16	4.2
■ Lower demand[c]	70	$16	3.9

a. ULL price on copper (per month)

b. Real dollars (including a 1 percent per annum real price increase); includes existing premises, greenfield and brownfield developments

c. Includes a 'glide path' back to scenario 2 price trajectory after 10 years

Source: Implementation Study

This difference is reflected in the NBN wholesale prices modelled under each scenario. Exhibit 4–46 outlines the wholesale prices modelled for common packages of services, under each scenario. To re-iterate, this is an indicative price architecture only, to illustrate the principles described and for business case modelling. NBN Co, as a commercial entity, should retain flexibility to design and update a price architecture. For example, NBN Co may decide to not offer a basic broadband service without voice—creating an entry-level service of $30-$35 depending on the ULL scenario in our modelled architecture. Furthermore, these prices do not factor in migration incentives. A voice-only service, with a wholesale price of $25 per month would need some migration incentives to retailers to cater to low-ARPU voice-only subscribers. In both scenarios, as shown in Exhibit 4–46 the wholesale prices modelled for a basic service package (e.g. basic double-play), as well as weighted ARPU, fall within the ranges that should encourage service providers to switch to copper (Exhibit 4–37).

The second dimension modelled in the revenue sensitivities is peak penetration of fixed broadband. We discuss the drivers of this metric in Section 4.5, and have modelled a range of potential outcomes. Each is broadly consistent with the trends discussed in that section. Exhibit 4–47 presents the three fixed-broadband penetration scenarios used in the business-case sensitivities. Note these do not represent Implementation Study forecasts of the likely outcome, but are scenarios developed for the purposes of modelling. To be clear, these scenarios represent penetration of fixed broadband, which is likely to be shared between fibre, copper and HFC platforms.

Exhibit 4–46. Example NBN wholesale prices modelled under two scenarios

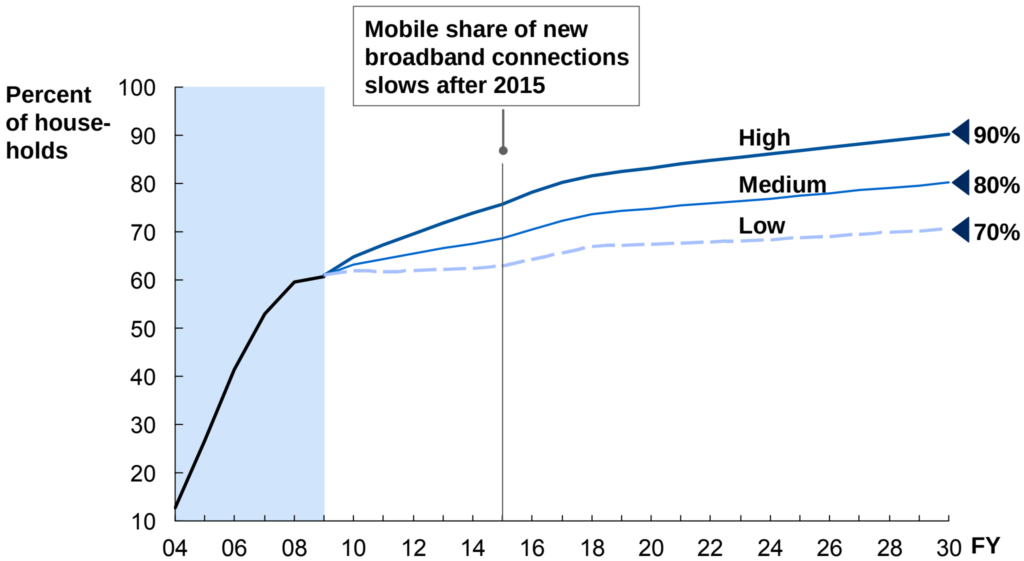
Wholesale service	Wholesale price per month ($16 ULL)	Wholesale price per month ($23.60 ULL)
Basic broadband only	25	30
Voice only	25	30
Double play (basic broadband, voice)	30	35
Triple-play (basic broadband, voice, IPTV)	33	38
Premium broadband double-play	45	50
Small business[a]	60	60
Blended WARPU (2011)	33	38

a. Assumes business customers demand voice and fast broadband and some form of higher service options

Source: Implementation Study

In Chapter 7 these scenarios are integrated with potential cost outcomes, to present overall business-case sensitivities for the NBN.

Exhibit 4–47. Fixed-line broadband penetration scenarios



SOURCE: Pyramid; J.P. Morgan; Implementation Study

5 Ensuring national availability of high-speed broadband

SUMMARY

- High-speed broadband services can be provided within Government's initial capital expenditure estimate by deploying a mix of fibre, satellite and wireless technologies.
- Based on the nature of the geographies served and the characteristics of wireless and satellite technologies, Government’s coverage objective should be interpreted as ensuring at least 12 Mbps peak data rates are available to all premises beyond the fibre footprint. Under the solution proposed by the Implementation Study, many premises in the final 10 percent would receive substantially higher data rates of up to 100 Mbps.
- Detailed geospatial and cost analysis indicates that the fibre footprint should be extended to 93 percent of premises. This will enable 100 Mbps broadband data rates to be delivered to almost a third of premises in the final 10 percent.
- NBN Co should offer a wholesale Ka-band satellite broadband service targeting the final 3 percent of premises, but available to all premises beyond the fibre footprint to ensure the NBN coverage objective is met. This next-generation technology will deliver a step change in performance, enabling average data rates more than 20 times higher than today. Government should also facilitate a near-term improvement in current Ku-band satellite performance.
- Government should tender for the provision of a fixed-wireless service delivering at least 12 Mbps peak data rates. The successful tenderer(s) should offer both wholesale and retail services to end users. Cost analysis suggests this network should cover premises between the 94^{th} and 97^{th} percentiles, with the specific coverage area to be proposed by the tenderer and approved by Government as part of the tender process. Should no commercial tender prove adequate, NBN Co should be instructed to build the network.
- NBN Co should provide fibre transit backhaul to tower sites priced consistently with the rest of NBN Co’s transit backhaul, in areas where the fixed-wireless provider faces backhaul bottlenecks. Transit backhaul to towers should be offered to other market participants on an equivalent, open-access basis.
- Government should add carrier licence conditions to the upcoming 700 MHz spectrum auction to require network operators to implement future technology upgrades in rural/regional areas in parallel with metropolitan areas and should review options to include data rate and coverage requirements. If prices for similar services in metropolitan and rural/regional areas diverge, Government should conduct a review of options to ensure national affordability.

Throughout this chapter we refer to 'the final 10 percent' of premises. This refers to those 10 percent of premises which are the most expensive to serve with fibre. Since the cost to deploy fibre correlates strongly with geographic density, the final 10 percent of premises therefore comprise a mix of truly remote areas, small regional towns, outskirts of larger regional towns and urban fringes. As a result, the boundary between the fibre and non-fibre footprints is complex, and should be specified by NBN Co based on detailed geospatial modelling

While there are a number of challenges in serving the final 10 percent, affordable high-speed broadband can be provided to all Australian premises within Government's initial expenditure estimate. In this chapter, we outline the details and implications of the proposed solution, which will deliver a step change in broadband performance and exceed Government's stated objectives.

This chapter is organised in five sections:

5.1 Making high-speed broadband available nationally

5.2 Extending fibre to 93 percent of premises

5.3 Delivering world-leading satellite broadband services

5.4 Facilitating development of a high-speed wireless broadband market

5.5 Ensuring national availability of voice services.

5.1 Making high-speed broadband available nationally

Deploying high-speed broadband in the final 10 percent is difficult. Distances are great, population density low and infrastructure deployment costly. By implementing a range of broadband technologies, a workable solution which delivers on Government's objectives for these areas is possible in spite of these challenges.

This section outlines the challenges of deploying broadband to the final 10 percent of premises, evaluates the technologies that are capable of serving them, and recommends a preferred solution. These findings are laid out in four parts:

5.1.1 Understanding the characteristics of the final 10 percent

5.1.2 Identifying appropriate technologies to serve the final 10 percent

5.1.3 Defining a preferred solution for national availability of broadband

5.1.4 Ensuring availability of next-generation broadband applications.

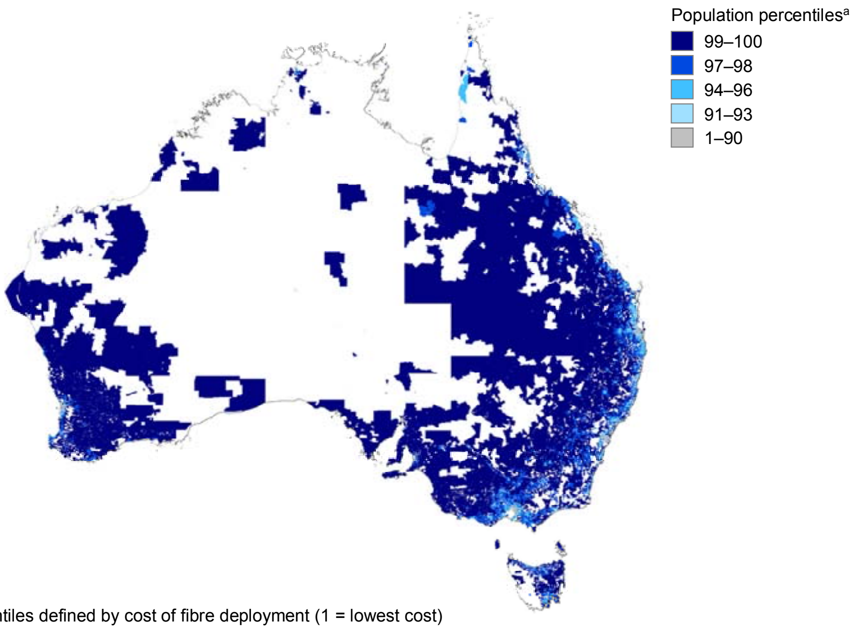
5.1.1 UNDERSTANDING THE CHARACTERISTICS OF THE FINAL 10 PERCENT

Understanding the geography of the final 10 percent

The final 10 percent is characterised by very low average population density. To illustrate—90 percent of the Australian population occupies only 0.2 percent of the landmass. By contrast, the final 10 percent covers a total of 8.8 percent of Australia, with the remaining 91 percent uninhabited. Within the final 10 percent, population density varies significantly. The 91st population percentile on its own occupies less than 0.1 percent of the land area whereas the 100th percentile occupies 5.3 percent. Clearly any solution in the final 10 percent must not only cover wide areas but also be flexible enough to accommodate premises with sharply different density characteristics.

The coverage area is also highly fragmented, incorporating small towns, urban fringes, isolated rural properties and remote communities. Exhibits 5–1 and 5–2 show illustrations of the fragmentation of these areas based on our detailed geospatial modelling (described in Section 4.3.3). This fragmentation produces complicated boundaries between potential fibre and non-fibre areas. While rough demarcation boundaries can be determined up-front (e.g. to allow planning for fixed-wireless and satellite footprints), the total cost of fibre roll-out and precise distribution of fibre and non-fibre areas will not be known before the end of NBN Co's network roll-out.

Exhibit 5–1. Australia divided into Mesh Blocks ranked by cost of fibre deployment



a. Population percentiles defined by cost of fibre deployment (1 = lowest cost)
SOURCE: Implementation Study

NBN Co may choose to extend fibre to selected areas beyond its initially defined footprint if roll-out costs are lower than projected, or if communities or commercial organisations choose to subsidise fibre roll-outs beyond initial boundaries (Section 5.2).

Exhibit 5–2. Potential boundary between fibre and non-fibre areas

SOURCE: Implementation Study

Alternatively, if build costs exceed initial projections, Government may revisit the extent to which fibre can be extended beyond the initial 90 percent coverage objective.

Understanding current broadband service levels in the final 10 percent

Broadband services in the final 10 percent are currently provided by a mix of fixed line, wireless and satellite technologies. DSL broadband extends to about 92 percent of premises. The remaining premises are either too far (usually more than 5 km) from an exchange or located in an area where network operators deem the economics of providing DSL services unattractive.

Wireless broadband is the largest platform outside the DSL footprint, with an estimated 150,000 Telstra subscribers.[138] Coverage statistics suggest wireless broadband extends well into the final 10 percent of premises:

- Telstra's Next G network reaches 99 percent of the population;
- Optus reaches 98 percent with 2G coverage, with 3G coverage below 90 percent;
- VHA's 2G coverage reaches an estimated 94 percent of premises.

Despite this broad coverage, the reality for many users who do not live in close proximity to wireless towers is that service quality can be relatively poor, with experienced data rates often well below advertised peak rates—particularly for indoor use.

Broadband penetration in the final 10 percent is estimated to be below two-thirds of the levels in metropolitan areas, partly reflecting the lower service performance available to end-users. Multiple government programs have helped improve broadband services delivered to underserved regional areas, including the ABG program.

The obvious impediment to the delivery of high-speed broadband services to the final 10 percent is cost. Capital expenditure per premises can be an order of magnitude higher than in metropolitan areas due to low population densities, and the revenue pools are correspondingly lower. Where commercial providers do participate, their motivation can be indirect. For example, the ability to advertise broad mobile coverage areas can be beneficial for attracting customers in metropolitan areas.

138 Industry interviews

5.1.2 IDENTIFYING APPROPRIATE TECHNOLOGIES TO SERVE THE FINAL 10 PERCENT

A range of technology platforms can be used to provide high-speed broadband beyond the fibre footprint and deliver Government's objective of providing at least 12 Mbps peak data rates to all premises. We start by providing a perspective on speeds in Exhibit 5–3.

Understanding wireless

Third generation (3G) wireless technologies can now deliver peak data rates of 42 Mbps in Australia.[139] Fourth-generation (4G) technologies will increase this performance capability to over 100 Mbps for an uncontended service.

The choice of 4G technology deployed by carriers depends on multiple factors including performance, availability, spectrum compatibility, cost, access to a global ecosystem of providers to ensure supply continuity, innovation and continued cost decreases for equipment. 4G technologies are currently undergoing commercial tests, with a number of commercial launches expected in 2010. Deployment in Australia is expected on 700 MHz spectrum in 2014–15 when the spectrum becomes available due to the 'digital dividend'. The upgrade may occur before that on other frequency bands.

Both the WiMAX and 3GPP technology families offer 4G standards that could be used to achieve Government’s objectives, as we discuss below in Exhibit 5–17. Whichever 4G standard is chosen, a number of factors are key to determining the performance of wireless technologies. In particular:

- **Physical barriers and use of external antennas.** The strength of wireless signals decreases significantly when passing around physical barriers such as house walls or when reaching premises out of line-of-sight from the tower. With LTE (part of the 3GPP family), achieving peak data rates of 12 Mbps when indoors requires premises to be within about 1 km of a wireless tower if 2.3 GHz spectrum is used. This distance increases to about 2 km if 700 MHz spectrum is employed. With the use of an external high-gain antenna, these distances increase to about 7 km for 2.3 GHz and about 14 km for 700 MHz. External antennas improve service performance by:
  - Reducing signal loss by about 11 dB by moving the point of signal reception and transmission outdoors and, in the case of elevated antennas, potentially into a line-of-sight path from the tower;
  - Increasing received signal strength by an additional 15 dB, dependent upon antenna type and configuration.

[139] *Telstra launches world’s first HSPA+ Dual Carrier network*, media release, Sydney, 15 February 2010

Exhibit 5–3. Deciphering the language of speed

Deciphering the language of speed

Understanding peak performance

Broadband data rates advertised to end-users typically describe the maximum peak data rates achievable on a service under ideal conditions, and often for a limited period of time. The actual experience of the end-user is generally inferior to this headline rate, sometimes substantially so.

Maximum peak data rates decrease with increasing distance from the transmitter. For example, a user close to a copper exchange could experience 20+ Mbps peak data rates over an ADSL link, while users more than five kilometres from an exchange may not be able to receive any broadband service at all.

In wireless networks, with the implementation of 4G technologies such as LTE, more customers will be able to receive peak data rates of 12 Mbps as the coverage range of an existing tower will be extended. If 12 Mbps peak data rates are to be achieved for all customers using a particular wireless network, the network must be dimensioned so that the premises on the outer edge of a cell boundary can receive the 12 Mbps peak data rate. This has the consequence that users closer to the towers can experience peak data rates much greater than 12 Mbps—up to 100 Mbps with 4G wireless technologies.

Understanding average data rates

Telecommunications networks are dimensioned with less capacity than the sum of all access connections would require if they were all used concurrently at their maximum potential, with the resulting restriction of performance known as contention. Dimensioning is based on statistical assumptions of subscriber activity during ‘busy hours’ when the highest number of users are active. The data rate available to each active user during such a busy hour is commonly termed the average data rate.

Contention is common to all broadband technologies at the point where data is aggregated (e.g. on backhaul links), and it is particularly acute with shared access media such as wireless and satellite where the total throughput of the access network is a limiting factor. The higher the number of premises served by an individual wireless tower or satellite beam, the lower the actual data rate experienced by any given user, and the lower the average data rate enabled.

Providing average data rates of 12 Mbps to subscribers with wireless technologies, while theoretically possible, is very expensive. A wireless tower with 50 Mbps capacity operating with 4 distinct sectors could provide an average data rate of 12 Mbps to only 4 premises. This implies a cost of $100,000 per premises for the tower alone. The cost of providing an uncontended 12 Mbps service via satellite can be even higher.

Specifying the 12 Mbps performance objective

The Implementation Study believes that Government's objective of delivering at least 12 Mbps should be defined in terms of peak data rates to be enabled in the final 10 percent due to the prohibitively high cost of delivering average data rates of 12 Mbps.

In this chapter, we refer to the 12 Mbps target as a peak data rate target. Where applicable we also refer to appropriate average throughput rates that should be provisioned as we believe this to be the most relevant metric in evaluating the quality of end-user experience. Providing minimum 12 Mbps peak data rates to all premises in the final 10 percent represents a step change from current broadband experience.

Source: Implementation Study

Exhibit 5–4. Defining cell radius

Defining cell radius

The cell radius defines the distance between the base station and a point at which a specified performance level, for example the delivery of 12 Mbps peak broadband data rates, can be delivered. Beyond this defined point, the signal strength becomes too weak or attenuated to deliver the required performance.

To dimension the fixed-wireless network, the cell radius within which 12 Mbps peak broadband data rates can be delivered was calculated based on radio propagation modelling. Key factors considered were

- **Frequency band of operation**. Modelling was performed on both 700 MHz and 2.3 GHz spectrum. Lower frequency bands such as 700 MHz have superior propagation characteristics, enabling larger cell sizes.
- **Base station and CPE antenna height**. An LTE 4X2 MIMO antenna system was assumed, with 4 antennas deployed per wireless tower at a tower height of 40m, and 2 antennas deployed at the customer premises at a height of 5 m

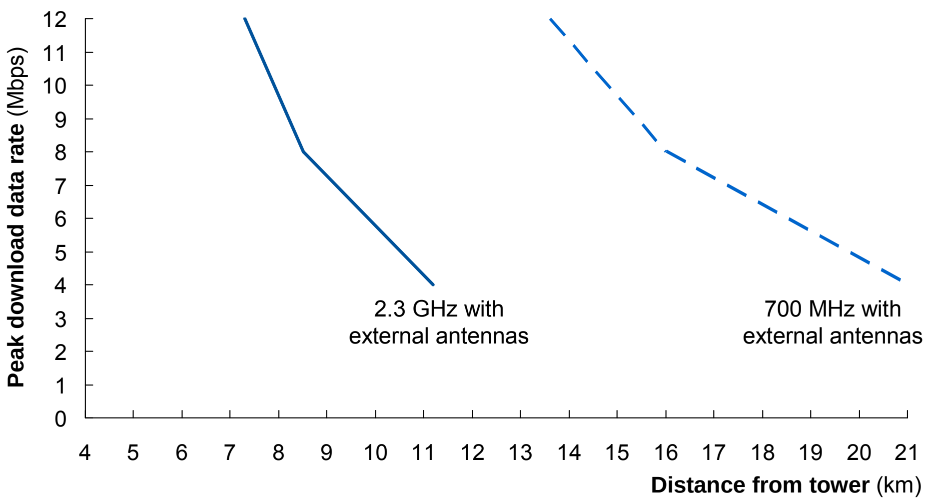
Based on these assumptions, the cell radius to deliver 12 Mbps peak data rates was estimated at roughly 14 km if 700 MHz spectrum is used and roughly 7 km if 2.3 GHz spectrum is used. The return path is dimensioned in accordance with industry benchmarks at a 1-to-4 ratio.

SOURCE: Implementation Study

- **Distance of premises from the tower.** Signal strength decreases as signals propagate further from the tower, reducing the peak data rates available to users, as described in Exhibit 5–4 and 5–5.
- **Sharing of capacity.** Wireless broadband capacity is shared among all users served by a tower as described in Exhibit 5–3.

Exhibit 5–5. Relation of distance from the wireless tower to peak data rates over LTE technology at different spectrum frequencies

Relation of distance to peak data rates over LTE technology at different spectrums



SOURCE: Implementation Study

Data rates achieved on wireless broadband networks—even where 4G wireless technologies are deployed and peak data rates of at least 12 Mbps are provided—are not able to support applications that require continuous streaming of high-quality video images such as IPTV.

Understanding satellite

Broadband satellite services are currently provided in Australia via two main satellite systems: IPSTAR and Optus, both operating geostationary (GEO) satellites over Ku frequency bands.

Next-generation GEO satellites operating over the Ka-band will offer more than 10 times the capacity of today's mid-size Ku satellites, substantially reducing the cost per Mbps of satellite broadband capacity. As a result, Ka-band satellites are the most appropriate choice for Australia's future broadband needs (Section 5.3.2). As an example, two Ka satellites with capacity of 55 Gbps each would be capable of supplying broadband at peak data rates of 12 Mbps and an average data rate more than 20 times higher than today to a coverage area of about 350,000 premises.[140]

Although satellite can provide high-data rates, it suffers from some inherent limitations:

- **Service availability.** Satellite signals degrade in adverse weather conditions, particularly heavy rainfall, and occasionally in solar events. The impact of extreme weather on satellite service performance varies with frequency bands: in the Ka band the effect of rain attenuation is more significant than in lower Ku frequencies.
- **Latency.** High orbit altitudes of around 36,000 km for GEO satellites lead to high latency, reducing the attractiveness of the platform for real-time applications such as voice and online gaming.
- **Need for redundancy.** Given that large numbers of customers can be served by a single Ka-band satellite, providing an acceptable level of service assurance requires launching more than one satellite due to the long lead time of 3–4 years to build and launch a new satellite. This is discussed in Section 5.3.
- **Sharing of capacity.** As with wireless, broadband subscribers share total satellite capacity. This means that the contention ratio must be carefully managed to assure service performance.

Satellite technologies, even when providing high peak data rates, are a less attractive platform for real-time applications such as voice and online gaming. Due to the current high cost of satellite bandwidth, it is not commercially viable to support applications requiring high committed data rates, such as IPTV via satellite. By contrast, the satellite

140 Assumptions: 70 percent subscriber activity rate in busy hours, with upload speeds at 25 percent of peak download speeds

platform is extremely well suited to delivery of broadcast television as is common across Australia today.

Understanding hybrid broadband

Some communities and commercial organisations worldwide serve remote areas via localised solutions based on hybrid satellite and wireless technologies. The most common of these use a single radio device mounted on a high structure, with satellite backhaul providing the link between the community and core network. Delivered average data rates are typically low, with use of satellite backhaul leading to high latency.

5.1.3 DEFINING A PREFERRED SOLUTION FOR NATIONAL AVAILABILITY OF BROADBAND

Using accurate cost comparisons in evaluating technologies for the final 10 percent

Cost per premises activated is the metric used to compare the financial implications of the choice of technology in the final 10 percent. It is calculated by distributing the fixed costs of each technology over the total number of premises activated and then adding the incremental cost per premises activated of the customer premises equipment (CPE).

An accurate comparison of costs between fibre, wireless and satellite requires inclusion of all initial capital investment costs, ongoing operational expenses, and capital replacement costs, as the life cycles and operating models of each technology differ.

Deploying fibre entails a high upfront capital cost (for trenching, hauling cable, etc). However, the passive infrastructure has a long lifecycle (e.g. the fibre and ducts are expected to last 40 years or more) in contrast to satellites which must be replaced every 15 years.

The annual expense of maintaining and operating a fibre network differs to those of wireless or satellite networks. Wireless and satellite networks both require licensed access to spectrum to operate, and these costs can be incurred on an ongoing basis. In a wireless network, each tower site typically requires ongoing land lease, power and maintenance costs. If a tower is leased rather than built, the operator typically incurs an annual tower leasing cost of over $10,000.

In comparing the three different technologies, the replacement costs (e.g. upgrading wireless active electronics, and launching new satellites every 15 years) and capitalised operational costs have been included in cost per premises activated calculations. Replacement costs have been discounted to their net present value and operating costs have been capitalised at a discount rate of 9 percent.

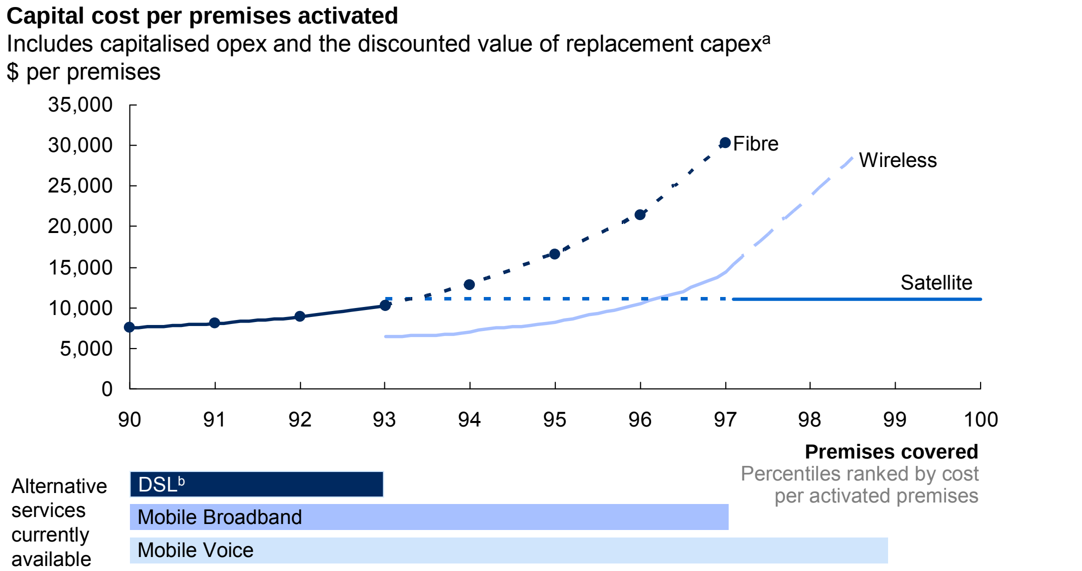
In comparing cost curves, both the financial and service quality implications must be considered before drawing the cut-off points between fibre, wireless and satellite technologies.

As we discuss in Section 5.1.2, from a performance standpoint, fibre is preferred to wireless which, in turn, is preferred to satellite. This is largely due to inherent differences in service quality offered by these respective technologies. Therefore, boundaries between technologies do not simply follow cost curve cut-off points but also account for these quality differences.

Exhibit 5–6 compares the whole-of-life costs of fibre, wireless and satellite for premises in the final 10 percent, accounting for the anticipated take-up rates of each of the technologies. The increase in cost of fibre accelerates sharply after the 93rd percentile, and the additional cost compared to wireless continually widens.[141] The whole-of-life cost of wireless begins to accelerate after the 97th percentile, and by the 98th percentile is markedly greater than the whole-of-life cost of satellite, due to the increasing number of new towers required to serve premises in the final 3 percent.

Unlike fibre and wireless, a satellite solution has a large fixed cost (to launch two satellites and establish gateways) but if spot beams provide national coverage there is no incremental investment to serve additional premises other than in CPE (by contrast, fibre

Exhibit 5–6. Cost comparison of alternative technologies in the final 10 percent



a. Network specific operating expenditure (including maintenance, leases and power) capitalised at 9% discount rate; replacement capital expenditure modelled based on useful life of active and passive infrastructure and discounted at 9%
b. Fixed-line broadband currently covers 92% of premises. Future greenfields adjacent to the fibre access network mean the percentage of premises with access to fixed-line broadband is expected to rise to ~93% in 2018–19

SOURCE: Implementation Study

141 The cost curve does not include the cost of providing transit backhaul due to the complexities in accurately allocating these costs to each percentile.

requires costs associated with the drop, and wireless networks can require additional towers). The satellite line on Exhibit 5–6 shares the fixed costs over the final 3 percent of premises plus an estimated 50,000 premises in wireless blackspots and includes CPE costs.

Defining the mix of technologies

The principal decisions facing Government in deploying high-speed broadband to the final 10 percent of premises are:

- The specific mix of technologies to use to deliver high-speed broadband services, taking into account technology performance, cost and competition factors;
- The extent to which NBN Co, existing operators or potential new entities should participate in the implementation and delivery of the desired solutions.

The Implementation Study concludes that the final 10 percent of premises could be served via a combination of fibre, wireless and satellite solutions that deliver world-leading broadband data rates relative to the size and population density of the areas covered.

The basis for determining the preferred solution is the clear hierarchy of preferred technologies for delivering broadband services, from fibre and DSL (highest speeds, lowest latency) through wireless (lower speeds, low latency) to satellite (lower speeds, high latency). To the extent possible given expenditure constraints, Government should therefore prefer solutions in this order, and the decision on the extent of a particular technology footprint should not be informed exclusively by cost of deployment. For example, Government may wish to extend wireless service coverage beyond the point at which cost of deployment becomes cheaper on satellite due to the inherent performance advantages of wireless broadband.

The total cost of the fibre, wireless and satellite solution as proposed in this chapter is estimated at $5.3 billion on a whole-of-life basis, assuming costs at the high end of the plausible range of estimates (described further in Chapter 7). No breakdown into the individual fixed, wireless and satellite components has been provided in light of the anticipated commercial tender for the build-out of the fixed-wireless network.

Extending fibre to 93 percent of premises

The Implementation Study recommends that Government set NBN Co an objective to deploy fibre to 93 percent of premises by the end of the 8 year network roll-out, rather than the 90 percent objective in the original policy statement. This recommendation is based on three reasons:

- First, the cost of deploying fibre to 93 percent is not prohibitive. The Implementation Study's geospatial modelling shows that the cost to deploy fibre rises as premises density declines. It increases steadily from the 80th percentile and starts to accelerate more sharply as it nears the 90th percentile, at which point it is 1.9 times more expensive per premises than at the 50th percentile. By the 93rd percentile it costs 2.8 times the 50th percentile. Beyond this, the cost of fibre deployment begins to sky-rocket.

- Second, stopping at 90 percent would mean fewer premises would get fibre than those that already get DSL. Most premises out to 93 percent have DSL services available today that are likely to be superior to wireless or satellite services. Practically, it would very difficult to deliver a superior service by shifting an end-user from a DSL-based broadband service to a wireless or satellite service.
- Third, the actual cost per premises activated for an NBN wireless service is likely to be higher than fibre between the 90th and 93rd percentiles. While the cost of covering premises beyond 90 percent is much cheaper with wireless, take-up rates of a wireless service in competition with a DSL service and mobile broadband services from established providers are expected to be materially lower. Applying a realistic take-up rate in the calculation of cost per premises activated across wireless and satellite technologies makes the cost per activated user of implementing a wireless solution higher than fibre, as shown in Exhibit 5–9. Even if take-up was expected to be higher and average cost lower, Government should be willing to pay a premium for fibre, although the quantum itself is a question for Government.

Over time, we expect that Government could aspire to extend fibre even further.

Providing a fixed-wireless network for the 94th to 97th percentiles

The Implementation Study concludes that the NBN wireless broadband network should extend to the 97th percentile. Beyond the 97th percentile, the whole-of-life cost per premises of providing 12 Mbps peak data rates via a wireless network escalates dramatically, and at the beginning of the 99th percentile the cost (about $24,000) is more than double the estimated cost per premises of providing a Ka satellite service (about $11,000).

In the near term, Government should conduct a commercial tender process for the provision of a fixed-wireless network to ensure 12 Mbps peak data rates are delivered to the 94th to 97th percentiles.

The winning tenderer(s) should be required to operate the network on both a wholesale and a retail basis. Tendering for construction of this network will facilitate use of existing wireless infrastructure (such as towers, backhaul or spectrum) to provide an efficient network build. Using existing commercially available spectrum will also enable a fast roll-out of services. Where required by the winning tenderer(s), NBN Co would provide additional backhaul to tower sites to facilitate the network build. This transit backhaul should be offered to all operators and priced at the same rates as transit backhaul within the fibre footprint.

We expect that in some areas these services can be available within two years from the conclusion of the proposed tender process (Section 5.4). The tender should be designed so that if an acceptable commercial approach is not received, the contract can pass to NBN Co in a subsequent process.

In addition, Government should add carrier licence conditions to the 700 MHz spectrum auction to require network operators to implement future technology upgrades in rural/regional areas in parallel with metropolitan areas and review options to include data rate and coverage requirements. If prices for similar services in metropolitan and rural/regional areas should diverge, Government should conduct a review of options to ensure national affordability.

Ensuring all premises outside fibre are covered by an NBN Co satellite service

To ensure ubiquitous access to high-speed broadband, NBN Co should implement a vastly improved satellite service based on next-generation Ka-band technologies. This service would be available to all premises beyond the fibre footprint, as well as customers in wireless blackspot areas. To ensure resiliency of the service, a minimum of two Ka-band satellites should be deployed. Launching two satellites means a substantial amount of capacity will be available and Government should seek to use this efficiently.

The Implementation Study believes satellite should be the primary delivery vehicle for the final 3 percent of premises.

Prior to the launch of Ka-band satellites, Government can facilitate an improvement to the existing Ku-band service in two ways:

- Capture scale purchasing benefits on existing underutilised Ku-band satellites by aggregating demand, for example by requiring NBN Co to bulk-purchase the capacity on behalf of retailers. This can enable greater satellite bandwidth and an improvement in average data throughput rates to be delivered to end users at no extra cost.
- Provide updated modems with higher spectral efficiency than those in use today, enabling higher broadband data rates to be delivered over a given satellite bandwidth.

The combination of these improvements can enable a significant improvement in near-term service performance.

Preserving the option for improved DSL availability

The Implementation Study estimates that around 400,000 premises outside the recommended fibre footprint (i.e. in the final 7 percent of premises) have the potential to be served by DSL as they are sufficiently close to current copper exchanges and are not expected to suffer from pair gain/RIM issues.

Most of these premises do not have the option of a DSL service today, either because the volume of addressable customers within the footprint of an exchange is insufficient, or because the price of backhaul is too high to justify the investment. Under the proposed fibre and wireless solutions, NBN Co will be building backhaul into the final 10 percent area to connect fibre exchanges to POIs, and to connect towers in the fixed-wireless network. If NBN Co is required to unbundle this transit backhaul and make competitively priced access available to other market participants, this would likely improve the business case for new entrants providing DSL services and may increase DSL availability.

Since customers outside the fibre footprint will also be offered wireless and/or satellite services under the Implementation Study's proposed solution, offering DSL services in the last 7 percent would also provide competition for these alternative technologies in the near term. The Implementation Study believes this is an appropriate approach while the copper network is functioning, as it is consistent with delivering customers in the final 10 percent the best possible service available.

In practice, many of the premises in the final 7 percent who are eligible for DSL service will be relatively far from the nearest copper exchange, so that experienced data rates will be much lower than headline rates. In this case, the fixed-wireless service, offering at least 12 Mbps peak data rate, would be expected to compete well against DSL.

If the copper network is gradually retired over time, as could be expected given the high costs of copper maintenance in the final 10 percent, customers using a DSL service would need to migrate onto one of the alternative available technologies.

5.1.4 ENSURING AVAILABILITY OF NEXT-GENERATION BROADBAND APPLICATIONS

Understanding the requirements of Internet applications

Bandwidth demand is growing rapidly. While much usage of the Internet today is still for low-bandwidth applications such as e-mail or web-browsing, higher bandwidth applications such as streaming audio and video, photo-sharing and social networking are becoming increasingly popular. Almost 90 percent of US Internet users use email, with over 60 percent now watching video on video-sharing websites.[142]

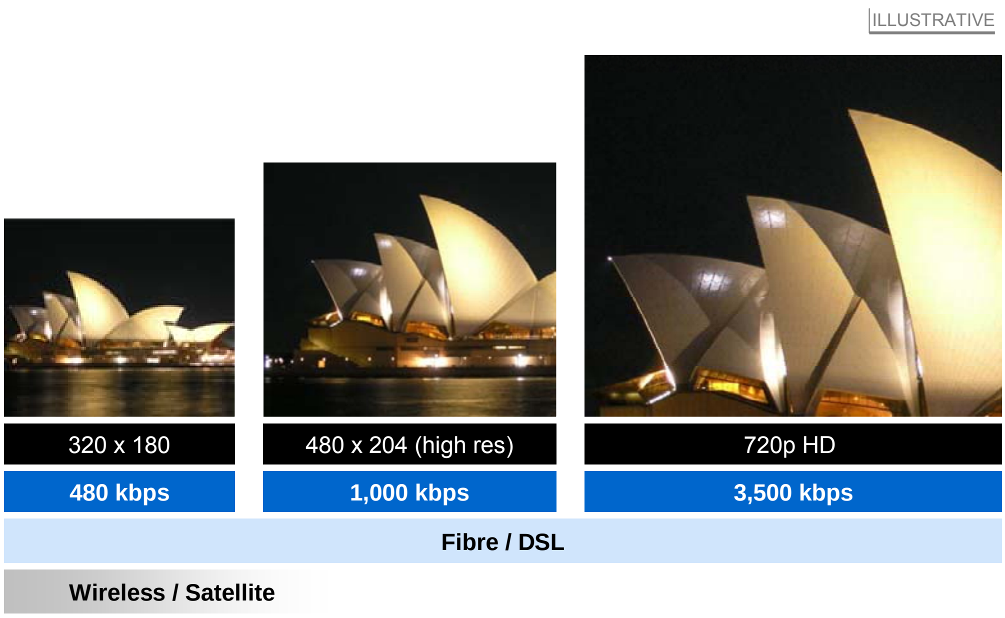
Understanding usage patterns is key for dimensioning wireless and satellite services, since the amount of capital investment required depends not only on the peak data rates that must be delivered, but also the average data rates required. As more bandwidth-heavy commercial and social applications come online, it will be necessary to dimension the network accordingly to meet Government policy objectives and to ensure the full innovation potential from deploying the NBN are realised.

142 Pew Research Center 2009, Pew *Internet & American Life Projectt*, viewed 26 February 2010, <http://www.pewinternet.org/Data-Tools/Get-The-Latest-Statistics.aspx>

Two parameters define the range and availability of applications broadband solutions can support:

- **Sustained data rates:** Sustained data rates determine whether bandwidth-heavy applications can be supported at all. Interactive video applications can be supported by both wireless and satellite technologies, with applications offered at different quality levels to match the connection characteristics of the user. Exhibit 5–7 shows how the quality of video streaming services can be varied according to the capabilities of the user's broadband service. Provisioning high-bandwidth media services such as IPTV and HD-IPTV that require high sustained data rates is not viable over wireless or satellite broadband due to the costs of provisioning bandwidth for these services.
- **Latency performance**: Latency is a key factor in user experience for real-time applications such as videoconferencing, voice applications and playing online games. Real-time applications can be supported effectively by fixed-line and wireless technologies, and are usable over satellite technologies, albeit at significantly reduced user experience due to the high latency of geostationary satellite broadband platforms.

Exhibit 5–7. Relationship between resolution and video streaming bandwidth requirements



SOURCE: Implementation Study

Evaluating future requirements for wireless and satellite technologies

Significant increases in Internet data traffic have occurred in recent years, and are projected to continue in the future. Cisco Systems projects that global IP traffic will increase by a factor of 5 between 2008 and 2013, with IP traffic in Asia-Pacific projected to grow at a CAGR of 42 percent.[143] In addition to increasing broadband penetration, increases in consumer traffic are expected to be driven by growth in higher bandwidth applications such as video, which is projected to account for 91 percent of global consumer Internet traffic by 2013.[144]

Current statistics show that the average Australian Internet user typically downloads 2 to 5 GB of data per month, with usage volumes of wireless and satellite users lower than average due to the lower performance capabilities of the technologies.[145] Wireless and satellite solutions need to be dimensioned to accommodate anticipated increases in the usage requirements of individual users, taking account of the range of applications the technologies enable. The Implementation Study believes that to satisfy a realistic estimate of anticipated usage growth, wireless and satellite networks should be designed to accommodate increases of 25 percent CAGR from current usage levels and monthly download volumes more than three times the upper limit of today's Australian average of 2–5 GB per month.

Dimensioning the network to accommodate expected growth in usage will also increase its ability to support social applications such as e-government, e-education and e-health applications. The feasibility of enabling specific applications in these areas must be assessed in more detail when the exact scope and requirements for the services have been formulated. Delivery of some high bandwidth services to institutional premises in remote areas is unlikely to be viable. Alternative technology solutions to provide access to these services are discussed in Exhibit 5–8 below.

143 Cisco 2009, *Cisco Visual Networking Index Usage Study 2009*, viewed 19 February 2010, <http://www.cisco.com/go/vni>

144 Ibid

145 ABS 2009, *Internet Activity, Australia, June 2009*

Exhibit 5–8. Delivery of broadband to public institutions outside the fibre footprint

Delivery of broadband to public institutions outside the fibre footprint

Consumer-grade wireless and satellite services are likely to be unsuitable for many larger institutions and agencies located outside the fibre footprint, some of which require enterprise-grade services that can:

- Provide sufficient bandwidth to enable a good level of service to be delivered to a number of concurrent users (e.g. multiple classes in a school)
- Enable real-time applications such as high-quality video conferencing for e-education and e-health applications

There are a variety of technology solutions available to provide bandwidth-heavy services to remote areas. The choice of the most appropriate technology in any given situation will be dictated by the specific circumstances involved (including location, applications to be enabled and quality of service requirements). As a result, the choice of technology to use should be made on a case-by-case basis. Possible technical solutions include:

- **High-bandwidth satellite.** For very remote locations where only satellite broadband services are available, the provision of high-speed broadband relies on the upgrade of customer premises equipment. Depending on the existing equipment, either the indoor unit, outdoor unit or both need to be changed for the availability of these services. This solution can enable high-bandwidth services, but is suboptimal for real-time applications due to high latency.
- **Point-to-point microwave.** For locations close to fibre or wireless broadband access networks, point-to-point microwave links connecting premises directly to backhaul networks can offer high-bandwidth, low-latency solutions enabling the full suite of Internet applications.
- **Point-to-point fibre.** For areas outside the nominal fibre footprint that are a priority for high-bandwidth connectivity, Government could choose to extend a fibre connection to the institution or agency in question, potentially using amplifiers to extend the range of the fibre where needed. This solution would enable usage of the full range of Internet applications by multiple concurrent users.

Independent of the technology chosen, providing these bandwidth-heavy solutions would require significant upfront investments.

Source: Implementation Study

5.2 Extending fibre to 93 percent of premises

Fibre technology delivers the highest quality broadband service today and is best equipped to meet growing broadband demand in the future. For this reason, maximising the deployment of fibre should be a priority for Government.

This section explores the possibility of extending the fibre footprint beyond the original 90 percent objective. It concludes that Government should set NBN Co an objective to deploy fibre to 93 percent of premises by the end of the roll-out. Over time, the Implementation Study expects that Government will aspire to extend fibre even further.

The details and rationale for this recommendation are described in the following sections:

5.2.1 EXTENDING THE FIBRE FOOTPRINT TO 93 PERCENT OF PREMISES

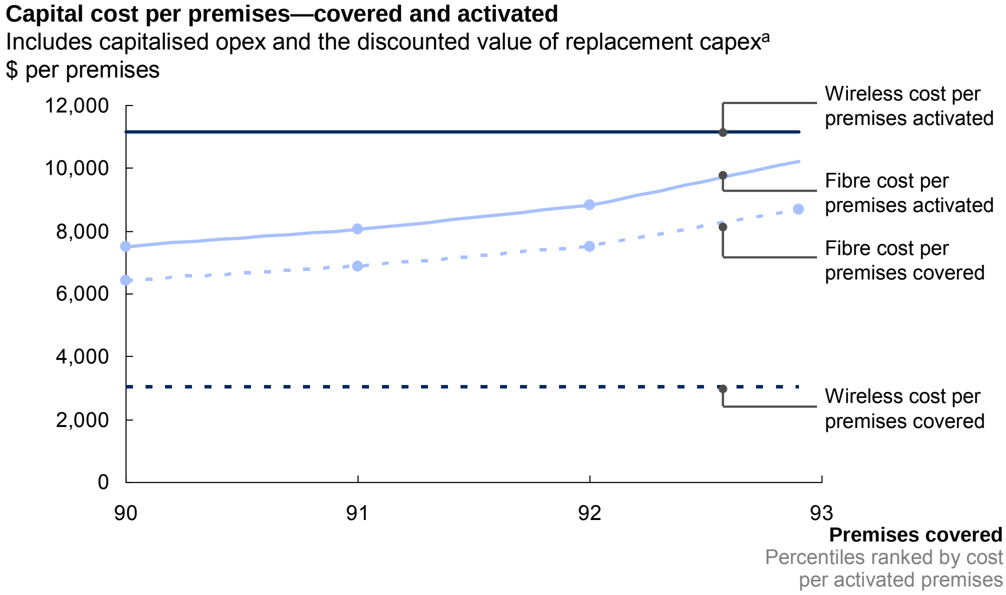
The Implementation Study’s modelling indicates that the cost curve for deploying fibre increases gradually to around 80 percent, increases more steeply to around 93 percent, and accelerates very significantly after 93 percent. Fibre can be deployed beyond the original 90 percent target without exceeding Government's initial expenditure estimate, or incurring a prohibitive marginal cost per premises activated.

We recommend that Government set NBN Co an objective to deploy fibre to 93 percent of premises by the end of the 8-year network roll-out, rather than the 90 percent objective in the original policy statement. This would provide almost a third of premises within the final 10 percent access to the optimal broadband technology enabling 100 Mbps broadband data rates. Over time, we expect that Government will aspire to extend fibre even further.

Understanding the cost of fibre deployment

Exhibit 5–9 below shows the cost comparison between extending the fibre exchanges and the fixed-wireless network from the 90th to 93rd percentiles. The solid lines represent the cost per premises activated for fibre and wireless, accounting for the differences in expected take-up levels between the two technologies. Fibre has a significantly higher expected take-up rate than wireless due to the superior level of service, and the absence of competitive offerings. Wireless, on the other hand, is expected to have a lower take-up rate as there are competing DSL and mobile offerings available.

Exhibit 5–9. Cost comparison of alternative technologies from 90–93 percent



a. Network specific operating expenditure (including maintenance, leases and power) capitalised at 9% discount rate; replacement capital expenditure modelled based on useful life of active and passive infrastructure and discounted at 9%

SOURCE: Implementation Study

Hence, as noted in Section 5.1.3, while the cost of covering premises beyond 90 percent is much cheaper with wireless than with fibre, applying a realistic take-up rate to a wireless service in competition with mobile and DSL lifts the average cost per actual user substantially.

The cost drivers of fibre deployment are described in Section 4.3, and the cost drivers of a fixed-wireless network are described in Section 5.4.

5.2.2 FACILITATING FUTURE FIBRE FOOTPRINT EXPANSION

In the coming years, changes in both demand and supply side economics may make it viable to extend the fibre footprint even further than the proposed 93 percent coverage.

On the demand side, both demographic changes and end-user contributions may make extending the fibre roll-out viable:

- Increases in population density in areas beyond the fibre footprint are likely to result in increased demand and a decrease in deployment cost per premises. This may make fibre deployment economically viable in areas where costs were previously too high. While population increases during the timeframe of the anticipated NBN deployment have been factored in to the current analysis, population growth will continue and may improve the economic viability of further fibre expansion.

- Individual end users or groups of end users may be willing to contribute funding to obtain FTTP connections (Chapter 2).

On the supply side, innovations in fibre deployment technologies (e.g. trenching) and reductions in hardware costs could decrease the cost of fibre deployment significantly, making it economic to deploy to areas below today's feasible population density threshold. While specific developments cannot be predicted today, the scale of the network build and the potential for experience gained from a large-scale roll-out to reduce costs may result in fibre being rolled out to a greater number of premises than currently estimated.

5.3 Delivering world-leading satellite broadband services

Satellite has a critical role to play in ensuring nationwide availability of affordable, high-speed broadband beyond the fibre footprint. A much improved satellite service can be deployed to ensure access to wholesale-only 12 Mbps peak data rate broadband to all premises in the final 10 percent.

This section addresses the required technical capabilities for a next-generation satellite service as well as the preferred implementation model:

5.3.1 Confirming the need for a satellite solution

5.3.2 Designing a next-generation satellite platform

5.3.3 Defining the operating model and product offering

5.3.4 Understanding the cost of satellite broadband technology

5.3.5 Ensuring affordability of satellite services

5.3.6 Improving satellite service in the near term.

5.3.1 CONFIRMING THE NEED FOR A SATELLITE SOLUTION

Satellite services will continue to be important for providing broadband in the future due to the prohibitive cost of serving lowest-density areas with other technologies. Currently, satellite broadband services are delivered to over 100,000 premises[146] in Australia via GEO satellites operating on the Ku frequency band, most of which already lie in the final 10 percent of the population.

Exhibit 5–6 illustrated that the costs of deploying fibre or wireless networks increases steeply in the final percentiles, due to the high fixed costs associated with providing incremental coverage to low density areas. The fixed costs of satellite differ in that they can be evenly distributed across all premises activated by satellite. Hence if the satellites can be utilised at close to their capacity, the cost per premises activated is significantly lower than for fibre or wireless.

The Implementation Study estimates the cost for NBN Co to build a fixed-wireless service to be around \$6,500 per premises on a whole-of-life basis at the beginning of the 94th percentile. This cost increases gradually to \$10,500 at the beginning of the 97th percentile, then to \$14,400 at the beginning of the 98th percentile, and finally rises substantially to \$23,800 at the beginning of the 99th percentile. The assumptions underlying these cost estimates are described in Section 5.4. While it is expected that a

146 Industry interviews

commercial provider could construct the fixed-wireless network at lower cost than NBN Co (for example by re-using existing tower, backhaul or spectrum assets), the cost of serving premises is still expected to quickly become prohibitive beyond the 97th percentile.

As a result, the Implementation Study believes there will be a need for a satellite solution under any viable scenario. We have modelled a satellite service primarily targeting the final 3 percent of premises, but offering service to all premises in the last 7 percent. This latter requirement ensures all premises in the last 10 percent have access to a wholesale-only offering, and also ensures that no premises are unable to receive at least a 12 Mbps service, for example due to blackspots in the fixed-wireless coverage. In practice, take-up is expected to be low outside the final 3 percent of premises given high-speed wireless alternatives.

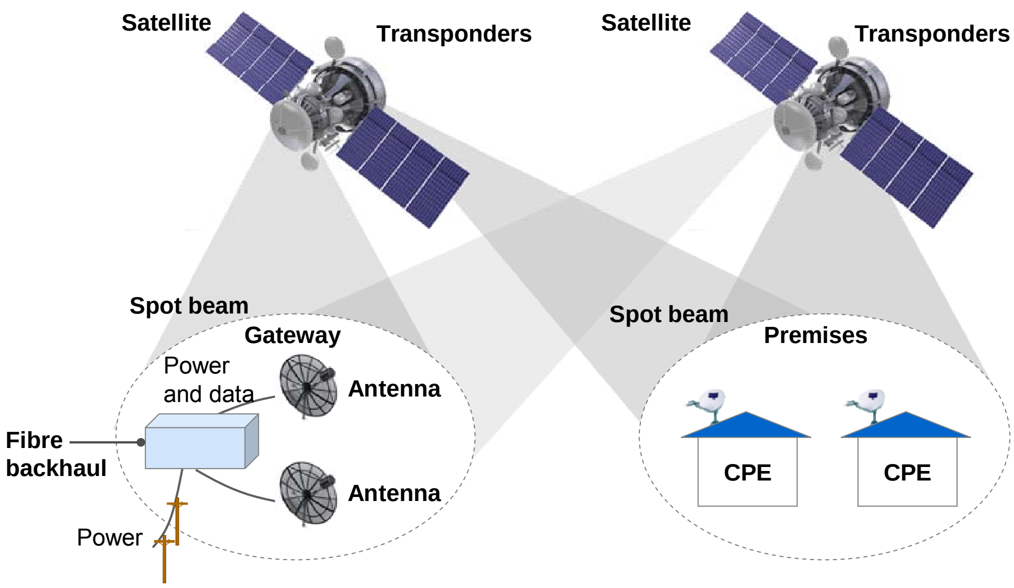
The estimated whole-of-life cost of deploying a Ka-band satellite solution is roughly $11,000 per premises (the upfront capital cost is significantly lower). The resulting intersection of the fibre, wireless and satellite cost curves is shown in Exhibit 5–6.

5.3.2 DESIGNING A NEXT-GENERATION SATELLITE PLATFORM

When designing the next-generation satellite platform, a number of design considerations should be addressed to ensure resilience and high service quality. Exhibit 5–10 illustrates the schematics for a satellite network.

Exhibit 5–10. High-level satellite network schematic

ILLUSTRATIVE



SOURCE: Implementation Study

Exhibit 5–11. Classification of satellite platforms

Classification of satellite platforms
Satellite platforms are classified into 3 groups based on orbit altitude ■ **Low Earth Orbit (LEO)** satellites orbit the earth at a height of 200–2,000 km, with typical average orbit durations of about 90 minutes. Multiple satellites are required to achieve continuous coverage. LEO satellites provide lower latency than other orbits; however their currently limited available capacity makes them unsuitable for high-throughput broadband applications. ■ **Medium Earth Orbit (MEO)** satellites have larger coverage areas, higher latency and longer orbit cycles than LEO satellites. Nevertheless, reaching consistent coverage for a land mass the size of Australia requires multiple orbiting satellites. Since no commercial broadband deployment is currently available, the feasibility and commerciality of such a solution is untested and therefore it is not proposed here as a suitable solution for the NBN. ■ **Geostationary (GEO)** satellites orbit the earth at an altitude of 36,000 km. As their name suggests, geostationary satellites occupy fixed orbital positions relative to the Earth. Use of GEO satellites results in high signal latency due to the long distance between the satellite and earth stations, with signal delays of about 500 milliseconds for a return trip.[147]
Source: Implementation Study

Selecting the technology platform

GEO satellites offer the most cost-effective broadband solution and are expected to remain the standard satellite broadband platform both worldwide and in Australia. Exhibit 5–11 compares the characteristics of LEO, MEO and GEO satellite platforms.

Next-generation Ka-band satellites are expected to enable substantial increases over the more limited capacities of today's Ku-band satellites. A high-capacity Ka-band satellite is expected to be able to provide a total throughput of over 100 Gbps, compared to typical capacities of around 5 Gbps on a Ku-band satellite today.[148]

This capacity improvement will enable significantly lower costs per bit. Ka-band satellites should therefore be the technology of choice for delivering high-speed satellite broadband. In the unlikely event of Ka-band technology experiencing implementation difficulties, Government should seek to continue provision of high-quality Ku-band service, either leased from commercial providers as is the case today, or by launching additional Ku-band satellites over time.

147 Signal processing and ground-transfer also cause latency, but the effect is small compared to signal transfer to and from GEO satellites

148 Industry interviews. Thaicom 4/IPSTAR is a large Ku satellite with a capacity of 45 Gbps

Providing for redundancy

To ensure service continuity, the Implementation Study believes the satellite service should be provisioned based on two orbiting satellites. Satellites can be configured such that each serves around half the total number of subscribers. In the case of one satellite failing, the remaining satellite would be capable of serving the entire footprint, albeit at reduced service quality. Given that design-to-launch times are typically 3–4 years, the alternative of using a single satellite risks subscribers losing service for an unacceptably long period, in the unlikely event of a catastrophic failure. Based on the Implementation Study's modelling of demand, two medium-sized satellites would provide adequate capacity over the lifetime of those satellites given expected rates of growth in premises served.

Due to technical constraints, the two satellites would need to be separated in orbit by at least two degrees. In the case of satellite failure, CPE dishes that had been oriented towards the failed satellite would therefore need to be re-oriented toward the remaining operational satellite. While it is possible to procure dual-antenna dishes that are capable of receiving signals from both satellites and avoid this re-pointing, the Implementation Study considers that the low risk of an in-orbit satellite failure does not justify the additional cost of these antennas.

Planning satellite capacity and spot beams

Long design-to-launch times and the high capital expense required for satellite deployment make careful capacity planning crucial to delivery of high-quality services and efficient operation. The satellite system should be designed to have enough total capacity to provide subscribers with a pre-determined quality of service. In the case of NBN services, the system should be designed to be capable of providing both an affordable entry-level product as well as at least one product with peak data rates of at least 12 Mbps to meet Government objectives.

The service will also need to be dimensioned to cater for the expected growth in usage patterns over time. Although nobody can accurately predict trends in usage demand over the coming years, a reasonable estimate of data usage trends (described in Section 5.1.4) suggests that dimensioning for average data rates in the 300–400 kbps range is appropriate. This represents a very substantial change from the average data rates provisioned today of less than 10 kbps, and reflects an expected change in usage patterns away from simple web browsing to more use of video and interactive services. The final judgement on service provisioning requirements should be made by NBN Co.

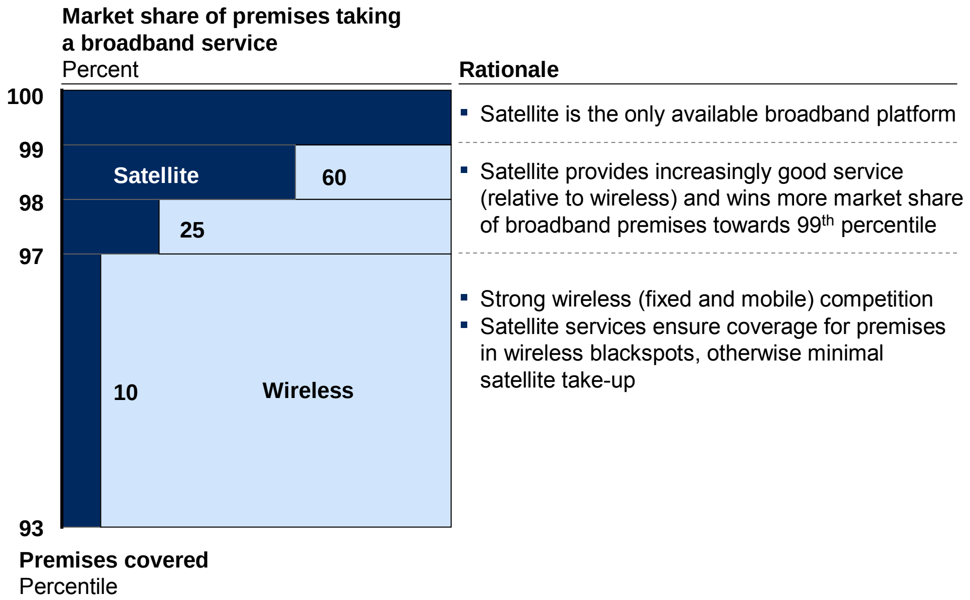
Recommendation 43. That NBN Co be required to provide a next-generation satellite service ensuring access to at least 12 Mbps peak data rates to all premises beyond the fibre footprint. Satellite system capacity should be dimensioned to offer an average data rate per premises that reflects potential growth in usage patterns over the lifetime of the satellite system.

GEO satellite capacity is typically provisioned via a number of spot beams providing concentrated coverage in defined areas. Once the satellite is in orbit, the spot beam locations and beam radii are largely fixed, so the selection of the number and location of the beams is a critical consideration.

One practical approach to facilitate effective demarcation of the fixed-wireless and satellite coverage areas is for NBN Co to define the coverage requirements for the fixed-wireless network based on its geospatial modelling. This will enable NBN Co to design the satellite coverage areas effectively, based on precise knowledge of the planned fibre and fixed-wireless network footprints. Alternatively, it may be desirable to allow a tenderer for the fixed-wireless network to identify those premises beyond the fibre footprint that it would classify as the 94th to 97th percentiles. NBN Co could then configure its satellites accordingly.

Dimensioning the satellite system will also require NBN Co to project take-up of the service. Exhibit 5–12 shows an illustrative example of potential take-up rates in different percentiles within the final 10 percent that was used in the business case modelling. Where strong wireless service competition is present, take-up is expected to be largely limited to customers in blackspot coverage areas who receive either poor or no high-speed wireless broadband services.

Exhibit 5–12. Illustrative model for potential take-up of satellite services



SOURCE: Implementation Study

Provisioning of excess satellite capacity beyond projected demand trends is prudent due to the long potential lead time to acquire additional capacity if planned requirements are exceeded. If the entire satellite capacity is not consumed by domestic broadband customers, it may be possible for the satellite provider to offer capacity to other countries with similar longitude to Australia. However, since spot beams typically cannot be re-allocated dynamically post-launch, this decision would have to be taken before satellite launch, based on the forecast take-up of services.

To enable optimised capacity planning and utilisation, satellite launches can be staggered so that observed take-up rates for services on the first satellite can be used to guide the configuration of spot beams on the second satellite launched. Given the low probability of in-orbit satellite failure it is feasible to delay the second satellite launch for a period of 18–24 months to enable capacity to be monitored.

Providing gateway redundancy

The location and design of satellite gateways should support service continuity and resilience to weather effects and component failure. In practice, there are two options to improve resilience:

- Each gateway location is designed with a total of four antennas—two primary antennas (one per earth-to-satellite link) and two to provide redundancy to each primary antenna;
- Each gateway location is designed with a total of three antennas—two primary antennas (one per earth-to-satellite link) and one to provide shared redundancy to the two primary antennas.

The redundant antenna should be separated from the primary antenna(s) by at least the distance of an average rain cell size, enabling at least one antenna to communicate with the satellite in most weather conditions.

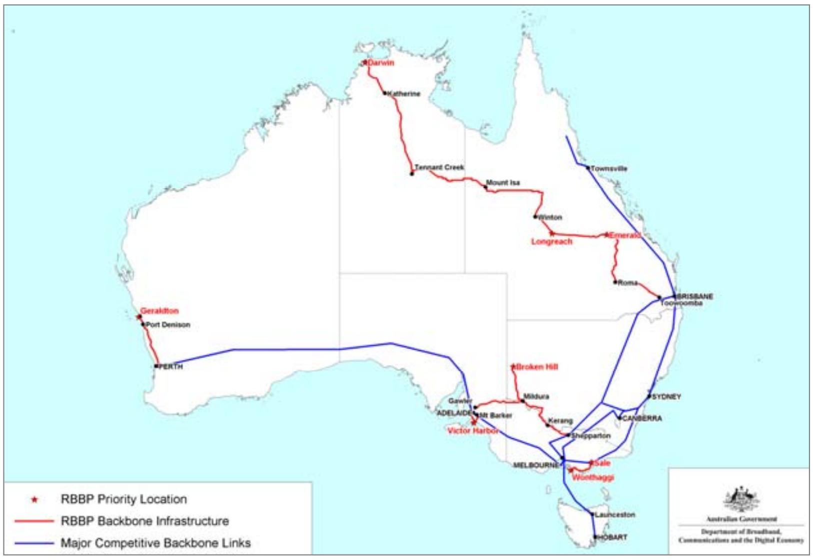
Enabling frequency reuse

The use of spot beams to transmit the satellite signal allows reuse of satellite frequencies, enabling a greater throughput for a given amount of spectrum. The high frequency of the Ka-band enables smaller spot beams compared to current Ku-band services, enabling a higher frequency reuse factor. As long as no two adjacent spot beams are operating in the same frequency band, each frequency band can be reused multiple times.

To maximise frequency reuse, the gateways that provide satellite up-links need to be placed outside the footprint of the beams. This means it is desirable to place gateways in remote locations away from the premises covered by the beams. While in theory the availability of backhaul to connect gateways can be problematic, in practice locating remote gateways in locations with access to backhaul should be feasible:

Exhibit 5–13. Cross-nation backhaul links pass through remote areas offering good locations for gateways

Regional Backbone Blackspots Program—All RBBP Routes



SOURCE: DBCDE

- Existing remote gateway locations for Ku-band and other satellite types can be reused for a Ka-band satellite system;
- Existing cross-country backhaul links passing through remote areas already offer various potential gateway connection points requiring little new backhaul construction (Exhibit 5–13). Transit backhaul built by NBN Co will provide even more optimal locations over time.

5.3.3 DEFINING THE OPERATING MODEL AND PRODUCT OFFERING

Securing Ka-band satellite capacity

NBN Co's options for securing satellite capacity depend upon the likelihood of Ka-band capacity being available in the commercial market at the time of service launch. If capacity is expected to be available, NBN Co can consider a leasing model utilising third-party satellite infrastructure. A leasing model avoids large upfront investments and enables NBN Co to adjust capacity to demand flexibly, within the limits of agreed contract conditions.

Currently there are no plans to launch Ka-band satellites providing broadband coverage in Australia, and it is unclear whether the market by itself will supply the desired capacity. For this reason, the advice of the Implementation Study is that NBN Co should contract with satellite operators to provision a new satellite platform comprising two next-generation Ka-band satellites and the required gateways.

Advice. That NBN Co secure capacity for satellite services by contracting an operator to provision a new satellite platform comprising two next-generation Ka-band satellites and the required gateways.

Defining the satellite product offering

Ka-band satellite services should be offered by NBN Co on a wholesale-only basis, with per customer incentives defined to ensure retailer entry. Services should be offered at Layer 3 due to the need to optimise the satellite link, as described in Exhibit 5–14.

While the requirement for NBN Co to offer Layer 3 satellite services constrains the degree to which retailers are able to differentiate their satellite service offerings, the much higher peak data rates and average data rates enabled by Ka-band technologies will enable a range of services and applications to be delivered.

NBN Co should have some flexibility in defining the range of wholesale services offered, which should include a service offering peak data rates of 12 Mbps, with vastly improved average data throughputs (e.g. in the order of 300 kbps). For example, a 360 kbps average forward data rate could be provided through a total capacity of 110 Gbps provided by two Ka-band satellites to approximately 350,000 premises.[149]

An entry-level service with a lower peak data rate and average data rate should be provided (e.g. 6 Mbps and 200 kbps respectively), priced at a comparable level to entry-level fibre and wireless products. Additional services could also be provided to promote end-user choice and commerciality, for example a premium service with higher peak data rates and average data rates (e.g. 20 Mbps peak and 480 kbps average data rates).

Exhibit 5–14. Choice of layer in the stack

Choice of layer in the stack

The GEO earth-to-satellite data link is characterised by high latency, precluding the use of standard transport protocols and requiring stringent network management to ensure good service levels. For this reason the satellite link is always implemented at Layer 3 with both customer premises equipment and retailers connecting at Layer 3.

For a retailer, interconnection at Layer 2 has no added value as the owner of the access data link will be required to shift traffic to Layer 3 to enable effective network management.

Under a Layer 3 capacity leasing model, NBN Co would lease satellite transponder capacity and the supporting earth station network equipment from satellite and earth station operators. Retailers would interconnect to the network through an NBN point of interconnection (POI) at a location with competitive backhaul, with, for example, one POI per state. All network management would be performed by the satellite operator, with retailers operating through a Layer 3 connection.

Source: Implementation Study

149 Assuming a 4-to-1 forward-return ratio and 70 percent activity rate

5.3.4 UNDERSTANDING THE COST OF SATELLITE BROADBAND TECHNOLOGY

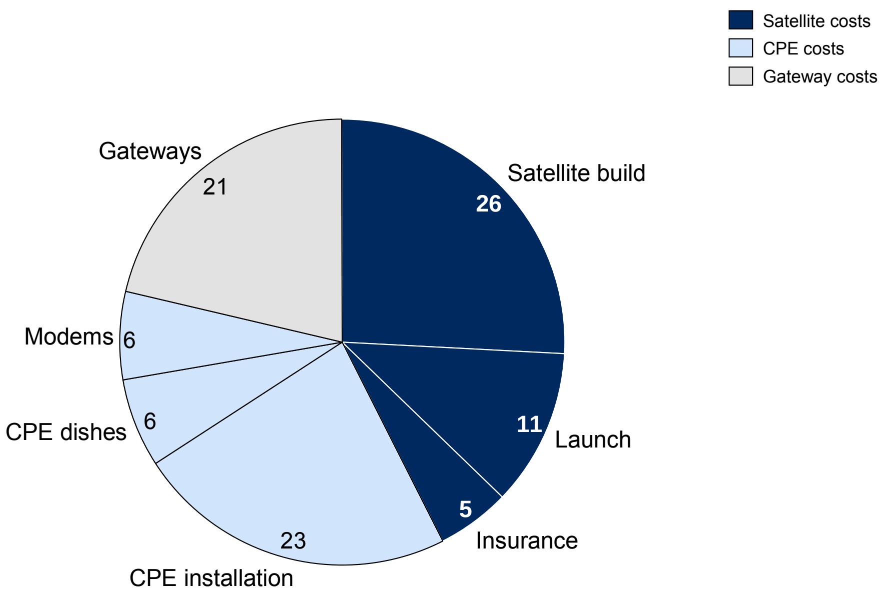
A satellite network has three major cost components: satellite (design and launch), gateways, and customer premises equipment (CPE).[150] A cost breakdown of these three elements is shown in Exhibit 5–15.

Estimating satellite and launch costs

The primary cost drivers of a satellite system are the build and launch of two Ka-band satellites, together with the construction of gateways to support the satellites. The cost of two medium-sized Ka-band satellites with 110 Gbps total throughput would have three main components:

- Cost of building two satellites (about 26 percent of the total satellite network cost)
- Cost of launching two satellites (about 11 percent of the total satellite network cost)
- Cost of insuring two satellites for launch and the first year of operations (about 5 percent of the total satellite network cost)

Exhibit 5–15. Satellite network total cost percentage breakdown



SOURCE: Implementation Study

150 Satellite spectrum licences are an annual operating expense. Spectrum licence costs have been included at $2.5m per annum for two satellites.

The rationale for a dual satellite system is to provide redundancy in the case of a satellite failure. Failure could occur during launch (about 5 percent probability), or in rare cases once the satellite is in orbit. Further details on satellite redundancy requirements are explained in Section 5.3.2.

Estimating gateway costs

Multiple gateways need to be constructed to host network equipment and enable data connections with the orbiting satellites. Based on industry consultation, it has been estimated that around 11 gateways would be required to support two Ka-band satellites with 110 Gbps total capacity as described in Section 5.3.3.

The required number of gateways is driven by a number of factors, including:

- The total required throughput of the satellite system;
- The number of spot beams and frequency reuse factor;
- Spectrum availability.

The cost of each gateway is driven by a number of factors, for example:

- The level of redundancy built into each gateway;
- The required throughput of each gateway;
- The amount of backhaul and power extensions required to reach the gateway.

Estimating customer premises equipment and installation costs

The cost of the Ka-band satellite customer premises equipment and installation is expected to be around $2,000 per premises, approximately $500 lower than typical Ku-band CPE costs. The main components of this are:

- Outdoor dish and antenna (about $350 per premises)
- Indoor modem (about $350 per premises)
- Cabling and installation costs (average of $1300 per premises)

5.3.5 ENSURING AFFORDABILITY OF SATELLITE SERVICES

The high cost of providing satellite services means that it is unlikely that a next-generation satellite service could provide affordable prices and achieve a commercial return.

Exhibit 5–16. Overview of the ABG program

Overview of the ABG program

The Australian Broadband Guarantee (ABG) is a government program with the purpose of helping residential and small business premises located in remote and rural regions of Australia access metro-comparable broadband services, defined as services offering minimum 512 kbps download data rates, and providing 3 GB per month data usage.

The ABG provides an up-front subsidy to retailers of $2,500 per premises activated, covering the cash cost to provision and install satellite CPE. Additional payments are made to retailers acquiring customers in remote regions where installation costs are significantly higher than average, and for retailers acquiring customers in regions where climatic conditions require more expensive CPE (e.g. tropical north Queensland, where larger dishes are deployed to enable services to operate during the frequent periods of heavy rain). In return, retailers guarantee that the total end-user cost of the service over the first three years does not exceed $2,500, including all installation, equipment and help-desk service costs.

Currently, over 100,000 premises receive satellite broadband services under the ABG program. Commonly used plans provide peak data rates of 512 kbps, consistent with program requirements, with low average data rates of less than 10 kbps provisioned per subscriber. Currently, these low average data rates do not appear to be a bottleneck for many users, with usage demands low. As usage demands increase, however, customer experience may deteriorate as relatively expensive bandwidth costs are likely to encourage retailers to add subscribers to existing capacity (thus degrading performance), rather than purchase additional capacity. Effectively supporting increased usage will likely require a mechanism to ensure provision of additional capacity at affordable prices.

Source: DBCDE 2010, *Australian Broadband Guarantee*, viewed 2 February 2010, <http://www.dbcde.gov.au/broadband/australian_broadband_guarantee>

There are two drivers of the high cost of satellite broadband services:

- Infrastructure costs: While the ongoing operating expenses of a satellite solution are relatively low, the upfront capital costs of deploying the satellites, earth stations, associated equipment and backhaul links are high. A satellite provider would need to charge high prices for bandwidth to earn a commercial return, with these high wholesale prices likely translating into unaffordable retail prices for end users.
- CPE costs: The high cost of CPE equipment and installation is also a significant barrier to offering an affordable service. Passing on CPE costs to end-users in full, whether as a single up-front payment or spread over the duration of the service contract, would result in a service that is not affordable to end users.

The capital costs of launching two Ka-band satellites should be borne by NBN Co as part of its overall capital expenditure budget, with Government stipulating that NBN Co charge wholesale prices for bandwidth that facilitates affordable retail offers. As described in Section 5.3.3, NBN Co should offer satellite services at Layer 3 on a wholesale-only basis. The exact characteristics of the pricing architecture should be determined by NBN Co, for example by pricing on a retail minus basis, with reference to target retail pricing.

The cost of end-user CPE hardware and installation incurred on customer acquisition or contract renewal can be paid by NBN Co as the satellite operator, as modelled in the Implementation Study's base case. Alternatively, the cost can be covered by a separate subsidy program under which a customer acquisition payment covering CPE costs is made to retailers on customer acquisition, analogous to the current ABG program (Exhibit 5–16). Both models can ensure retailers are incentivised to enter the market and price services affordably to end-users.

Customer acquisition payments to retailers should be designed to ensure retailers actively market affordable, high-quality broadband services throughout the targeted satellite coverage area. This means:

- **Designing to drive take-up.** The payment should cover up-front CPE and installation costs to enable retailers to capture a fair margin on an ongoing basis.
- **Recognising cost to serve differences.** Payments should be tiered to recognise the increased costs of installing CPE in very remote areas and ensure effective marketing of services to those areas.
- **Securing high service quality.** The scheme should include mechanisms to ensure provision of high-quality services to subscribers. For example, retailers receiving the customer acquisition payments can be required to purchase a defined capacity per subscriber that guarantees a minimum quality of service standard is delivered.
- **Providing clarity on rules of engagement.** Clear guidance should be provided on an individual customer's eligibility for NBN-funded CPE, particularly whether customers who have accepted CPE for a fixed-wireless service qualify to receive CPE for a satellite service as well, and vice versa.

> **Recommendation 44.** That Government ensure affordability of next-generation satellite broadband services for premises underserved by other technologies through a program that funds satellite CPE costs incurred by retailers and guarantees a high quality of service.

Pricing and service levels will be important competition and demand management levers, and retail service providers should be provided with an appropriate level of service and pricing flexibility to enable effective demand and revenue management of satellite services. Specifically, the service provider should be free to define reasonable product and price differentiation to support commerciality and consumer choice beyond the requirement for an affordable entry-level product and a product compliant with Government's 12 Mbps target.

5.3.6 IMPROVING SATELLITE SERVICE IN THE NEAR TERM

There are two primary mechanisms to improve satellite service in the near term, prior to the switch-on for Ka-band services that is at least 3 years away:

- Increasing bandwidth supply at current prices by procuring Ku-band capacity at lower cost
- Improving Customer Premises Equipment (CPE)

This section explores these two mechanisms.

Increasing Ku-band bandwidth supply

Current provisioned average data rates under the ABG program are low (less than 10 kbps) compared to about 35 kbps typical of fixed-line DSL customers. As previously discussed, this may simply reflect lower use of high-bandwidth Internet applications by satellite broadband customers currently, however over time the amount of bandwidth purchased by retailers and provided to end users is likely to become a bottleneck given the high cost of this bandwidth.

Increasing bandwidth supply to customers is therefore expected to be a key way to improve broadband performance. Fortunately, existing Ku-band satellites serving Australia have spare capacity available to enable such near-term improvements.

Increasing bandwidth supply can be achieved by:

- Negotiating lower prices from satellite providers to reduce the cost of bandwidth, enabling services to be improved at no additional cost to end-users;
- Increasing the volume of bandwidth purchased per subscriber at current prices, requiring additional expenditure.

If Government does not have appetite to increase the current ABG subsidy levels, the former option is most attractive. This can be achieved by Government centrally procuring satellite capacity on behalf of all retailers, leveraging the ABG program's scale to secure lower prices than currently achieved by retailers negotiating individually. It can then manage bandwidth supply to ensure that promised service quality levels are delivered. Alternatively, Government could have NBN Co do this on its behalf.

Improving customer premises equipment (CPE)

New satellite modems can enable peak data rates more than 6 times greater than some existing modems in use today.[151] Additionally, new modems can have twice the spectral efficiency of existing modems, enabling twice the data rate to be provided with no increase in satellite bandwidth leased. For users with older, low performance modems, replacement can enable a significant improvement in broadband performance.

Ensuring that investments in CPE for interim Ku-band satellite solutions are usable for future Ka-band satellites is challenging. Ku- and Ka-band services operate at different frequencies, will utilise different satellites, and satellite systems must be designed as end-to-end integrated solutions to function effectively. The outdoor unit (comprising an antenna dish, low noise block down converter and block up converter) that enables signal reception and transmission is specific to a given frequency band, and would need to be replaced on migration from a Ku- to Ka-band. While it is possible to design dual band Ku/Ka antennas, in practice issues such as the uncertainty of the future orbital location of Ka-band satellites make this difficult, meaning that new Ku antennas would also require replacement on migration to Ka services.

Satellite modems are capable of operating on both Ka and Ku frequency bands, meaning that modems upgraded or installed as part of a near-term Ku-based improvement program—if properly designed—would not necessarily need to be replaced when next-generation Ka satellites begin operation.[152] This functionality should be a design objective for interim solution CPE as it has the possibility to reduce costs of migrating customers to next-generation services by about $350 per customer,[153] depending on individual model costs.

151 Industry interviews

152 All elements of a satellite system (gateways, satellite and CPE) must be carefully designed to function as an optimised system, meaning the design for a modem must be carefully selected. Any provider selected for the project would need to design the modem and its outdoor interface together to ensure effective functioning in current Ku- and future Ka–band setups

153 Industry interviews

5.4 Facilitating development of a high-speed wireless broadband market

Wireless technologies have a substantial role to play in delivering broadband services to the final 10 percent of premises.

Unlike satellite and fibre, the wireless market has multiple operators with existing infrastructure. Currently however, the business case to provide wireless broadband to much of the final 10 percent at the data rates Government envisages is not viable for these operators. This is due to the high cost of backhaul, the relatively low number of subscribers per wireless tower and the low overall revenue pool available.

Incentives are therefore needed to encourage and accelerate provision of high-speed broadband in these areas. As with the satellite solution, a two-part approach should be pursued to deliver both an immediate improvement and a long-term path for market development.

This section covers four topics:

5.4.1 Implementing a fixed-wireless network to deliver at least 12 Mbps

5.4.2 Understanding cost and affordability of a fixed-wireless network

5.4.3 Enhancing mobile broadband competition

5.4.4 Providing competitively-priced backhaul for wireless.

5.4.1 IMPLEMENTING A FIXED-WIRELESS NETWORK TO DELIVER AT LEAST 12 MBPS

To ensure delivery of a wireless network capable of delivering a 12 Mbps peak data rate to a substantial portion of the final 10 percent in the near term, Government should run an open tender process for a provider (or providers) to build and operate a fixed-wireless network that meets specified broadband coverage targets. Detailed geospatial cost modelling conducted by the Implementation Study suggests this network should cover premises in the 94th to 97th percentiles, subject to confirmation based on NBN Co’s own geospatial modelling and network planning.

Participating parties would submit a proposed network design, parameters of proposed service offerings, timing and milestones for the build-out of the network as well as required Government expenditure to deliver the outcomes specified.

Using a tender process to achieve an efficient outcome

Government has several options to deliver a fixed-wireless network. For example, it could instruct NBN Co to build the network; instruct NBN Co to run a tender process; run a tender process in which NBN Co participates; or run a tender process in which NBN Co does not participate. The Implementation Study believes the last of these options is the preferred approach for several reasons:

- Industry participants are better positioned than NBN Co to construct the network as they would be able to construct and operate the network at a significant discount to NBN Co, by making use of existing assets (e.g. towers, backhaul and spectrum) and expertise (e.g. existing wireless network engineers and technicians). For some operators there would be the added incentive of protecting against loss of revenues.
- If an industry participant constructs the network, they can offer both wholesale and retail services, preventing the potential retail market failure that might result if NBN Co builds a wholesale-only network, given that some communities of users will be small and remote and potentially unattractive to retailers.
- If a commercial tender process is run, Government is better placed to run the tender than NBN Co since it can provide objectivity (preserving the right to ask NBN Co to build the network as a fallback in the event of an unsuccessful tender), and is the logical entity to provide oversight after the tender is executed.

The tender should start with an expression of interest (EoI) process to assess interest from the market and help inform the tender design, particularly in light of previous experience tendering for the provision of a fixed-wireless network under the Broadband Connect program. Government should also consider alternative approaches, such as a competitive grant, that may allow more flexibility in dealing with interested parties. In the design of the tender, Government should be flexible on technology, given both WiMAX and LTE technologies could deliver on Government's objectives (Exhibit 5–17 below)

If a new fixed-wireless network is constructed, it is also likely to be suitable for providing mobile services. While this is not the primary aim of the network, the winning tenderer(s) (or parties) should be allowed to provide roaming or other mobile services if they are consistent with the tender agreement (e.g. do not reduce fixed-wireless service performance). In practice, however, a network covering only 4 percent of the population is likely to have limited utility for mobile services without significant network extension.

NBN Co should not participate in this tender process directly due to concerns over the impartiality of government owned entities competing with private companies in a tender. However, Government should ask NBN Co to provide an initial estimate of the costs it would incur to provide such a network (one such estimate has already been provided to Government as part of the Implementation Study). This will serve as a valuable reference point when evaluating the tenders received. In the unlikely event that no acceptable

Exhibit 5–17. Comparison of LTE and WiMAX

Comparison of LTE and WiMAX

4G wireless technologies deliver high-speed broadband performance using advanced techniques including sophisticated antenna arrays (e.g. 4x2 MIMO), large frequency bands up to 20 MHz per sector, all-IP flat networking architecture, and advanced time and frequency division multiplexing (TDD and FDD).

Both 3GPP and WiMAX technology families are developing 4G upgrades:

- 3GPP (GSM), developing the LTE standard;
- IEEE 802.16 (WiMAX), developing mobile WiMAX R2 (802.16m).

Both standards can enable peak broadband data rates of 100 Mbps to be delivered in optimal conditions and enable a significant advance in performance over today's wireless technologies. 4G WiMAX equipment is already available, and the first commercial LTE service was recently launched by TeliaSonera in Sweden.

Existing mobile operators in Australia are expected to make LTE the technology of choice for mobile wireless broadband for a number of reasons:

- LTE is expected to enjoy greater take-up and usage internationally, leading to larger production volumes which will drive innovation and reduce equipment costs;
- The 700 MHz spectrum that is being freed up by the switch from analogue to digital television is expected to be a popular spectrum band for the implementation of LTE internationally, leading to a large equipment ecosystem at this frequency;
- The total throughput of a tower is increased through multiplexing techniques and, hence, there is sufficient capacity to serve a higher number of subscribers with higher speeds.

WiMAX is associated worldwide with higher frequencies (2 GHz and above), with metropolitan WiMAX network roll-outs in a number of markets including Perth and Adelaide.

The appropriate standard for a fixed-wireless network within the final 10 percent will be determined by the spectrum available for operation, the economics of the standard at that spectrum and the expertise of the company tasked with delivering the service.

Both standards can effectively deliver high-speed fixed-wireless broadband.

Source: Implementation Study

commercial bid emerges, Government should reserve the right to instruct NBN Co to build the network, in which case Government may also need to contemplate incentives to encourage retailers to enter some parts of the market.

The Implementation Study believes the tender process is likely to generate viable bids based on both the analysis of the current market and the experience of the Broadband Connect tender. Several participants in the market are likely bidders, having the necessary expertise, and being in a position to benefit from either monetising existing assets or protecting against the loss of existing revenues.

Exhibit 5–18. Implications of spectrum choice for fixed-wireless service design

Implications of spectrum choice for fixed-wireless service design
The choice of spectrum for the fixed-wireless service design has important commercial and operational implications. It can be delivered across any range of spectrums, including 1.5 GHz, 2.7 GHz or 850 MHz. For the purposes of cost modelling, the Implementation Study evaluated two specific options of using 2.3 GHz spectrum and 'digital dividend' 700 MHz spectrum (126 MHz of spectrum from 694–820 MHz), the latter of which will likely become available no earlier than 2014. While a range of other frequencies could be used for providing fixed-wireless services, these two spectrum options have been modelled as representative outcomes. Both frequencies have advantages for use in providing a fixed-wireless service: ■ **Fast deployment over 2.3 GHz.** 2.3 GHz—or other spectrum available in the near term—enables fast deployment, allowing customers within the network footprint to experience a significant increase in broadband performance in the near term. 700 MHz spectrum, by contrast, is likely to become available in late 2014 at the earliest, after national restacking of the spectrum following the analogue television switch off. This precludes using 700 MHz spectrum to deliver near-term broadband improvement ■ **Low cost of 700 MHz.** 700 MHz spectrum has a lower cost of deployment than 2.3 GHz spectrum due to the larger cell sizes enabled by the lower frequency. With an external antenna, 12 Mbps broadband data rates can be delivered up to 14 km from the cell site using 700 MHz spectrum, but only 7 km using 2.3 GHz spectrum. However, 700 MHz spectrum incurs a high opportunity cost, unlike 2.3 GHz spectrum. 700 MHz spectrum is desirable for mobile voice and broadband applications, due to its ability to provide good indoor coverage. The preference of operators consulted during the Implementation Study is to reserve 700 MHz spectrum for non-fixed applications. As a result, dedication of part of the 700 MHz spectrum to provide fixed services is likely to impair spectrum auction revenue significantly. On balance, the Implementation Study believes that the benefits of utilising spectrum in the 2+ GHz range, should it be available in the near term, outweigh those of using 700 MHz spectrum, despite the higher network build costs. While 700 MHz spectrum would enable a more capital-efficient network build than 2+ GHz spectrum, its opportunity cost and lack of availability prior to 2014 makes 2+ GHz a better choice to achieve near-term improvements.
Source: Industry interviews; Implementation Study

In designing the tender process, Government should ensure the availability of commercially-available spectrum for the purposes of building the fixed-wireless network. Exhibit 5–18 discusses some of the tradeoffs around the choice of spectrum to use in network design.

While spectrum in the 2.3 GHz range is likely to be commercially available as one example, Government may need to consider further action to free suitable spectrum if required. Given the risk of limited spectrum availability, Government should also guarantee spectrum renewal rights for the fixed-wireless network operator.

The successful tenderer(s) would be required to offer both a wholesale MVNO service as well as a retail offering. Similar to the satellite wholesale service, the MVNO service would be provided by default at Layer 3. As part of the tender specification, Government should also consider whether to require tenderer(s) to offer support for a Layer 2 tunnelling protocol (L2TP) that would enable Layer 2 data streams to be provided over the network.

The required retail offering is intended to guard against potential failure of the retail market for customers in extremely remote areas. However, in the case of an NBN Co build, NBN Co should not be required to provide retail services due to the substantial additional complexity this would impose. Instead, additional customer acquisition incentives could be provided to encourage entry by other retailers.

The successful tenderer(s) should be required to provide a description of an expected upgrade path for the implemented technology. Additionally, Government should subject data rate conditions imposed on the fixed-wireless operator to regular reviews. These reviews would ensure that fixed-wireless network data rates are consistently upgraded to reflect advancements in wireless technologies.

Previous experience has shown that designing a successful tender process for the provision of fixed-wireless services is not straightforward. To maximise the likelihood of success, the tender should:

- Allow the tenderer(s) to identify the 4 percent of total premises they would cover beyond NBN Co's fibre footprint, using the filtered geospatial data provided by NBN Co and approved by Government. Once the tender is concluded, NBN Co can configure its satellite to serve the remaining 3 percent. This permits maximum re-use of existing infrastructure and alignment with retail interests.
- Require tenderer(s) to define specifications of proposed offers in detail, including minimum average data rates and busy-hour usage assumptions for inclusion in the network design. Both an entry level product (e.g. at least 4 Mbps peak data rate) and a 12 Mbps peak data rate service compliant with Government objectives should be required. To ensure affordability of the entry level product, the price should be broadly consistent with entry-level pricing for fibre and satellite offerings, and set with reference to mobile broadband pricing. A mechanism for adjusting the price over time would also be required, and could vary from a cap on the annual price increase permitted to a regulatory mechanism administered by the ACCC.
- Build in flexibility for inevitable adjustments in coverage boundaries. As NBN Co deploys its fibre network, it may not be exactly as originally planned. The tender needs to contemplate fibre being deployed to some wireless areas, and the provision of wireless to service gaps in the fibre network.
- Have NBN Co deploy additional transit backhaul to wireless tower locations where required. This will reduce the cost of building the wireless network and remove

backhaul bottlenecks. This backhaul should be offered to other operators on an equivalent, open-access basis.

Government should consider a hybrid option for contract delivery, for example milestone payments combined with payments when customers sign on. This can create an ongoing incentive to bring people onto the network while allowing the provider enough cash flow upfront to finance the investment.

Recommendation 45. That an Expression of Interest (EoI) and tender process be conducted for a commercial provider to build and operate a fixed-wireless network, specifically:

1. That the network offer services on both a wholesale and retail basis beyond the fibre footprint to cover 4 percent of total premises;
2. That the services include an offer with at least 12 Mbps peak data rates and high average data rates, with service characteristics subject to periodic review; that the services include an entry-level offer providing a high-quality broadband experience at a specified price comparable to entry-level pricing on the fibre and satellite footprints; that Government specify as part of the tender a mechanism for adjusting prices of the entry-level and 12 Mbps offerings over time, for example via a cap on annual price rises or another regulatory mechanism;
3. That the tenderer(s) describe an expected upgrade path for the implemented technology;
4. That spectrum renewal rights for the fixed-wireless network operator be guaranteed;
5. That, in the absence of an acceptable bid, NBN Co be required to build the network and offer services on a wholesale-only basis.

Upgrading customer premises equipment as part of the network roll-out

As described in Section 5.1.2, use of an external antenna can allow peak data rates of 12 Mbps to be received up to seven times further from the cell site than without an external antenna.

The successful tenderer(s) should therefore be required to provide fixed external antennas to premises where necessary to meet minimum service requirements. This could be based on the distance of a premises from a wireless tower or base station. The type and cost of this CPE should be specified as part of the tender, with CPE costs reimbursed as customers are acquired, similar to the approach currently employed in the ABG program.

Government will also need to decide whether to allow or require the network operator(s) to serve customers outside the 12 Mbps coverage footprint who prefer a wireless service to satellite. For example, a customer who is able to receive a low-latency 10 Mbps peak service over wireless may prefer this to a high-latency 12 Mbps satellite service.

The view of the Implementation Study is that the successful tenderer(s) should not be required to serve such customers—as this would add significant complexity to network dimensioning—but should do so where it is reasonably practical and would not negatively affect network performance. These customers would not receive any minimum service guarantee relating to peak data rates.

To assist with this assessment, NBN Co should be required to report regularly on the performance of the satellite service and the successful tenderer(s) on the performance of the fixed-wireless service as implemented.

5.4.2 UNDERSTANDING COST AND AFFORDABILITY OF A FIXED-WIRELESS NETWORK

For the purpose of assessing the business model for NBN Co, we have taken the conservative position of modelling a fixed-wireless network build by NBN Co. As discussed above, we believe that a tender process will succeed and result in lower costs to build than NBN Co could achieve.

The Implementation Study has considered the options of building a fixed-wireless network using either the 2.3 GHz or 700 MHz spectrum. The cost modelling assumes that 2.3 GHz spectrum would be used, which adds a second layer of conservatism as more towers would be required to provide the same level of service compared with a 700 MHz solution.

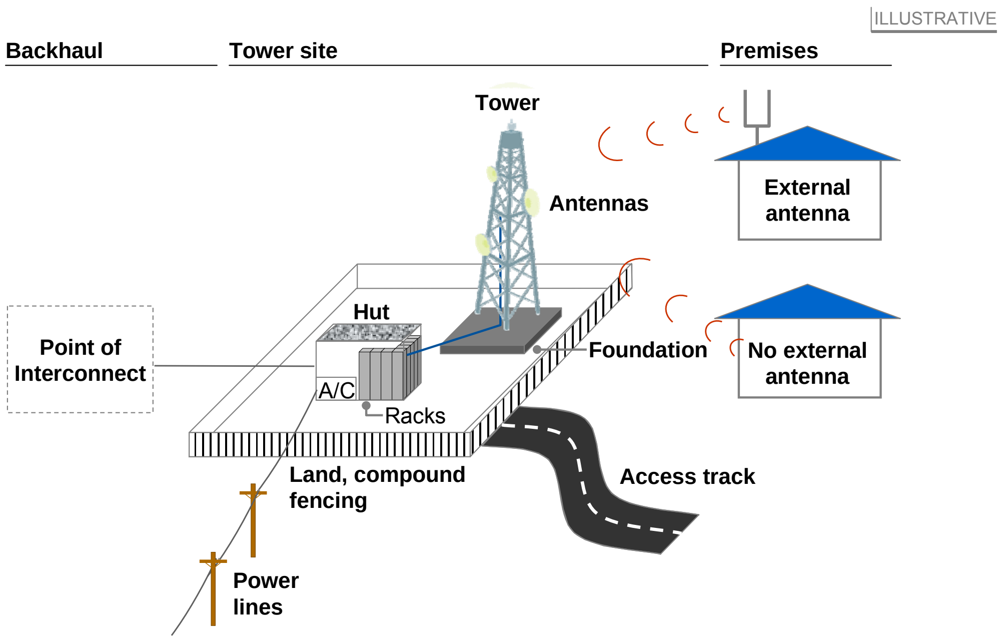
The fixed-wireless network has four major cost components: the towers, the CPE, backhaul and the cost of spectrum licences. Exhibit 5–19 provides a high-level overview of a wireless access network.

Estimating wireless tower costs

Cost of a new-build single tower include:

- Preparing and designing the site, including civil works to create road access, build a compound around the site and provide power by connecting to the electricity grid
- Building the tower, including foundations, the steel lattice and the antennas that transmit/receive signals
- Purchasing and installing the active components that transmit and receive wireless data via feeder cables and the antenna
- Building a hut (external building) in which the active electronics are stored

Exhibit 5–19. High-level wireless access network schematic



SOURCE: Implementation Study

Substantial savings are possible if towers are shared between network operators. Today, the major mobile network operators frequently share towers, and a number of towers are owned by independent third parties that specialise in providing tower infrastructure to mobile network operators.

Estimating the costs of providing a fixed-wireless network to meet defined coverage objectives necessitates detailed geospatial modelling. Both the distribution and density of premises affects the number of premises that can be served per tower, which in turn has significant implications for the level of fixed-investment per subscriber. Exhibit 5–20 discusses the detailed approach to geospatial analysis that the Implementation Study has taken in its modelling.

Exhibit 5–20. Geospatial analysis of the number of towers required

Geospatial analysis of the number of towers required

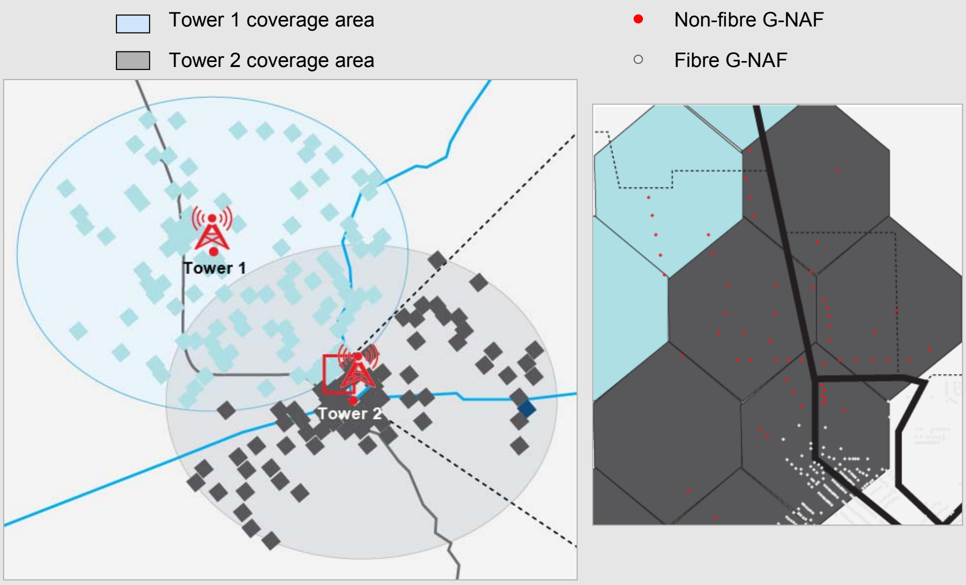
We assessed the number of towers that NBN Co would require to deliver peak speeds of 12 Mbps to the 94th to 97th percentiles on the basis of the LTE wireless network parameters defined in Exhibits 5–4 and 5–5.

Geospatial modelling is required to identify the distribution and density of premises in areas that require wireless coverage and to determine how many towers are required to serve the premises.

First we divided the country into equal sized hexagons (1 km by 1.5 km) to cover land areas outside of fibre coverage. Towers were then placed, starting at the centre of the most dense hexagon as a seed and repositioning the tower to keep adding the next most dense adjacent hexagon. The algorithm ensures that the maximum cell radius is not breached and also generates a second tower when the total number of premises being served by a tower begins to compromise the service levels required.

We illustrate the coverage areas of two towers below, where the hexagons highlight areas with non-fibre premises. In this example, Tower 1 was first placed and filled to its capacity limit of 500–600 premises passed, then Tower 2 was added to give coverage to remaining premises that are either outside the 7 km radius or would breach the capacity limit.

Illustration of geospatial tower placement



SOURCE: Implementation Study

A network operator may choose to rebalance the load on each tower or adjust locations of the towers where there are two or more in close proximity, however this was not required for the purposes of cost modelling.

A large number of existing towers in non-fibre areas were identified and these sites were preferred when locating towers. It is likely that the fixed-wireless network operator may not be able to gain access to all existing towers, and we conservatively assume that they would need to build a new tower in an adjacent location to an existing tower around half of the time. We estimate that a total of around 1,100 towers (containing a mix of existing and new towers) will be required to serve the 94th to 97th percentiles by wireless with the 2.3 GHz spectrum.

We used commercially available datasets, including the Geocoded National Address File (G-NAF) for the location of premises, and the ACMA Spectrum Licensing RadDEM database for the location of existing mobile base stations.

Source: Implementation Study

Estimating customer premises equipment and installation costs

The cost of the customer premises equipment depends whether a high-gain antenna is required to achieve 12 Mbps. Based on geospatial modelling of the cell radius within which 12 Mbps can be delivered indoors using 2.3 GHz spectrum, we estimate that 80% of premises in the fixed-wireless coverage area will require an outdoor high-gain antenna in order to receive a 12 Mbps service. The components of wireless CPE cost are:

- Indoor modem;
- Outdoor high-gain antenna;
- Cabling and installation costs, which are only incurred when a high-gain antenna is required

Estimating backhaul costs

The Implementation Study recommends in Section 5.4.4 that NBN Co should build fibre backhaul to existing tower sites as well as new proposed locations nominated under the fixed-wireless tender proposal. The cost of building this backhaul network has been estimated on the basis of tower locations that would be required to deliver a 12 Mbps peak service using LTE with 40 MHz of spectrum in the 2.3 GHz range.

The main components of fibre backhaul are:

- Trenching, ducting and laying the fibre
- Purchasing and installing additional active equipment to transmit the total throughput of towers

Exhibit 5–21 discusses in detail the geospatial analysis of backhaul requirements.

Exhibit 5–21. Geospatial analysis of backhaul requirements

Geospatial analysis of backhaul requirements
After the optimal locations for all towers were identified, we used a Dijkstra algorithm to determine how to connect towers at minimum cost. The process was completed in two stages: 1) Towers within 5 km of a fibre exchange or a fibre backhaul ring were first connected 2) Remaining towers were then connected to the towers that were connected first, rather than to the nearest fibre exchange or fibre backhaul ring. The fibre backhaul network modelled to wireless towers follows a single point link formation, rather than fibre rings that provide redundancy.
Source: Implementation Study

Estimating spectrum licence costs

Spectrum access costs depend on the frequency band that is selected for the deployment of the fixed-wireless network. AUSTAR proposed to sell its 2.3 GHz spectrum to OPEL in January 2008 for $65 million.[154] This provides a useful reference point for evaluating potential spectrum licence costs for the purposes of our modelling.[155]

Managing price levels in wireless markets

If NBN Co—or another provider—builds and operates a fixed-wireless network beyond the fibre footprint, its broadband products will compete against mobile broadband products from existing operators as well as potential fixed-wireless products from mobile operators, should they choose to offer them. The fixed-wireless network operator will need to offer prices to compete effectively with existing wireless offers. As with fibre, estimating user willingness to pay a premium price is difficult.

For most end-users, the fixed-wireless network is likely to offer significantly higher average data rates due to denser tower infrastructure and available spectrum that will be used primarily for fixed-wireless broadband services. These advantages will be further augmented by the provision of ubiquitous fibre-backhaul to towers (see 5.4.4). However, the resulting difference in service quality may be difficult to communicate and may not be recognised by some end-users. This will limit the fixed-wireless operator's ability to charge a premium for its services in the near term. In the medium to longer term it is likely that the value of faster speeds to end-users will dramatically increase.

Managing retail pricing of fixed-wireless products

Participants in the tender process should be required to comply with a condition requiring an entry-level offer delivering a specified minimum performance level (e.g. at least 4 Mbps peak data rate) at a price specified by Government as part of the tender requirements. The price of this offering should be broadly consistent with the entry-level pricing for fibre and satellite offerings, and be set relative to the price of competing mobile broadband products as described above. The minimum performance level required should be reviewed over time as developments in technology occur.

The Implementation Study believes that the fixed-wireless network operator should be free to define reasonable product and price differentiation over and above the entry-level product, with a product compliant with Government's 12 Mbps peak data rate objective required.

[154] AUSTAR 2008, Annual Report

[155] This cost could potentially be incurred by NBN Co if it builds the network itself, or by another operator, depending on the outcome of the tender process

Managing wholesale pricing of fixed-wireless products

As we discuss in Section 5.4, as part of the tender conditions to build the fixed-wireless network, the operator should be required to provide Layer 3 MVNO wholesale products to complement the operator's retail offering.

The use of cost-plus pricing mechanisms to set wholesale price levels in this market environment is challenging. For a new operator with a small customer base, the economic price is likely to be above the price imposed by market dynamics. Additionally, true cost levels are distorted by the influence of Government subsidies.

A more feasible price setting mechanism is a retail-minus approach. Under retail-minus pricing, wholesale prices are set to provide retailers with a margin below the expected retail price of the product. Margins should be set to enable the commercial viability of retailers and a viable retail market.

Ensuring long-term affordability of wireless broadband products

It is important to ensure long-term affordability of wireless broadband products to enable continued take-up and the achievement of high broadband penetration. This will require ongoing review of the pricing of the entry-level fixed-wireless broadband product.

Consistent with the initial pricing, prices should be kept broadly consistent with the entry-level pricing of fibre and satellite offerings. Price-setting mechanisms could vary from an explicit cap set on the annual price increase permitted to a mechanism administered by the ACCC (e.g. maintaining equivalence to fixed broadband pricing in metro regions).

Current Telstra retail pricing caps, for example, are regulated under the *Telstra Carrier Charges - Price Control Arrangements, Notification and Disallowance Determination No. 1 of 2005*, administered by the ACCC. A similar legislative arrangement could apply in relation to the pricing of the entry-level fixed-wireless broadband product.

5.4.3 ENHANCING MOBILE BROADBAND COMPETITION

The Implementation Study believes that, over time, Government should facilitate infrastructure-based competition in the wireless broadband market by encouraging expansion of the footprint that is served effectively by commercial mobile wireless operators.

In particular, the upcoming availability of ‘digital dividend’ 700 MHz spectrum provides an opportunity for Government to ensure that mobile broadband coverage in regional and rural areas is improved. The 700 MHz spectrum is a valuable resource for mobile operators, with the large spectrum blocks expected to enable significantly improved mobile broadband services. This spectrum is also being used by a number of international

Exhibit 5–22. Using carrier licences for coverage conditions

Using carrier licences for coverage conditions
Under Section 60 of the *Radiocommunications Act 1992*, ACMA has discretion to set procedures for allocation of spectrum, such as the 700 MHz spectrum on which we expect LTE to be implemented. It is not established practice to include coverage or quality of service conditions in spectrum licences, and it is more effective to embed conditions in carrier licences: ■ The Minister has powers to set carrier licence conditions under Section 63 of the *Telecommunications Act 1997*, granting the Minister direct control over the definition of conditions and their ongoing supervision. ■ Carrier licence powers allow the Minister to remove or restrict a right or obligation ■ Conditions can distinguish between carriers, including on the basis of the service offered in different geographies.
Source: Telecommunications Act 1997; Radiocommunications Act 1992; Implementation Study

operators for LTE deployment,[156] so is expected to have a healthy and substantial ecosystem going forward.

Deployment of LTE technology in the final 10 percent areas would increase the performance of wireless broadband services significantly. To encourage this deployment, Government should add carrier licence conditions to the 700 MHz spectrum auction to require network operators to implement future technology upgrades in rural/regional areas in parallel with metropolitan areas. Exhibit 5–22 sets out the logic for preferring carrier licences for this purpose as opposed to spectrum licences.

Prior to the auction, the value of requiring one or more successful bidders to expand their coverage footprint should also be reviewed, in conjunction with a consultation process with industry.

Prices for mobile services tend to be uniform nationally and are likely to remain so for the foreseeable future. However, in the event that prices in metropolitan and rural/regional areas diverge too greatly, Government should conduct a review of options to ensure national affordability (e.g. regulatory action or subsidies for high-cost areas).

> **Recommendation 46**. That carrier licence conditions associated with the 700 MHz spectrum be added to require network operators to implement future technology upgrades in rural/regional areas in parallel with metropolitan areas; that Government review prior to the 700 MHz auction the value of requiring one or more successful bidders to expand their coverage footprint.

156 For example, Verizon in the USA is currently rolling out LTE over 700 MHz (C-Block) spectrum. Verizon plans to begin the commercial roll-out of LTE in 2010, and to upgrade its existing 3G network to 4G LTE by the end of 2013 (Verizon, *Verizon's $17 Billion Network Investment in 2009 Pays Off,* media release, New York, 29 December 2009)

5.4.4 PROVIDING COMPETITIVELY-PRICED BACKHAUL FOR WIRELESS

The lack of access to competitively priced backhaul at adequate capacity is expected to be one of the largest barriers to expanding high-speed fixed-wireless coverage beyond the fibre footprint. Discussions with stakeholders have indicated that provision of backhaul is one of the key considerations in network providers' decisions as to how far they will roll out their networks.

Whereas base stations in metropolitan areas frequently connect via fibre links, most towers in the final 10 percent connect via microwave backhaul, which offers lower capacity and performance characteristics.

Moreover, market prices for backhaul capacity remain very high in regional and remote areas. As discussed in Chapter 6, the economics of providing backhaul across vast distances to service a small number of regional and remote premises has produced natural monopolies on many routes and uncompetitive pricing.

To help alleviate this bottleneck, where requested by the fixed-wireless provider(s), NBN Co should extend fibre transit backhaul links to existing towers and new tower sites needed to provide coverage to the designated footprint. Based on Implementation Study modelling of a fixed-wireless network covering the 94th to 97th percentiles, this may require providing up to 3,500 km of additional fibre links from existing fibre backhaul networks required to serve 93% of the population with fibre. This transit backhaul should be offered to all operators and priced at the same rates as transit backhaul within the fibre footprint.

Recommendation 47. That Government instruct NBN Co to extend transit fibre backhaul to existing towers and new tower sites needed by the fixed-wireless network operator to provide coverage in the designated areas (e.g. between the 94th and 97th percentiles); this transit backhaul to be offered to all operators and priced at the same rates as transit backhaul within the fibre footprint.

5.5 Ensuring national availability of voice services

Copper-based fixed lines are currently the primary delivery method for voice services to customers in the final 10 percent and are expected to remain so in the near term. While a detailed consideration of voice services and treatment of the USO by Government is beyond the Implementation Study's scope, it is important to understand the implications for voice of migrating customers to wireless and satellite broadband solutions.

Within the fibre footprint, as traffic migrates onto the NBN, the copper network is expected to be retired over time. As the amount of copper retained across the country decreases, the cost per premises to maintain it will increase.

Telstra, or whoever bears the voice USO responsibility in the future, will face a choice: continue to maintain a small and expensive copper network to provide voice services (or, potentially, if they are not the copper network owner, pay the owner to maintain the copper network), or utilise alternative technologies to deliver voice services to the majority of customers in the final 10 percent.

These issues are discussed in the following sections:

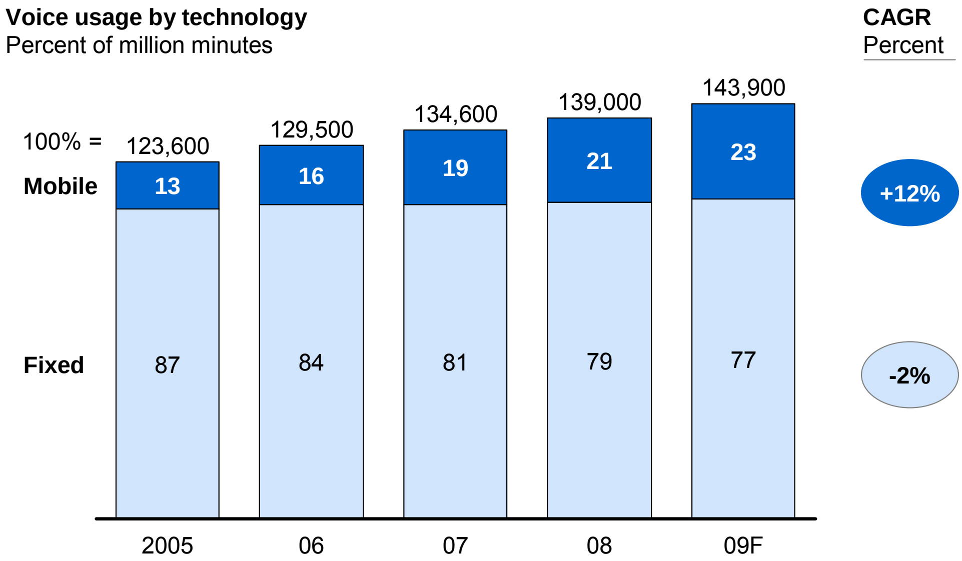
5.5.1 Understanding the voice service landscape

5.5.2 Exploring options for voice service provision.

5.5.1 UNDERSTANDING THE VOICE SERVICE LANDSCAPE

Fixed-line technologies are the predominant platform for delivering voice services in Australia. Nearly 90 percent of households currently subscribe to a fixed telephony service, compared to 65 to 70 percent that subscribe to broadband services. Fixed-mobile voice substitution is increasing, as shown in Exhibit 5–23, but fixed-line telephony will remain a core telecommunications service for many Australians in the coming years.

Exhibit 5–23. Fixed-mobile substitution in Australia



SOURCE: Ovum; Quantifica

Today, 99.75 percent of all premises are capable of receiving voice over Telstra's copper access network, with low latency and high availability providing a high quality of service. In addition, Telstra implements a number of copper-based solutions to serve remote premises, including pair-gain systems that enable service for long loops and serve multiple customers over a single copper line.

Radio and—for a small number of premises—satellite technologies provide voice services to the remaining premises.

- Radio concentrators are the most common radio-based solution. Premises in remote communities connect via fixed copper lines to small local exchanges (Remote Line Concentrators or RLCs). RLCs, in turn, are connected to copper exchanges using relatively low frequency wireless peer-to-peer connections.
- Single/Dual Channel Radio connections are used to connect very remote premises far from any communities or clusters of other premises, with 1 to 2 voice channels transmitted over VHF frequencies.
- GEO satellite phones provide voice services to some isolated premises. Latency is high due to the long distance signals travel between the Earth and satellite. Calls between satellite subscribers experience a delay of about 1 second due to the signal travelling twice to and from the satellite and earth between subscribers (the 'double hop').
- LEO satellite services are available and used by some consumers. LEO services are characterised by low latency and relatively high quality of voice service outdoors.

Indoor reception, however, is poor. LEO voice services are currently provided by Iridium satellites, with per-minute prices around $2.[157]

Radio and satellite infrastructures provide significantly lower voice quality than copper-based services, with high latency an additional issue reducing the user experience of GEO-based satellite services.

5.5.2 EXPLORING OPTIONS FOR VOICE SERVICE PROVISION

From an economic standpoint, the cost of maintaining copper lines in the final 10 percent is high, due to long runs and frequently harsh environmental conditions. As a result, it is desirable to find more economic (and acceptable quality) alternatives.

With the roll-out of fibre, it is expected that the existing copper infrastructure serving fibre areas will be shut down over time, with customers provided with the option of PSTN emulation on ONTs if they wish to continue to receive a fixed-line telephone service. This provides an acceptable copper-voice service substitute, enabling copper lines to be decommissioned without worsening end-user experience.

Outside the fibre footprint the choice is more complex. While mobile and satellite technologies support voice services, these do not always equal the quality of today's copper voice services:

- **Mobile voice.** The large and increasing share of total voice usage taken by mobile demonstrates that for many users it is already an acceptable substitute for fixed-line services. Fixed-mobile voice substitution is increasing and, additionally, technical developments are improving the call quality of wireless voice services (Exhibit 5–24). Combined with improvements in network quality, these developments are progressively removing the quality advantage historically enjoyed by fixed-line voice services.
- **Satellite voice.** Both GEO and LEO have significant disadvantages as voice platforms. The high latency of GEO services, particularly in 'double hop' situations, makes service quality unacceptable for many users. LEO services enable low latency. They suffer, however, from poor indoor reception if no external antenna is used and are high cost.

[157] TR Telecom 2009, *Iridium satellite call plans: Australia*, viewed 12 February 2010, <http://www.trtelecom.com/plans-and-pricing.htm>

Exhibit 5–24. Rise in mobile call quality

Technological developments are enabling increases in the quality of mobile voice
Wireless technology innovations such as HD voice are improving the quality of mobile voice transmission and bringing it closer to fixed-line quality. Mobile HD voice uses improved codecs to sample a much wider frequency range than currently sampled in 3G technologies today, sampling frequencies as low as 50 Hz and as high as 7 kHz. The result is a more realistic reproduction of sounds, providing a more 'in-person' feel to voice calls. Due to improvements in processing power and codec software, HD voice requires only slightly more bandwidth than the previous GSM voice codecs (12.65 kbps vs. 12.2 kbps). HD voice is expected to be implemented by a number of operators in coming years. Industry analysts predict new developments such as HD voice will increase fixed-to-mobile substitution by removing the quality advantage historically enjoyed by fixed-line voice services.

Source: Green 2010, 'High-definition voice won't bring higher revenues for operators', Ovum, viewed 22 February 2010, <http://www.ovum.com/news/euronews.asp?id=8365>

Options for deactivating copper in the final 10 percent

The acceptability of wireless as a substitute for copper-based voice services makes the decommissioning of many copper lines outside the fibre footprint feasible, both within the coverage area of the proposed NBN fixed-wireless broadband network and in areas covered by existing wireless operators. Most premises in the final 10 percent will be able to receive mobile voice services, with today's mobile voice coverage level of about 99 percent of the population likely to increase with an upgrade to LTE.

A number of premises that today receive copper-based voice services will, however, be unable to receive mobile voice services. Some of these premises will fall outside mobile coverage areas, while others will fall inside coverage areas but be located in coverage blackspots. While small in number, these premises will be scattered throughout the area beyond the fibre footprint. Maintaining copper-voice services to these premises will require the continuing operation of a large number of exchanges. As many exchanges may have few lines active, the cost per premises of continuing copper voice services will be very high, and alternatives should be explored.

Ensuring fixed-line comparable pricing structures

The experience of fixed-line abandonment in many countries—including Australia—suggests mobile wireless can provide voice service quality acceptable to most users. Ensuring it is regarded as an acceptable substitute will also require matching fixed-line pricing architectures.

One potential approach is to offer home-zone fixed-line equivalent pricing in wireless areas. In this model, if a customer outside the fibre footprint wants a standard telephone service, it would be provided over the mobile telephone network but with untimed local calls offered within a zone corresponding to the user's premises. Over time, price levels would evolve with regulatory reviews of access fees and call charges as is done today.

Such a home-zone voice service would need to be available on a standalone basis to meet the needs of consumers not wishing to take broadband or other products. In addition, providers should be free to market bundled offers such as dual play offerings of fixed-wireless voice and broadband, or, potentially, offers including both fixed and mobile components. Allowing bundling enables retail price competition and innovation, and encourages retailers to pass on some of the economic benefits from serving customers with multiple product bundles.

6 Ensuring ubiquitous backhaul availability

SUMMARY

- Unavailability of competitively priced backhaul is a bottleneck to providing affordable, high-speed broadband services in many parts of Australia today. In addition to building its fibre access network, NBN Co should therefore also provide sufficient transit backhaul capacity to alleviate this bottleneck. This should be achieved through two targeted investments.
- First, the NBN should include approximately 70,000 km of transit backhaul on routes that are currently monopolies. This backhaul should connect NBN Co's fibre exchanges to points located deeper in the network where multiple backhaul service providers are available, to ensure service providers can always link to NBN Co's network via competitive backhaul connections. This portion of the transit backhaul build would include the 6,000 km of links being constructed under Government's Regional Backbone Blackspots Program.
- Second, NBN Co should provide approximately 3,500 km of additional transit backhaul to connect to wireless tower locations, where required by the provider(s) of the future fixed-wireless network.
- NBN Co should be prepared to build its own backhaul network, but should also be open to securing long-term indefeasible rights of use (with concrete options to renew) from existing dark fibre assets on these routes.
- NBN Co transit backhaul services should be specified and priced separately from access services and available to other network operators on an open-access, equivalent basis. Where transit is offered, to ensure a level playing field, all service providers should be required to use this service to connect to the NBN access network, and not permitted to connect below the POI.
- Transit backhaul should be priced affordably, for example as a small percentage of the total price of the access service for a given premises, given a defined contention ratio.
- The shared transit backhaul network is most appropriately run as a public asset over the long term due to the risks of anti-competitive behaviour in a privatised model. Regulation of backhaul assets will be difficult given high projected levels of traffic growth, and corresponding needs for investment in active equipment.

Australia's geographically dispersed population means that backhaul routes form natural monopolies due to the long distances (and hence high costs) relative to the sizes of the available revenue pools in remote areas.

In order to achieve Government's objective of providing superfast broadband to all Australians at affordable prices, NBN Co will therefore need to intervene selectively to provide competitive backhaul and remove existing bottlenecks.

This chapter proposes the role NBN Co should play in providing transit backhaul services as part of the NBN. Three subsections follow:

6.1 Creating a transit backhaul network to enable the NBN access service

6.2 Creating a future-proof transit backhaul solution

6.3 Managing the transit backhaul network to meet evolving market needs

6.1 Creating a transit backhaul network to enable the NBN access service

NBN Co's mandate is to enable affordable and competitive availability of broadband services to all Australians. This firstly requires service providers to have competitive access to its fibre access network anywhere it is deployed. Second, it requires that NBN Co set wholesale prices—including all necessary network links—that encourage affordability of retail services.

Today, backhaul capacity is expensive in many regional areas, preventing delivery of competitive retail services. Current high prices are driven by both structural and industry factors. NBN Co should make lasting interventions to ensure affordable capacity for NBN services, constructing the necessary transit backhaul to connect all fibre serving areas and fixed-wireless access points to NBN Co points of interconnect.

Unlike other assets such as the fibre access network, this shared backhaul network is most appropriately run as a public asset over the long term due to the risks of anti-competitive behaviour in a privatised model. Regulation of backhaul assets will be difficult given high projected levels of traffic growth, and corresponding needs for investment in active equipment upgrades.

This section discusses the need for, and appropriate scope of, the NBN's backhaul services:

6.1.1 Addressing affordability of NBN retail services with backhaul

6.1.2 Intervening in backhaul where required

6.1.3 Deploying a 60–70,000 km fibre transit network

6.1.4 Anticipating backhaul to support fixed-wireless.

6.1.1 ADDRESSING AFFORDABILITY OF NBN RETAIL SERVICES WITH BACKHAUL

Access to affordable backhaul capacity is an essential part of delivering retail broadband services. To reach their customers, access seekers such as retail service providers (RSPs) and application service providers (ASPs) need to establish connections to NBN Co's fibre exchanges from their points of presence (POPs). This generally involves leasing backhaul capacity, of which there are three main types (Exhibit 6–1).

Exhibit 6–1. Introduction to backhaul

What is backhaul?

Backhaul is a generic term for the transmission links that connect service providers' core networks with points of service delivery, for example:

- Copper network exchanges and mobile towers today
- Fibre exchanges in a future NBN

For the purposes of this report we define three types of backhaul:

- **International.** Transmission between Australia and the rest of the world via submarine optical fibre cables. Six high capacity cables exist for Australia.[a] These are generally considered competitive, particularly with the recent addition of the PPC-1 cable. The stated Southern Cross list price for 5 Gbps of restored Australia-US capacity is currently around $US0.28 per GB downloaded, 86 percent lower than December 2003[b]
- **Intercapital.** Long distance transmission between Sydney, Melbourne, Brisbane, Perth, Canberra and Adelaide. Intercapital routes are all competitive
- **Community.** Links between local exchanges, regional aggregation points, towns and cities and the rest of the network. 5,000+ community backhaul routes exist, primarily provided by Telstra. Only a small number of routes in densely populated areas are competitive today. Community backhaul can be separated into two subcategories:
  - Intercity connects regional aggregation points to intercapital backhaul
  - Intracity / regional connects local exchanges to regional aggregation points

In this chapter, the term 'transit backhaul' refers to an NBN Co-provided link between fibre exchanges and points of interconnect (POIs) in the fibre network. This can be any type of backhaul, but is likely to be community backhaul.

a. Industry interview 2009

b. Corner, S 2008, 'Australian Researchers' 10 Gbps links to US guaranteed to 2020', *iTWire*, 8 February 2010, viewed 10 February 2010, <http://www.itwire.com/telecommunications-news/networks/36632-australian-researchers-10gps-links-to-us-guaranteed-to-2020?start=1>

Source: Implementation Study

Backhaul drives significant costs in today's service provider business model due to a lack of competition in parts of the network. Intercapital routes, some intercity community backhaul routes and some intracity community backhaul routes in the CBD areas are considered competitive.[158] However, on many regional routes, costs of backhaul are particularly high due to a number of inter-related factors:

- **Monopoly and duopoly pricing.** Many routes are served by only one or two providers, increasing the ability to extract monopoly rents;
- **Vertical integration.** Telstra is the only national backhaul provider, and also operates in the fixed and mobile retail access markets. This vertical integration provides incentives to set higher prices on backhaul to reduce competition from other retailers;

158 ACCC 2008, *Telstra's domestic transmission capacity service exemption applications*, Canberra

- **High build costs.** Long distances in regional Australia drive high costs, requiring higher prices to generate a return on investment. This discourages the deployment of new fibre links;
- **Case-by-case, cost-based regulation.** Uncompetitive backhaul links are declared services under the *Trade Practices Act 1974* and subject to the negotiate-arbitrate access regime. However, the ACCC has not set an arbitrated price because all disputes have been withdrawn prior to ruling.

These factors result in high costs for service providers—in some cases 20 percent of operating costs are for backhaul.[159]

These high costs make backhaul a bottleneck today in many areas. Absence of competitive backhaul prevents service providers from competing in regional areas, and is a constraint on the regional DSL market.[160] For around 2 million premises, served by exchanges large enough to justify retail competition, Telstra is the only DSL provider, as other ISPs have not secured backhaul on affordable terms.[161] Unless resolved, this limited competition is expected to continue in a future fibre access world, with many retailers unable to offer affordable services to fibre customers due to a lack of competitively priced backhaul up to NBN Co's fibre aggregation points. NBN Co therefore needs to play an active role in backhaul to fulfil its mandate.

6.1.2 INTERVENING IN BACKHAUL WHERE REQUIRED

There is reason to believe that today's backhaul bottlenecks will persist without direct intervention by NBN Co. An operator's willingness to build capacity on a given backhaul link is determined by the size of the revenue pool served, the share of that revenue pool the operator expects to capture and the capital costs involved. Many community backhaul links in Australia are long and serve locations with small, isolated revenue pools (Exhibit 6–2). These links will not support progressive (link-by-link) competitive entry. Exhibit 6–3 shows this effect for intracity backhaul routes of less than 50 km.

159 Stakeholder interviews

160 Stakeholder interviews

161 ACCC 2009, *Fixed LRIC model documentation*, report prepared by Analysys, Cambridge, UK; ADSL2exhanges.com 2009, *ADSL2exchanges.com.au*, viewed 1 December 2009 <http://www.adsl2exchanges.com.au>; NBN Implementation Study analysis

Exhibit 6–2. Backhaul market dynamics

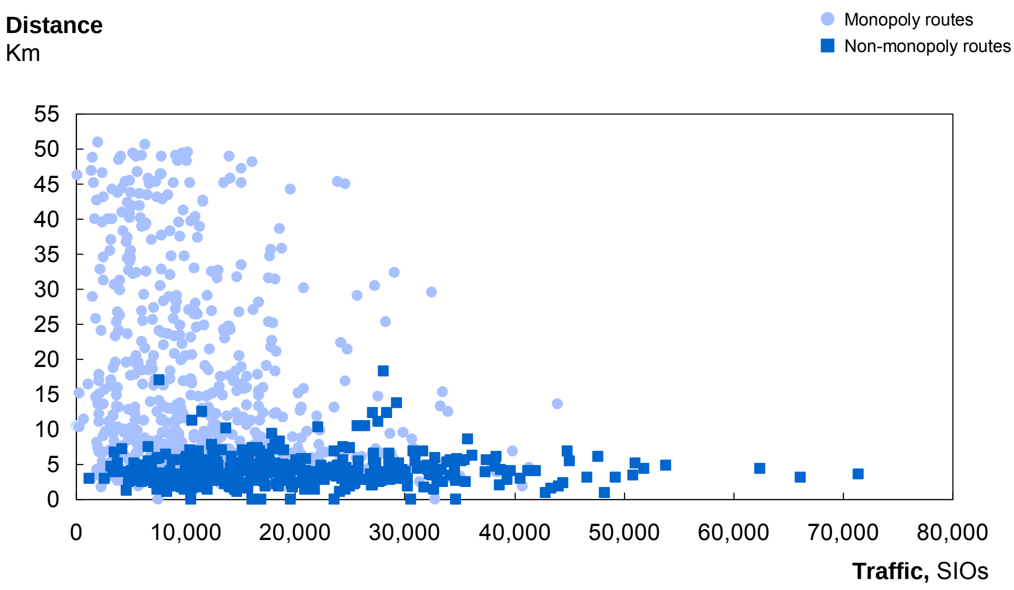
Backhaul market dynamics
Many community backhaul routes in regional Australia are natural monopolies as they are characterised by high sunk capital costs due to the long distances involved, unlimited upgrade capacity at relatively low cost and small market sizes.

- **High sunk capital costs.** Backhaul exhibits a classic infrastructure cash flow profile—very high upfront capital expense and low recurring cash costs. The long distances involved in regional Australia make these costs relatively high per head of population. Because of these high barriers to entry, backhaul competition can be limited by market size resulting in many community backhaul links being monopolies
- **Upgrades with relatively small additional expenditure.** Once the physical link is built, transmission equipment can be upgraded at a relatively low cost. With upgrades, a single fibre is able to transmit terabits per second
- **Small market sizes separated by large distances.** Approximately 20 percent of premises are in areas categorised by the ACCC under its ULL pricing regime as regional or remote. With a smaller population density, the high capex costs are shared among fewer users. For example, the capital expense of building backhaul to Alice Springs has been estimated at $4,000 per premises. This cost equates to approximately $30 per premises per month assuming 100 percent market share. These links are either monopolies or have no fibre backhaul.

Source: Implementation Study

Highlight. Market forces have resulted in little competition on community backhaul routes of more than 10 km in length.

Exhibit 6–3. Competitiveness of intracity community backhaul routes less than 50 km



SOURCE: ACCC LRIC model; ADSL2+ website; Implementation Study

One option for resolving the bottleneck caused by monopoly links is regulation. However, there are multiple difficulties with applying a regulatory solution in practice:

- **Average unit cost varies from link to link, as it depends on distance and total traffic.** The primary component of backhaul cost is the passive cabling, which is determined by the distance of the link. The fully allocated unit cost of capacity on a link will depend therefore primarily on the distance, and the total traffic on the link.
- **Fair regulation at LRIC can be difficult to implement.** As the unit cost for capacity varies, effective LRIC regulation requires the regulator to maintain a cost model for each backhaul route and keep track of the capacity on each route. Effective price regulation of backhaul routes could therefore be administratively onerous and problematic to implement. Fair LRIC regulation is something that would be desirable in the long term, but could be problematic in the short term.
- **It is difficult to choose the right service to regulate.** There are two products that can be regulated, bitstream or dark fibre, but doing so would be difficult for both. A bitstream product would be difficult to regulate because it would need to be based on traffic volume, which is expected to rise rapidly in coming years. Dark fibre would be hard to regulate because at a given price, an access seeker can obtain almost unlimited bandwidth through active equipment upgrades, thereby capturing much of the traffic on a route. Access rights would therefore need to be limited.
- **A one-size-fits-all solution is inefficient**. A simple solution would be to ignore total capacity on the route and set prices for a bitstream service on the basis of distance. New Zealand’s telecommunications regulator chose this solution. However, it risks over-pricing regional backhaul links with limited capacity, because the revenue pool is limited and might not cover costs. Furthermore, the same price would be inefficient on very high capacity routes where the unit cost is low, resulting in inflated returns at the price set by the regulator.
- **There is a risk of market gaming**. Another issue is anti-competitive conduct. The access provider can refuse to increase capacity, by not adding or upgrading active electronics, by claiming spare dark fibre is needed for its own use or no space is available for co-location in the nodes.

As a result of these factors, the conclusion of the Implementation Study is that a purely regulatory approach is not a robust solution to ensuring access to backhaul at competitive pricing, and direct provisioning of backhaul capacity by NBN Co should be a core element of the solution.

6.1.3 DEPLOYING A 60–70,000 KM FIBRE TRANSIT NETWORK

The ‘transit backhaul network’ within the fibre footprint should link all fibre exchanges to points at which at least two independent backhaul fibre connections to the national backbone are available. Geospatial modelling by the Implementation Study suggests this network will need to cover a total distance of about 70,000 km. NBN Co should only procure backhaul capacity on non-monopoly routes where this is necessary to create redundant loops for network resiliency or for system management, in which case dark fibre or capacity should be leased at market rates from existing asset owners.

Providing a transit backhaul network as described is a ‘minimum’ intervention. Duopoly links will remain, with a risk that pricing on those links may not always be affordable, despite competitive pressures on those duopoly providers with NBN aggregating traffic to POIs. Currently, the business case for regional backhaul deployment is difficult. A new backhaul route in a regional area only provides connectivity to local premises at the end of that route, and redundancy may still be required, necessitating the use of third-party links—further undermining the business case for investment. In future, by enabling greater retail competition, the NBN will make the backhaul revenue pool more contestable for a new entrant, potentially increasing the likelihood of entry. Chapter 9 discusses the risk this poses to competitive outcomes for the NBN, and the need to maintain a watching brief on the backhaul market.

6.1.4 ANTICIPATING BACKHAUL TO SUPPORT FIXED-WIRELESS

As we discuss in Chapter 5, in addition to providing transit backhaul links within the fibre footprint, NBN Co should extend fibre backhaul to existing towers and new tower sites needed by the fixed-wireless network operator to provide coverage between the 94th and 97th percentiles of premises. These routes should be operated on an open-access basis and priced using the same mechanism as the transit backhaul network (See Chapter 5).

6.2 Creating a future-proof transit backhaul solution

NBN Co aims to create an enduring platform for long-term industry benefit. In the case of backhaul, this is particularly important because the cost of passive fibre links is high but the incremental cost of capacity through active electronics upgrades is low. Relying on a third party to provide capacity on a commercial basis where limited competition exists is risky for the long-term interests of the industry. In this section, the Implementation Study addresses how NBN Co should ensure backhaul bottlenecks are resolved. Two subsections follow:

6.2.1 Deploying a new backhaul network

6.2.2 Securing rights more efficiently where possible.

6.2.1 DEPLOYING A NEW BACKHAUL NETWORK

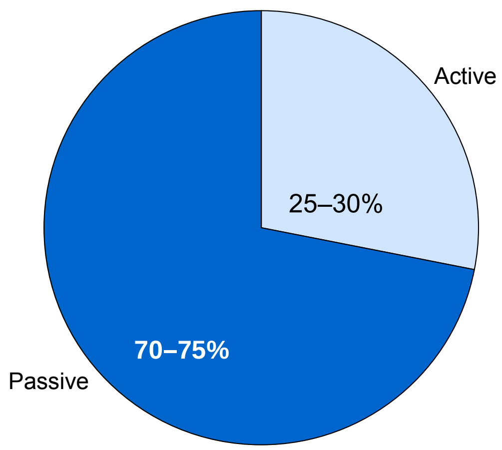
NBN Co should be prepared to build its own backhaul network. However, it should be open to secure long-term rights where they can be procured on an affordable basis from existing service providers. Ownership or rights of use over dark–fibre provides the greatest degree of control over pricing and quality of service, and enables fixed instead of variable costs for NBN Co.

While the logic of an infrastructure-sharing agreement is compelling for NBN Co and for Telstra, it is not assumed in our expenditure modelling. We have modelled an overbuild of approximately 70,000 km of backhaul for an estimated cost of approximately $3.5 billion (Exhibit 6–4).

Exhibit 6–4. Build cost for transit backhaul network of 70,000 km

Cost of transit backhaul network
$ Billions

Total cost = $3.5



SOURCE: Implementation Study

Exhibit 6–5. Approach to estimating backhaul construction costs

Approach to estimating backhaul construction costs

Estimating distance covered

- The assumed inter-exchange network ring in the ACCC LRIC model was used as a starting point for exchanges and geospatial modelling was employed to connect exchange sites in a ring structure with geographical diversity. Links assessed as competitive were then removed to calculate overall distances required to be built
- Where the transit network overlaps with the access network, trench and duct sharing is assumed, reducing cost per metre for those cable runs
- As NBN Co will only provide backhaul in areas with monopoly backhaul today, all non-monopoly backhaul is disregarded in the model. The number of exchanges without multiple DSL providers was used as a proxy for the number of exchanges with monopoly connections today, since competitive backhaul is assumed to coincide with DSL entry by providers other than the incumbent

Unit costs

- Unit costs for the passive and active cost drivers were estimated based on input from technical advisors and vendors
- For passive costs, the per metre cost of deploying fibre is estimated separately for areas with and without overlap with the access network
- Separate estimates of active costs per node were made for aggregation and local nodes, based on input from technical advisors and vendors.

Source: Implementation Study

The approach taken to estimating backhaul construction costs is described in Exhibit 6–5.

Recommendation 48. That NBN Co be required to construct a transit backhaul network to connect all fibre exchanges to the nearest practical point where backhaul services are available from Government (e.g., Regional Backbone Blackspots Program) or multiple providers, not including NBN Co; for fibre exchanges that are already located at a point with multiple backhaul providers or Government backhaul services, NBN Co not to construct transit backhaul links.

6.2.2 SECURING RIGHTS MORE EFFICIENTLY WHERE POSSIBLE

Although the construction of all necessary backhaul links is viable and would provide complete assurance of availability, it would be expensive and economically inefficient since most of the required infrastructure already exists. NBN Co should therefore seek commercial arrangements providing guaranteed access to existing dark fibre, where this is economically preferable to constructing a new network.

Recommendation 49. That NBN Co be directed to construct the transit backhaul network including passive fibre elements and active electronics, except where NBN Co is able to secure long-term indefeasible rights of use (with options to renew) to other parties' fibre assets at the physical layer ('dark fibre') more economically.

6.3 Managing the transit backhaul network to meet evolving market needs

NBN Co will need to manage its backhaul assets to meet the needs of an evolving industry. This will require creating a level national playing field and making backhaul available at an affordable price, while also ensuring policy objectives are supported. We discuss these requirements in the following subsections.

6.3.1 Creating a national level playing field

6.3.2 Providing backhaul at an affordable price

6.3.3 Recognising challenges in privatising backhaul

6.3.4 Providing open access to NBN transit links.

6.3.1 CREATING A NATIONAL LEVEL PLAYING FIELD

To create a national level playing field, NBN Co will need to carefully choose POI locations and design an appropriate transit backhaul product.

Choosing POI locations

NBN Co transit backhaul in the fibre footprint will provide connectivity from fibre exchanges to the nearest point at which multiple backhaul providers are available. Exhibit 6–6 shows three different options that NBN Co may use to achieve this. The POIs for the NBN Co transit backhaul services in each case will be located at the boundary of today's competitive backhaul. fibre exchanges served by multiple backhaul providers will become POIs.

Recommendation 50. That NBN Co be required to offer a single POI in relation to a given premises:

1. At a fibre exchange where there are multiple alternative backhaul providers; or

2. At a fibre exchange linked to the Regional Backbone Blackspots Program; or

3. At a point accessible from the fibre exchange over an NBN Co transit backhaul link.

It would be possible for the NBN Co to further aggregate traffic and offer POIs in capital cities. This would enable smaller providers with limited network footprints, such as ASPs, to connect easily to the NBN at an affordable price. However, this would involve stranding significant lengths of competitive backhaul that have been deployed through healthy market investment and would harm incentives for ongoing investment. It would also be an inefficient use of funds for NBN Co to procure access to backhaul which is already available to service providers at competitive prices.

The competitive benefits of such centralised POIs would be limited. Under the proposed model, NBN Co's customers will have access to backhaul from multiple providers from their POP to the POI that serves their customers. The capital expense of POI connection will be small—significantly lower than today's DSLAM equipment located in exchanges which serve fewer customers than a typical POI. It is true that ASPs lacking network infrastructure will need to purchase IP connectivity from wholesale network service providers. At this time, NBN Co need not intervene to provide such services. The potential dynamics of this market are discussed in Chapter 9.

On a regular basis, the location of POIs should be reviewed to determine if they need to be taken higher or lower in the network. POIs would be taken higher if the presence of multiple backhaul operators did not translate into affordable pricing on selected routes. In other words, NBN Co would overbuild duopoly routes in this instance. POIs would be taken lower where multiple providers were prepared to invest in building backhaul links. In such a case, NBN Co could lease or divest its backhaul links.

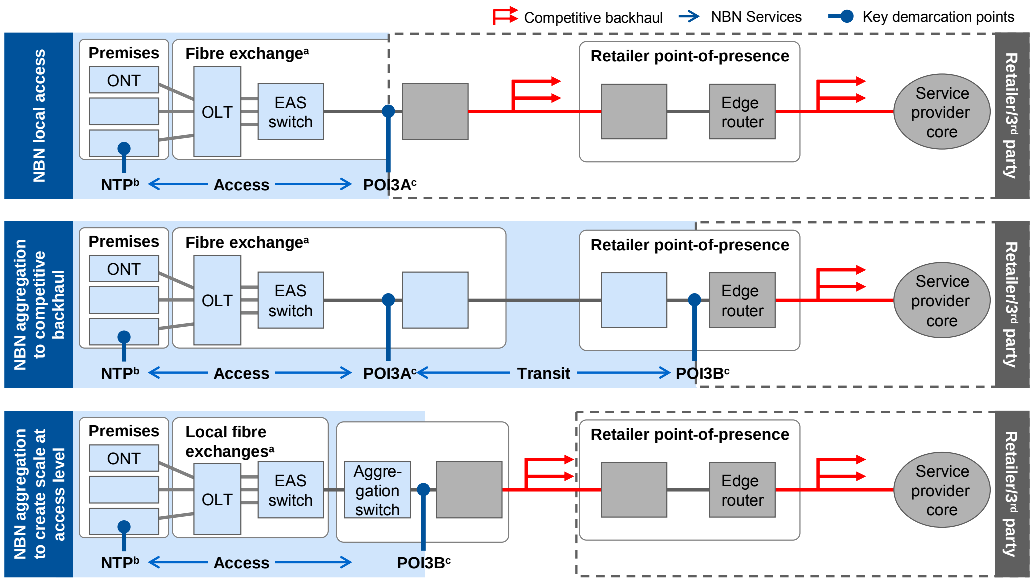
Recommendation 51. That the location of NBN Co's POIs be reviewed on a regular basis to permit new investment below the POIs and to ensure the objectives of affordability and a level playing field are met above the POIs.

Defining the characteristics of the transit backhaul service

The transit backhaul service should have the following features:

- **End-to-end**. The transit backhaul product offered by NBN Co should be an end-to-end product for connection from the POI to the fibre exchange including redundancy for backup. This would be instead of, for example, a point-to-point product on each route. An end-to-end product has two benefits. First, it will minimise the number of products a service provider is required to manage for connection from a POI to a fibre exchange. Second, it will simplify pricing. The product should have redundancy to provide backup in case of, for example, a cable cut. Exhibit 6–7 illustrates the difference between a route-by-route product and an end-to-end product. Note that pricing is purely for the purposes of illustration.
- **Modular.** The NBN access service and transit backhaul should be offered as separate services. This will allow access seekers to choose appropriate backhaul products for their required capacity. It will also allow uniformity of pricing on the access products across the country.

Exhibit 6–6. NBN interconnect options



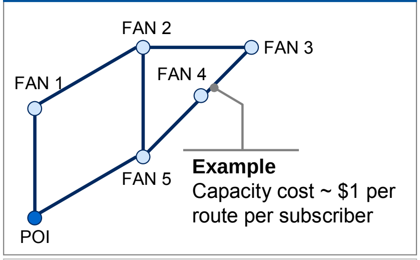
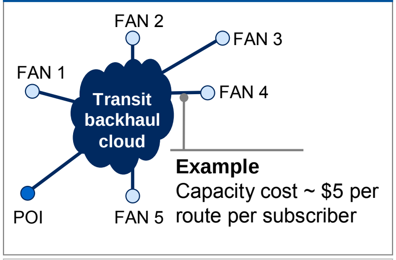
a. Fibre exchange or Fibre Access Node = Physical environment containing OLT, Ethernet switch, patch panels
b. NPT—Network termination point = Port on ONT
c. POI—Point of Interconnect to Access. Note: POI numbers refer to Communications Alliance reference architecture
SOURCE: Adapted from Communications Alliance 2009, *High level architecture options for the NBN*

Where NBN Co offers a transit service, access seekers should not be permitted to connect directly to the fibre exchange. In other words, there is a single POI per premises served. This is despite the NBN transit and access services being offered separately. Direct access to a fibre exchange (i.e. bypass of the NBN Co transit service) would not provide a level competitive playing field. Telstra is the most likely provider to seek this access. Telstra has a nationwide backhaul network, which is a sunk cost and is needed to support wireless services. The cost to Telstra of using the backhaul network for NBN access products is therefore marginal. Therefore, Telstra will have a cost advantage, compared to other access seekers who do not have a nationwide backhaul network, equal to the cost of using NBN transit backhaul—which, depending on pricing, could be in the vicinity of 10 percent of the retail ARPU for typical entry-level services. The ACCC could still require NBN Co to offer access at the fibre exchange to access seekers who have sourced alternative backhaul—although a more likely approach would be to move the entire POI lower in the network.

Exhibit 6–7. Options for transit backhaul product

Prices are illustrative only

Transit backhaul
POI
Fibre exchange (FAN)

	Route-by-route model	'Transit' model
		
Description	▪ NBN Co sells capacity on route by route basis; access seekers buy capacity on entire ring to ensure redundancy	▪ NBN Co sells capacity including redundancy at a flat rate to any fibre exchange within the POI area
Example—connection price from POI to FAN 1	▪ **$4** per user—capacity on routes between FAN POI, FAN 1, FAN 2 and FAN 5 provide redundancy	▪ **$5** per user—end-to-end connection from POI to FAN 1 incl. redundancy is bought at flat rate
Example—connection price from POI to FAN 3	▪ **$6** per user—capacity on all routes provides redundancy except from route between FAN 2 and FAN 5	

SOURCE: Implementation Study

Recommendation 52. That for defining NBN Co's backhaul services:

1. NBN Co be required to offer backhaul services as single Ethernet links from the POI to the fibre exchange, with some level of protection (alternative secondary links in the case of outages on the primary link) available on all links;
2. The transit backhaul bitstream product to be specified as a separate product from the access bitstream product, allowing service providers to select their preferred combination of backhaul capacity and access services;
3. NBN Co not to offer or be required to offer connection below the POI to an NBN Co access network.

Denying Telstra access to the fibre exchange in monopoly areas will effectively strand Telstra backhaul for the purposes of the NBN, if an agreement with Telstra to share this infrastructure is not reached. However, in this case Telstra would still use its backhaul assets to support other services such as mobile. Presumably such an outcome would only arise as a last resort given the strong commercial logic for both Telstra and NBN Co of sharing infrastructure.

6.3.2 PROVIDING BACKHAUL AT AN AFFORDABLE PRICE

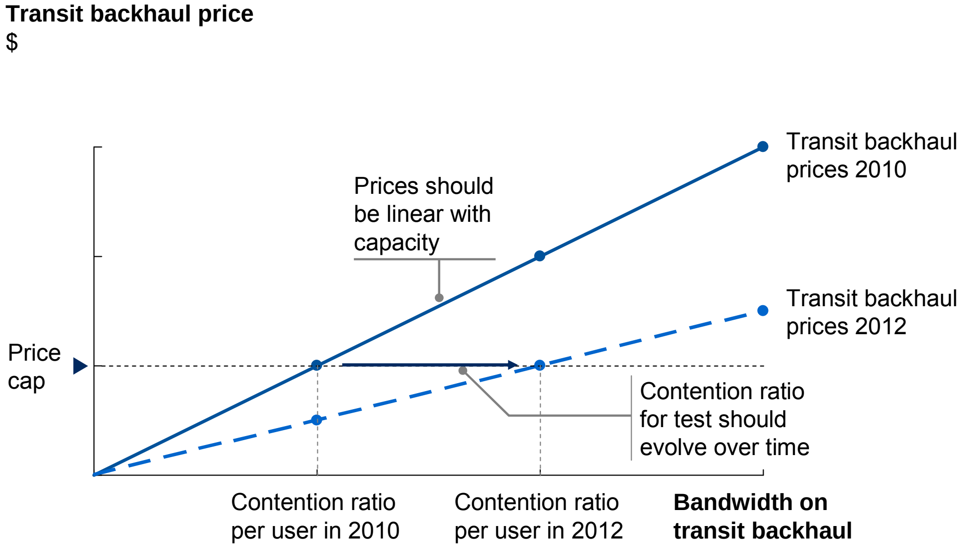
NBN transit backhaul products should meet a simple and measurable affordability test. In some areas, access seekers will only connect to the NBN Co access product through the

NBN Co transit backhaul services. This will provide NBN Co with an effective monopoly on backhaul for users of the NBN for around 20 percent of the country. Therefore, Government should require that NBN Co backhaul prices meet an affordability test set by Government. This is required because affordability of backhaul is important to achieving affordability of retail prices of NBN-enabled services, and ensuring take-up of services in areas without competitive backhaul.

Affordability of access prices should be evaluated on a per user basis as this would establish a transparent price that can be subject to comparison with retail ARPUs. Backhaul is typically sold as bandwidth that is shared by many end-users and a price per user depends on assumptions about an appropriate contention ratio. An affordability test for ‘a reasonable price level’ therefore has to be linked to a defined contention ratio—one that matches leading international standards and evolves with the market.

The transit backhaul product should be offered as a block of bandwidth end-to-end from the POI to the fibre exchange. Service providers can match the amount of bandwidth to the number of subscribers and the desired contention ratio. Link capacity should be priced in a linear fashion (Exhibit 6–8)—a 100 Gbps link should cost 10 times a 10 Gbps link. The linear scaling is important to avoid distorting the market and creating a disproportionate scale advantage for large providers. The linear pricing on bandwidth will also incentivise NBN Co to sell as much bandwidth as possible and upgrade active electronics to increase the revenue pool on transit backhaul.

Exhibit 6–8. Contention ratio for affordability test should be allowed to evolve



SOURCE: Implementation Study

Recommendation 53. That NBN Co be required to specify transit products to meet an affordability test; specifically:

1. That the price of transit backhaul services attributable to a single premises' access service be not more than a certain percentage of the retail price of a typical entry-level NBN wholesale broadband product;
2. That Government define the percentage, preferably not more than 10 percent; the transit backhaul service be defined from the POI to the fibre exchange, on a per-user basis, given a defined contention ratio;
3. That NBN Co be required to set a minimum contention ratio based on international benchmarks, and to review it annually based on ongoing monitoring of customer experience and observed network performance;
4. That the NBN Co transit backhaul prices scale linearly with bandwidth for contention ratios higher than the one used in the affordability test.

The price points in the affordability test should be determined by Government. This is a policy decision as the transit price drives the difference in price between regional and metro areas. It also requires a trade-off between consumer affordability and the commerciality of the NBN backhaul network. Our estimate is that a price less than 15 percent of wholesale ARPU—less than $4.50 for a $30 wholesale service—will be required to achieve affordability for all geographies. This would equate to approximately 10 percent of an expected entry-level retail broadband service. At this level, most retailers would be expected to absorb the difference and offer consistent pricing nationally. At 20 percent of the retail price, it would be difficult to have consistent retail prices and be profitable in regional areas—leading to less retail participation, lower end-user take-up and lower NBN Co revenue.

Service providers will need a minimum number of subscribers in a fibre exchange to receive the price determined by the affordability test. This is because backhaul is sold in blocks of bandwidth rather than on a per-subscriber basis. In the present DSL market, ISPs use 150–200 subscribers as a rule of thumb[162] for when it is commercially viable to enter an exchange, when affordable backhaul is available. NBN Co should strive to make backhaul viable for ISPs with around 100 subscribers. Small fibre exchanges in the NBN will serve approximately 1,000 premises, so this would translate to a target take-up in small exchanges of around 10 percent.

Highlight. The minimum unit of transit backhaul connectivity should be economically viable for a small service provider. Given the current DSL market threshold for DSLAM deployment of around 150–200 subscribers, the NBN Co should strive to make backhaul viable for around 100 subscribers. Based on a potential 20 Mbps residential service at 30:1 contention, this principle would suggest NBN Co offer the option of a 100 Mbps link rather than starting at a higher link capacity (this is referring to bitstream speed, not physical interface).

Note that in any case, the retailer is still free to determine the contention ratio and to purchase from NBN Co any dedicated or QoS bandwidth for the delivery of premium services. This pricing policy is intended to ensure that best-efforts Internet-grade connectivity can be provided to end-users at an affordable price.

6.3.3 RECOGNISING CHALLENGES IN PRIVATISING BACKHAUL

While Government has expressed a commitment to privatise NBN Co, privatising the backhaul assets will be problematic. The NBN backhaul will have strong natural monopoly characteristics and is unlikely ever to face competition on most links in either the active or the passive part of the network. In Chapter 10, we recommend an independent review of competition prior to privatisation. This review should start with a presumption not to privatise backhaul, but the flexibility to define an acceptable privatisation approach.

We considered several options for privatisation (Exhibit 6–9), but each has challenging issues. The privatisation of the passive fibre, based on an agreed lease payment for exclusive use of that dark fibre, is plausible, but is essentially a form of capital management rather than true privatisation. However, operational management can be outsourced through competitive tenders to improve the operating efficiency of the assets.

Not expecting to privatise the backhaul assets has implications for how ownership of the backhaul links being constructed under the Regional Backbone Blackspots Program may transition. It has been contemplated that ownership of these links would transition to NBN Co at the relevant time in the life of the contract. However, it makes more sense for them to remain owned directly by Government until the full independent competition review is undertaken. This would not preclude NBN Co from taking over operational responsibility.

NBN Co should manage the backhaul assets during the roll-out of the network. This would provide efficiency gains from rolling out the access and backhaul network in parallel, such as combined planning of fibre routes, sharing of trenches, etc. Operation of the government-owned backhaul can eventually be outsourced through competitive tenders. With strict SLAs, this option could optimise operations while ensuring high service standards. However, gains from this option are likely to be small given the typically low ongoing operational costs of backhaul links.

Exhibit 6–9. Options for privatising backhaul

Privatised part of backhaul	Privatisation issues
Passive and active layers	■ High backhaul prices likely if privatised due to strong integrated monopoly or duopoly ownership in a market that is difficult to regulate ■ Low quality of service in regional areas because competitive pressure to upgrade active equipment over time will be low. Upgrades are hard to force on a private entity.
Active layer alone	■ High prices in remote areas due to limited competition as the revenue pool is too small to support multiple providers of active equipment. A large variation in prices for active layer services would run counter to Government's affordability policy. ■ Low quality of service in remote areas because competitive pressure to upgrade active equipment over time will be low. Upgrades are hard to force on a private entity.
Passive layer alone	■ Possible, but risk of future increases in dark fibre costs for NBN Co ■ If objective is capital return to Government, backhaul assets could simply assume debt in line with very stable cash flows—no need for equity sale ■ No benefits for upgrade and no competition on active equipment as only passive part is privatised.

Source: Implementation Study

Exhibit 6–10. Economics of NBN backhaul

Economics of NBN backhaul
Investment in backhaul assets within the fibre footprint is not expected to provide a commercial return and should be seen as a Government investment to provide future telecommunication services to regions at an affordable price. Revenue will roughly cover the operational cost on the backhaul assets and the depreciation and interest on the investment in the active equipment. It will not contribute significantly to interest or depreciation of investment in the passive infrastructure. **Revenue.** NBN Co's revenue from the transit backhaul network will be determined by the transit backhaul ARPU (assumed to be $4 per month) and the number of premises with a fibre connection needing transit backhaul (assumed to be 20 percent). Revenue will slowly ramp up as the NBN is being rolled out and take-up of NBN-enabled services increases. The transit backhaul revenue from NBN services is estimated to be in the order of $100 million after full roll out of the NBN. NBN Co will have additional upside from providing backhaul to competing access technologies. However, NBN Co will compete with Telstra for this revenue. **Cost.** Cost of providing backhaul arises from the operational cost and the cost of capital and depreciation associated with investment in active and passive infrastructure. Operational cost of the passive infrastructure is negligible. The depreciation of the investment depends on the lifetime of the assets. The lifetime of the active equipment is expected to be in the order of 8 years. Lifetime for fibre infrastructure is likely to be greater than 40 years, but for modelling purposes it is been assumed to be 40 years.

Source: Implementation Study

The backhaul investment should be seen as a Government investment to provide future telecommunications services to regions at an affordable price. Exhibit 6–10 describes the economics of NBN backhaul if it were built. Revenue will roughly cover the operational cost of providing transit backhaul. However, it will not be enough to achieve a commercial rate of return due to the large investment in passive infrastructure.

6.3.4 PROVIDING OPEN ACCESS TO NBN TRANSIT LINKS

Once the backhaul network is in place, there is an opportunity to create value by enabling other access networks—for example, mobile providers, or WiMAX ISP operators—to access backhaul. This section proposes requirements for opening up NBN backhaul to provide backhaul services for all access technologies on an equivalent basis.

There is no commercial or technical reason why wireless and other access networks could not use the NBN backhaul as a transmission network. The NBN transit backhaul product should be a separate product from the access products (Subsection 6.1.3) and the product should be priced separately. An access seeker could therefore buy this service alone, if NBN Co permits. Denial of standalone transit backhaul services to providers of other access networks (e.g. mobile operators) would permit NBN Co to operate in a vertically-integrated way and protect its access network. Instead, backhaul is best managed as a standalone public utility. The bias for the backhaul assets to be structurally separated from NBN Co prior to privatisation and to remain in Government hands is consistent with this characterisation of backhaul as a public utility.

The impact of providing open access to the transit backhaul product on NBN Co's financial performance is expected to be limited over the long term. Mobile services are expected to be complementary to fixed broadband. As we discuss in Section 4.4. Telstra already has backhaul links everywhere in Australia, so NBN Co will face competition from DSL in the near term. Therefore, in the long-run, NBN Co should offer open access to the backhaul network to stimulate competition on all access technologies, not only on FTTP.

In the more immediate term, there are practical reasons why Government may choose to not make transit backhaul available to other network owners. This includes the operational complexity of forecasting unpredictable demand from alternative networks and the commercial imperative to drive early take-up of NBN services. Accordingly, some temporary relief for NBN Co to not be required to offer standalone transit backhaul could be appropriate. The effect of such temporary relief on wireless operators should be small given NBN Co is required to provide access services on a commercial basis—requiring transit services to be sold with access services below POIs. Clearly, such temporary relief would not be relevant to NBN Co's transit backhaul links to serve the 94th to 97th percentiles beyond the fibre footprint.

A final point to emphasise—the intention to allow transit backhaul products to be sold separately from access products should not be confused with an intention to allow connection to a fibre exchange below a transit link. In other words, for NBN Co's access network, the location of POIs should be determined by whether multiple alternative backhaul providers exist and connection below a POI should not be permitted.

Recommendation 54. That NBN Co be required to provide transit backhaul services to alternative network operators, specifically:

1. That such transit backhaul services be offered on equivalent terms to those offered to customers of its own access network;
2. That NBN Co provide a point of interconnect for the transit backhaul service in the fibre exchange environment (but not the access service if not at a POI) and access seekers be responsible for all costs of reaching and entering the fibre exchange environment to meet this point of interconnect;
3. That the Minister consider granting temporary relief from this requirement, but not in relation to backhaul services necessary to enable the provision of wireless broadband services beyond the fibre footprint, once it is defined.

B Creating sustainable commercial arrangements

Government policy is to set up NBN Co as a commercial entity, operating with commercial incentives and funded, to the extent possible, with private capital. This policy can be implemented over the life of the NBN. However, in the initial years NBN Co should be funded with Government equity to preserve policy flexibility and to avoid diluting the returns Government could earn over time.

Based on detailed cost modelling by the Implementation Study, even at the higher end of the plausible range of cost estimates, the coverage solution recommended in Part A can be realised within Government's original $43 billion capital expenditure estimate.

The projected internal rate of return (IRR) on the investment in NBN Co exceeds the assumed Government bond rate of 6 percent under most reasonable assumptions for cost and revenue, and where returns are lower, Government and NBN Co have a number of options to improve returns over time.

Government should fund NBN Co solely with equity investments until NBN Co can raise its own investment-grade debt and pay interest from its own earnings. Private equity should not be introduced at least until the network roll-out is complete. To do so any earlier will be too expensive and constrain Government's ability to establish the right policy and regulatory settings. It will also lead to substantial distraction for management around the equity transactions concerned. This applies to both cash injections and any proposals to vend in assets in return for equity.

When fully established, NBN Co could be attractive to a wide range of potential investors, but will be a large and complicated business to privatise. Government should preserve flexibility in both the timing and nature of privatisation to avoid diluting its return and to stay true to its coverage and competition policy objectives. Overall returns to Government are sensitive to the size of the exit multiple and the timing of privatisation. Alternatives to a traditional privatisation may also emerge such as taking on high levels of commercial debt to reduce Government's equity investment through dividends and/or capital returns.

NBN Co needs to have certainty of funding to engage confidently with suppliers and customers. Government can provide this certainty with a formal funding agreement. As an additional source of funding certainty, Government could also use or replicate the Building Australia Fund arrangements, which would suit the context of the NBN in several ways. It would enable Government to match funding to NBN Co's needs and performance and adapt it over time. Longer-term it would be positive for funding transparency and certainty.

Part B consists of two chapters:

- Chapter 7 integrates cost and revenue estimates from Part A and examines the overall returns for the NBN project under different scenarios
- Chapter 8 presents recommendations on the funding model over time, given the nature of the NBN project and the returns under different scenarios.

7 Presenting an integrated business case

SUMMARY

- Detailed cost modelling by the Implementation Study indicates the NBN can be built for approximately $43 billion in capital costs under conservative estimates. Infrastructure sharing agreements with existing service providers could reduce this amount.
- Post-construction, NBN Co will have strong free cash flows and margins, with a very high EBITDA margin estimated at 75 percent.
- Under most plausible scenarios, NBN Co will generate returns in excess of Government's cost of borrowing. If a lower-return scenario starts to emerge, NBN Co can use the repetitive nature of the project to drive efficiencies, or Government can be more flexible on policy settings to improve the expected return.
- Government can reduce risk around the cost of the network build by creating powers and immunities for NBN Co to access facilities, deploy infrastructure and obtain information about infrastructure that could potentially be shared.

Government has stated an objective to build the NBN on a commercial basis, attract private sector funding during construction and to privatise it eventually. This chapter integrates the analysis of build costs and revenues from Chapters 4–6, and presents the business case for NBN Co, in 3 sections:

7.1 Confirming the feasibility of building the NBN for $43 billion in capital costs

7.2 Integrating build costs with ongoing revenues and expenditure

7.3 Managing the business case under different scenarios.

7.1 Confirming the feasibility of building the NBN for $43 billion in capital costs

The Implementation Study's detailed cost modelling estimates that the NBN can be built for $42.8 billion in capital costs. Exhibit 7–1 compares the initial Government estimate (in nominal dollars in the year of expenditure) of $43 billion with the Implementation Study's estimate. The right hand side reflects the Implementation Study's recommended solution —that is:

- Fibre to 93 percent of premises;
- A next-generation fixed-wireless service for premises in the 94th to 97th percentiles;
- A next-generation satellite service for those in remote areas who cannot or choose not to take a fixed-wireless or commercially-available mobile broadband product.

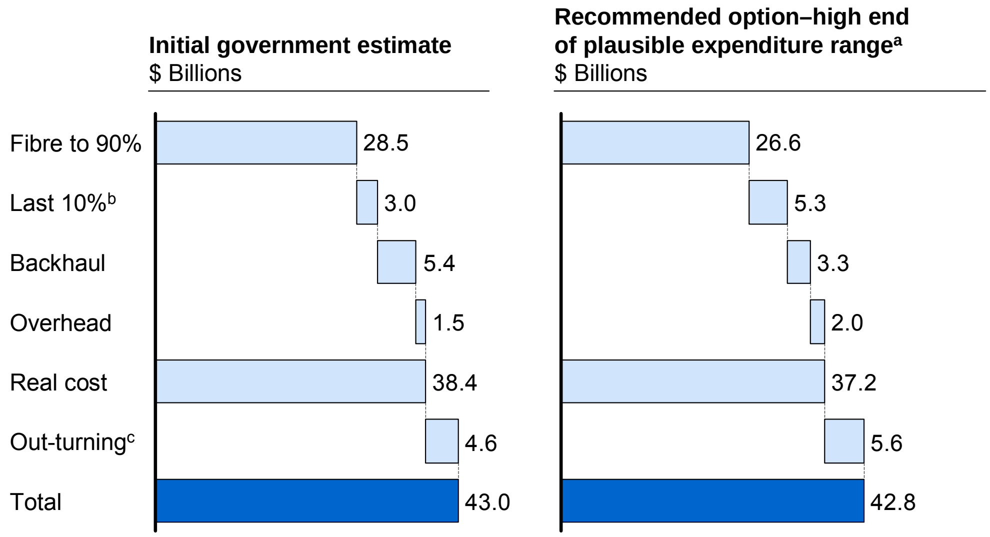
The Implementation Study takes a conservative approach to estimating costs and revenue, which will be detailed throughout this chapter. The costs in Exhibit 7–1 are at the higher end of the plausible capital expenditure range, and assume minimal use of existing telecommunications infrastructure.

This section contains a synthesis of our cost modelling as follows:

7.1.1 Estimating the cost of the NBN

7.1.2 Understanding major cost sensitivities.

Exhibit 7–1. Estimated cost to build the NBN



a. Cost assumptions are for the 'High-end of the plausible range' scenario.
Technology assumptions: 50% of the Fibre Access Network uses a Home Run topology; 50% uses a shared feeder with distributed splitter cabinets; Wireless network uses 2.3GHz spectrum and LTE technology; Satellite transitions to Ka Band.
b. Fibre from 90 to 93% is included in last 10%.
c. Conversion from real to nominal expenditure, using a nominal inflation rate of 2.5%
SOURCE: Implementation Study

7.1.1 ESTIMATING THE COST OF THE NBN

The Implementation Study models a range of cost scenarios because there is necessarily some uncertainty about the final cost to build the NBN. A point estimate, or a point estimate plus a flat percentage for contingency, can be misleading. This chapter shows the impact of 4 scenarios:

- The higher end of the plausible range (illustrated in Exhibit 7–1 above);
- The lower end of the plausible range;
- A blowout in fibre deployment costs;
- A reasonable sharing of infrastructure.

The first three scenarios assume minimal sharing of existing telecommunications infrastructure. Specifically, all backhaul links without two competitors are overbuilt, all exchanges are built rather than leased, and the deployment is a combination of aerial and new trenching—only a minimal portion of ducts are leased at current market prices. Reasonable sharing of telecommunications infrastructure could reduce the headline build cost by $5 billion or more, although the impact on NBN Co’s net present value will be less than this because the reduction in capital cost to build would be partially offset by an annual lease cost or a capitalised payment upfront. An agreement to share infrastructure would only be struck on terms which increase the net present value of NBN Co and would therefore increase the expected rate of return.

This chapter uses the higher end of our plausible range as a reference point, and shows the impact of various scenarios relative to this reference point. The next chapter, on funding, also uses these costs, combined with a mid-case revenue scenario, as the Funding Reference Scenario for ease of exposition, not because we consider that particular scenario to be the most likely.

Connecting 90 percent of premises with FTTP

The primary drivers of the cost of the fibre network are distance and the density of premises. These drive the civil works which are around 70 percent of the total build cost. Section 4.3 explains our modelling of the fibre access network in detail. The key points to recap are:

- The Implementation Study has modelled a mixed topology, with 50 percent of premises served by exchanges using a home-run topology, and 50 percent served by a shared topology where a single feeder is split into multiple distribution fibres in a street cabinet located in the field. In the latter case, this includes provisioning some home-run fibres to schools, hospitals, and other government or enterprise premises. The Implementation Study estimates deploying a pure home-run topology across the entire network would add up to $3 billion to deploying a mostly shared topology across the entire network. The premium to serve an exchange area with a home-run topology will vary by exchange. Modelling suggests 50 percent of exchanges could be served for around one-third of the nation-wide premium, and this is included in all the cost estimates presented. These cost estimates should be confirmed by NBN Co's in-field deployments to refine the actual cost premium and mix of topologies to be deployed.

- The coverage objective is measured against the number of premises in existence at the end of roll-out. New premises that are built during the roll-out are included, increasing the number of premises NBN Co needs to serve. Greenfield estates are assumed to be served by fibre, and brownfields are assumed to be distributed uniformly and hence served by the same mix of technologies as existing premises.[163]
- The Implementation Study used detailed geospatial modelling to calculate distances and densities covering the entire country. It modelled every address and street in Australia, down to the level of counting the number of fibres that would pass through each street (rather than using a sampling approach).
- Unit cost estimates are based on analysing local and international deployment experience where available, and calibrating for Australia via extensive consultation with industry vendors, network operators, and technical consultants. Field surveys were undertaken to ascertain the likely costs of civil works across regions with different geographical characteristics. A leading industry contractor was retained specifically to advise on cost assumptions.

Assuming a unilateral build, the Implementation Study estimates the higher end of the plausible range at $26.6 billion to build the fibre access network to pass 90 percent of premises, before out-turning. This includes the installation of the drop cable and ONT to all activated premises.

Covering the last 10 percent with a combination of fibre, wireless and satellite

The recommended solution for the last 10 percent comprises a mix of three different technologies. Sections 5.2, 5.3 and 5.4 explain the Implementation Study's modelling of the cost of each of these technologies in detail. The key points to recap are:

- Fibre can be extended to 93 percent of premises before the cost begins to accelerate significantly such that the cost relative to wireless or satellite becomes very high.

[163] Greenfield and brownfield sites are defined in Subsection 2.1.4. Greenfields are parcels of land where urban development is occurring for the first time. Brownfield sites are already covered by telecommunications distribution—although this may currently serve the block rather than every subdivision

- Satellite and wireless are both shared media, with relatively low throughput compared to what is achievable on fibre. Nevertheless, Government's objective of providing at least 12 Mbps is a step-change in performance relative to today. This speed objective is the biggest driver of the cost of non-fibre technologies as it translates directly into infrastructure expenditure.
- The other major drivers of the cost of satellite are the number of satellites required and the number of subscribers taking a satellite service. Two satellites are required, given the possibility that one could fail and a 3–4 year lead time for replacement. Each satellite subscriber requires around $2,000 in customer premises equipment including installation.
- The major drivers of the cost of a fixed-wireless network are the number of towers required to provide the required service level (which depends on the spectrum available), the number of existing towers which can be leased, the length and type of backhaul provided, and the number of subscribers.

In total, the Implementation Study estimates the cost of the recommended solution for the final 10 percent of premises (comprising fibre from the 90th to the 93rd percentiles, a fixed-wireless service from the 94th to the 97th percentiles and a next-generation satellite service) to be $5.3 billion.[164] This includes installation of drop cables and ONTs, fixed-wireless antennas and modems, and satellite dishes and modems.

Estimating the cost of transit backhaul

Transit backhaul is required between fibre exchanges and Points of Interconnect (POIs) where the exchange is not served by competitive backhaul. Subsection 6.2.1 summarises the modelling of the transit backhaul network. The key points to recap are:

- The Implementation Study calculates a unilateral build, with upside potential if an agreement to use Telstra's passive backhaul infrastructure can be reached on reasonable terms. The commercial logic for both NBN Co and for Telstra to share dark fibre on reasonable terms is compelling. An agreement would reduce NBN Co's capital expenditure significantly.
- Distance is the primary driver of passive infrastructure costs. Geospatial modelling was used to calculate that NBN Co would need to overbuild around 70,000 km of backhaul fibre if infrastructure sharing does not occur (this includes the 6,000 km Regional Backbone Blackspots Program).
- Expected traffic and provisioning is the biggest driver of active equipment costs.

164 The costs of each technology used in the final 10 percent are reported in aggregate (rather than as three separate components) due to commercial sensitivities.

The Implementation Study estimates the cost of transit backhaul to serve the fibre access network at $3.3 billion.

Adding the cost of overhead

NBN Co will incur significant overhead costs to deploy the NBN, including network designers, project managers, procurement specialists and contract managers. There are a range of operating models NBN Co could adopt, from a fully outsourced model to developing the capability to perform all this work in-house. An operating model that has a mix of outsourcing and in-house capability is assumed, but this should not be interpreted as a recommendation to NBN Co.

The Implementation Study estimates around 1,000 NBN Co employees will be employed during the roll-out phase to perform tasks like those described above. In addition, a fee of approximately 3 percent of civil engineering costs is paid to third parties to manage part of the construction process. In aggregate, this sums to $2.0 billion in capital costs during the roll-out phase. This reflects figures cited in industry consultations.

Incorporating real and nominal price movements

Real price movements are increases or decreases in the cost of labour and equipment above or below the general level of inflation. For example, construction labour costs have grown ahead of the consumer price index since 1997,[165] while the cost of active electronics has declined.[166] Nine different real price inflators or deflators are modelled, including construction labour; information, media and telecommunications labour; active equipment; fibre; and power (electricity).

Government typically reports planned expenditure as the nominal value in the year it will be incurred. This is known as out-turning. All costs are converted from real to nominal costs, using a general inflation rate of 2.5 percent per annum. This is in the middle of the Reserve Bank of Australia's target inflation range of 2–3 percent, and aligns with Government forecasts.[167]

The out-turning adjustment in the Implementation Study's analysis is $5.6 billion. This is higher than Government's initial estimate due to differences in the timing of costs being incurred, based on the Implementation Study's granular analysis of expected network roll-out and take-up.

[165] ABS 2009, *Labour Price Index, Australia, December 2009,* cat. no. 6345.0, Canberra

[166] iSuppli data, 1998–2007

[167] The 2009–10 Mid-Year Economic and Fiscal Outlook (MYEFO) forecasts headline inflation of 2¼ percent for 2010–11 to 2012–13 and then 2½ percent thereafter. We have used a headline inflation rate of 2½ percent throughout

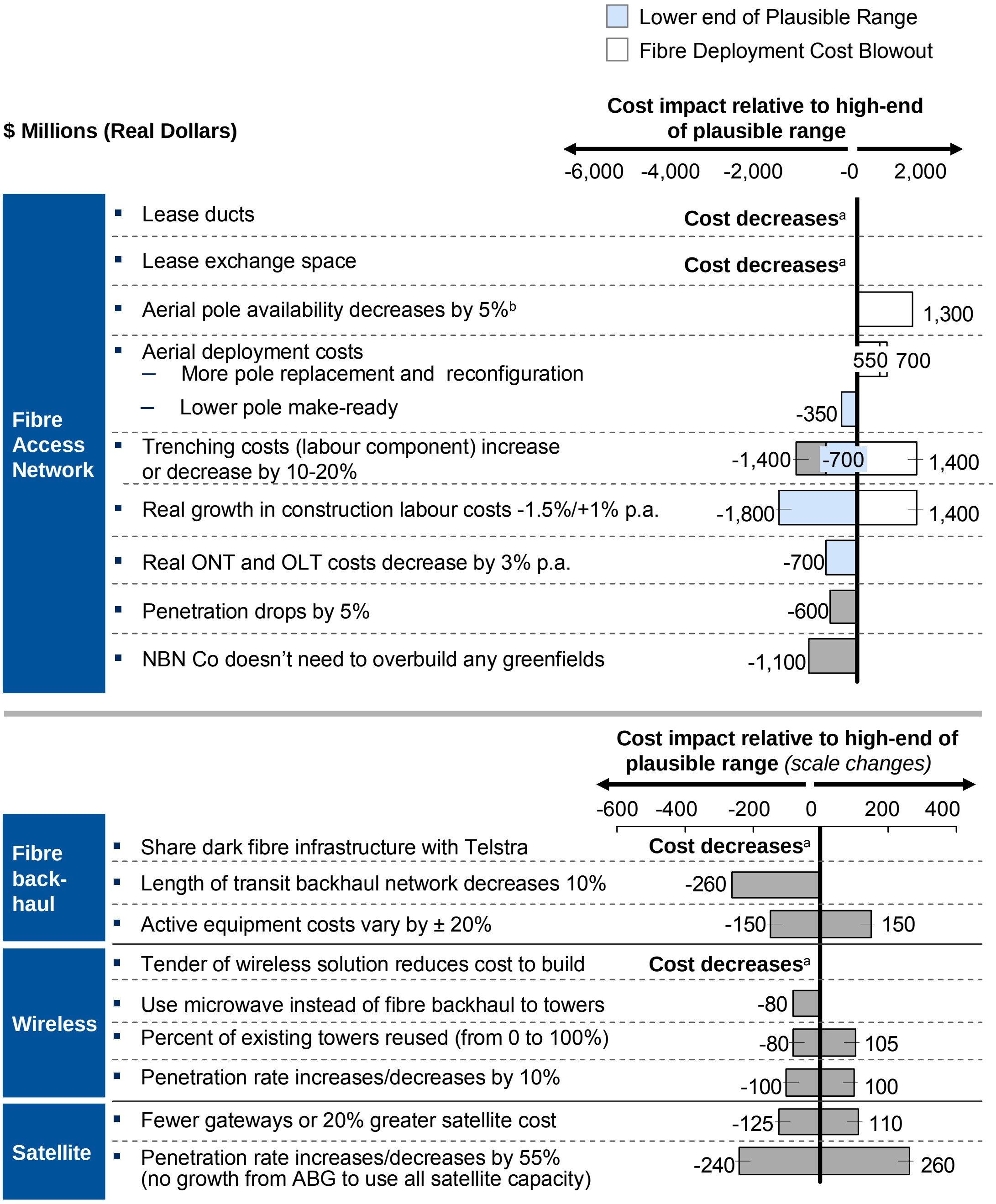
7.1.2 UNDERSTANDING MAJOR COST SENSITIVITIES

A cost to build of $42.8 billion is at the higher end of the plausible range of cost estimates, but is a reasonable reference point for Government to plan for funding and understand likely cash flows given the scale and unprecedented nature of the NBN initiative. It is a conservative number, for five reasons:

- **It calculates a minimal reuse of existing telecommunications infrastructure**, especially ducts, pits, exchange space and backhaul. As stated above, reasonable infrastructure sharing could reduce the build cost by $5 billion or more (although some of this reduction would be offset in value terms by higher ongoing operating costs or a capitalised upfront payment to use the infrastructure). Similarly in estimating the costs of a fixed-wireless network, conservative existing tower reuse assumptions were made.
- **It applies deflators and inflators conservatively.** It assumes NBN Co will incur real growth in construction labour costs in line with historical wage data, and not drive productivity improvements to keep real labour costs constant. The real cost of active electronics has decreased steadily over time, but is assumed to remain constant. There will be upgrades of active equipment which improve network performance over time, and we have assumed this fully offsets any real cost declines;
- **It assumes no scale benefits in procurement** of either active electronics or the civil works to deploy the fibre network. The magnitude of the NBN roll-out means substantial savings could be feasible.
- **It applies network parameters conservatively** in geospatial modelling, especially the rule that a fibre exchange serves a maximum of 30,000 premises. This translates to 2,000 fibre exchanges to serve 93 percent of premises, and this could be reduced by at least one-third and possibly much more.
- **The network modelling does not optimise for the cost of backhaul** when drawing the fibre footprint. Combined with the large number of premises on the fringe of the fibre network, there are some degrees of freedom for NBN Co to choose an alternative, lower cost footprint.

Exhibit 7–2 shows the major construction cost sensitivities for the NBN, shown as cost increases or decreases relative to the higher end of the plausible range. The blue-shaded bars represent the 'lower end of the plausible range' scenario. The cost increases in white are part of a 'fibre deployment cost blowout' scenario. The grey-shaded bars are not part of any specific cost scenario, although a drop in penetration does reduce build costs as well as revenue. A 'reasonable sharing of infrastructure' could have the most significant impact on construction costs, but this is commercially sensitive. These scenarios are integrated with different revenue scenarios in Section 7.3 to estimate the project rate of return.

Exhibit 7–2. Build cost sensitivities



a Commercially sensitive: subject to negotiation with infrastructure owners or tender
b Impact on capital expenditure to build network; not NPV impact including changes in lease costs
SOURCE: Implementation Study

The potential variation in costs differs between cost components. Fibre for access networks is essentially a commodity, as are many of the active electronics, such as OLTs and ONTs. By contrast, there is some uncertainty about the mix and cost of different trenching techniques, so a sizeable range is shown.

There is likely to be some correlation between different sensitivities: for example, an increase in aerial deployment costs due to real wage growth is likely to coincide with a similar increase in trenching costs. Some sensitivities can have a compounding effect—for example, if aerial availability decreases (forcing more of the deployment underground) and per-metre trenching costs rise, then fibre deployment costs could blowout. The figures in Exhibit 7–2 show a unilateral variation. These sensitivities are combined into coherent scenarios, and compounding effects are taken into account in the scenarios described below, which are then combined with revenue sensitivities in Section 7.3.

Impact of different cost scenarios

Fibre deployment cost blowout

Four sensitivities are combined to model a blowout in deployment costs. First, aerial pole availability is reduced by assuming 5 percent of poles are unavailable due to impeding infrastructure (in addition to the 5 percent estimated at the higher end of the plausible range). This decreases the percentage of distribution deployed aerially by 10 percent (because the loss of one pole requires an underground deployment covering twice the span). Second, aerial deployment costs for the poles that can be deployed are assumed to increase substantially (well above the range cited in industry consultations). Third, trenching costs are assumed to increase by 20 percent, which could only occur if the proportion of rock and the impact on the mix of trenching techniques of existing underground infrastructure was substantially higher than industry experts estimate. Fourth, we have compounded these increases by overlaying an ongoing real increase in construction labour costs. The largest single-year real increase in the construction labour cost series since 1997 was 3 percent (with a 12-year average of 1.5 percent). The blowout scenario assumes a 2.5 percent real increase every year, and applies this to wireless and satellite construction labour costs as well.

These effects compound into a larger overhead cost and an increase in the out-turning effect. In sum, this is a very pessimistic scenario, and would increase construction costs by around $6 billion.

Lower end of the plausible range

A more realistic scenario is a reduction in build costs. Four sensitivities are combined. First, the cost of pole make-ready is reduced. Second, trenching costs are reduced by 10 percent. In both cases, the lower estimates align with many industry estimates of a large-scale roll-out. Third, real growth in construction labour costs is held flat, assuming ongoing productivity gains offset real wage cost pressures. In the US, Verizon and other, smaller roll-outs have realised substantial productivity gains over time.[168] Finally, a real decrease of 3 percent per annum in the cost of active electronics is modelled, which is a conservative assumption relative to historic price declines to date.[169] Combined, these effects reduce the build costs by over $4 billion.

Reasonable infrastructure sharing

This scenario assumes a reasonable degree of infrastructure sharing—on ducts and backhaul—on terms that are favourable to NBN Co, but not markedly so. These assumptions are commercial-in-confidence.

[168] Bernstein Research 2008 *Verizon (VZ): Project FiOS;* CMSG 2009, *FTTH Deployment Assessment.*

[169] Decrease of 9 percent per annum from 1997-2008, iSuppli

7.2 Integrating build costs with ongoing revenues and expenditure

Like any telecommunications network build, upfront capital expenditure is substantial, but EBITDA margins and operating free cash flow to the company are high. By 2022–23, EBITDA margins are expected to be 75 percent or more, and free cash flow between $2.0–2.4 billion in today's dollars.[170]

The next two subsections synthesise the Implementation Study's perspectives on revenue operating costs and recurring capital expenditure:

7.2.1 Integrating sources of revenue

7.2.2 Estimating ongoing expenditure.

7.2.1 INTEGRATING SOURCES OF REVENUE

Exhibit 7–3 summarises the sources of revenue for NBN Co under different scenarios. It excludes any migration incentives, as the impact of these is negligible by 2022–23.

Exhibit 7–3. NBN Co sources of revenue

Revenue scenario	Revenue 2022–23, $billion real
FIBRE REVENUE SCENARIOS	**3.9–4.8**
1. Higher demand	4.8
2. Mid-case demand, higher price	4.4
3. Mid-case demand, lower price	4.2
4. Lower demand	3.9
OTHER SOURCES OF REVENUE[a]	**0.2**
TOTAL	**4.1–5.0**

a. Transit Backhaul, Wireless, Satellite

Source: Implementation Study

170 Free cash flow to the firm defined as EBITDA less Tax, less Replacement Capital less changes in working capital. These figures are based on the middle four boxes in Exhibit 7–4, which illustrates the impact of different cost scenarios

Incorporating fibre revenue

The fibre access network is expected to deliver 95 percent of NBN Co's revenue. The modelling of fibre revenue is explained in Section 3.4. The key points to recap are:

- NBN Co offers service providers a clear value proposition—the ability to deliver superior services at current prices. The indifference point for a service provider to use fibre over copper informs pricing, take-up and penetration assumptions.
- The revenue scenarios have three levels of demand for total fixed-line broadband (70, 80 and 90 percent penetration) and two reference prices, a $30 entry-level wholesale price from NBN Co and a $35 entry-level wholesale price.
- While benefits will accrue to the broader economy as broadband-based innovations emerge, the Implementation Study takes a conservative view of NBN Co's ability to capture a share of these benefits in revenue terms, and has not incorporated any additional revenue from new services or applications.
- A one percent real increase in price over time, which is a combination of a mix shift to premium service offerings and a real increase in the price of the basic service offering, is modelled. The latter would be subject to approval by the regulator and would remain within an overall cap on NBN Co's returns.
- A $300 per premises migration payment included. This has been treated as negative revenue.
- Unbundling is assumed to occur after 2022 across around one half of the network, with new providers at the active layer gaining national market share of approximately 20 percent.
- No provision has been included for any revenue from provision of an RF overlay service.

Incorporating non-fibre revenue

The other sources of revenue are small relative to fibre, and are addressed in Chapters 5 (wireless and satellite) and 6 (backhaul). To recap:

- Penetration for fixed-wireless and satellite is modelled for each percentile beyond the fibre footprint. In the lower percentiles, competition from mobile broadband products is expected to be strong, resulting in lower market share than in the last percentiles where satellite is expected to offer a clearly differentiated service
- The wholesale ARPU for both satellite and fixed-wireless is around $25, both of which are a weighted average across basic and premium products
- Backhaul revenue assumes that 20 percent of premises activated with FTTP use NBN Co transit backhaul, and NBN Co earns $4 per month from these premises.

7.2.2 ESTIMATING ONGOING EXPENDITURE

Estimating Operating expenditure

Operating expenditure is expected to reach around $1 billion per annum by 2022–23, in real terms. Depending on the trade-off made between capex and opex, around 35 percent is for lease costs, and 65 percent is for network maintenance, personnel and other expenditure.

Lease costs

The major lease costs are the land on which exchanges are built and ducts—the 'higher end of the plausible range' scenario assumes 20 percent of feeder is deployed in existing ducts, and NBN Co pays current commercial rates of $7 per metre per annum.

Leasing land for new wireless towers and space on existing towers costs around $25 million per annum.

Network maintenance, personnel and other expenditure

Network operations and maintenance costs are significantly lower for an FTTP network than a copper or FTTN network. These costs have been estimated using publicly available data from BT Openreach and Verizon. BT Openreach data is used to estimate the network operations and maintenance cost per line for a wholesale-only operator on copper and then adjusted for Verizon's experience in shifting from copper to fibre. Verizon has estimated the network operations and maintenance costs of its FTTP network are almost 70 percent lower than its copper network. These reductions are driven primarily by the ability to respond to requests to add, drop or change a service remotely and often through retailer 'self service' via a service portal. In a copper network, this is labour intensive and often requires a technician to be dispatched to the exchange or the premises. Other drivers include the reduction in faults and service outages from passive infrastructure (e.g. line shorts from water penetration), and the ability to monitor and repair the network remotely.[171] After scaling this saving back by 10 percent to be conservative, a 60 percent saving in cost per line is applied to the BT Openreach network operations and maintenance cost per line.

Industry estimates and public company data were used for the network operations and maintenance costs for wireless and satellite networks.

[171] Bernstein Research 2008, *Verizon (VZ): Project FiOS;* Analysys Mason 2008, *Final Report for the Broadband Stakeholder Group—The costs of deploying fibre-based next-generation broadband infrastructure;* Telcordia

The Implementation Study used a proprietary database that contains detailed overhead cost information for more than 850 organisations, to estimate the size of NBN Co's corporate centre. Benchmarks for functions including finance, IT, legal and compliance, human resources, and general support were used. In validating these overhead cost estimates, they were compared with utilities sector benchmark data showing overhead costs as a proportion of revenue per user.

Given the importance of the operational support system (OSS) and business support system (BSS) to telecommunications companies, a separate estimate for these systems has been included in the cost modelling. Vendor consultation and our own experience suggest that NBN Co, as a new organization, is most likely to outsource the development and maintenance of its OSS/BSS rather than build the capability to do this in-house. As such, most of the cost is an ongoing operating cost, although some upfront expenditure has been included as a capital item.

Finally, the cost of electricity to power the fibre exchanges and wireless towers has been included.

Estimating replacement capex

Active equipment like the radio antennas for the wireless network, or the ONTs and OLTs in the fibre network, have relatively short economic lives of 5–10 years. Passive infrastructure like ducts, fibre and wireless towers have relatively long economic lives, and in many cases are expected to last 40 years or more.

Ongoing capital expenditure to replace infrastructure and equipment is costed at today's prices multiplied by the relevant cost deflator(s), and included in both cash flow modelling and terminal value calculations.

7.3 Managing the business case under different scenarios

This section discusses how Government should manage the business case under different scenarios. It contains two sections:

7.3.1 Expecting an internal rate of return of 6–7 percent

7.3.2 Adapting plans to manage returns under different scenarios.

7.3.1 EXPECTING AN INTERNAL RATE OF RETURN OF 6–7 PERCENT

Exhibit 7–4 integrates the cost scenarios from Section 7.1 with the key revenue scenarios from Section 7.2. It shows the Internal Rate of Return (IRR) for the NBN project (see Exhibit 7–5 for an explanation of IRR).

The middle four boxes in Exhibit 7–4 show the expected IRR under the more conservative scenarios most appropriate for planning. These show a reasonable estimate for the project IRR is 6 to 7 percent. The next chapter compares this IRR to the costs of capital required by various investors and explores the implications for funding over time.

The scenarios at the top right and bottom left are theoretical corner cases. In both instances, the Implementation Study would expect Government and NBN Co to change plans if it seemed like either of these scenarios was unfolding.

Exhibit 7–4. Effect of cost and revenue sensitivities on project rates of return

Project IRR above Government borrowing rate
Project IRR below Government borrowing rate
Theoretical corner case without changing plans

Revenue Scenarios[a]	Fibre deployment cost blowout	Build cost at higher end of plausible range	Reasonable infrastructure sharing	Build cost at lower end of plausible range
Higher demand ▪ **$35 basic service**	5.0%	6.7%	7.5%	8.3%
Mid-case demand ▪ **$35 basic service**	4.5%	6.3%	7.0%	7.9%
Mid-case demand ▪ **$30 basic service**	4.2%	6.1%	6.8%	7.7%
Lower demand ▪ **$30 basic service**	3.6%	5.6%	6.3%	7.2%

Build cost scenarios

a. Fixed-line broadband penetration (ie the total of fibre, copper and HFC) ranges from 70% (Lower demand) to 80% (Mid-case demand) to 90% (Higher demand). Prices are entry-level prices at the start of roll-out. Real growth (including a glide path for the $30 entry price scenario) is applied thereafter

SOURCE: Implementation Study

Exhibit 7–5. Explanation of Internal Rate of Return (IRR)

Internal Rate of Return (IRR)
The Internal Rate of Return (IRR) is the discount rate which results in a Net Present Value of zero for all future cash flows. It assumes all net positive cash flows are invested at this IRR. We have used the Modified Internal Rate of Return (MIRR) which assumes all future positive net cash flows are reinvested at the entity's opportunity cost of capital. Because Government has stated its intention to reduce net public debt over time, the opportunity cost is Government's cost of debt, as any net positive cash flows would be used to pay down Government debt. The figures in this chapter are a project IRR. In the next chapter, the concept of equity IRR is introduced to examine the impact of funding choices on the actual returns Government can expect for the money it invests in NBN Co as equity. The IRR is in no way a proxy or a precedent for the Weighted Average Cost of Capital (WACC) that should be used by NBN Co in evaluating infrastructure-sharing deals or tradeoffs between spending capital upfront versus accepting higher ongoing operating costs. Nor is it a proxy or precedent for the WACC that the ACCC is expected to use for NBN Co's access undertaking. We would expect both the ACCC and the NBN Co Board to independently evaluate the nature of the commercial risks and reach their own conclusions.
Source: Implementation Study

If demand exceeds expectations and costs are lower, the returns could be above 8 percent, and Government could require NBN Co to expand the fibre footprint it deploys to. If costs are exceeding expectations and demand is lower translating into a low IRR, then Government and NBN Co would likely adapt their plans—the potential actions are described in the next subsection.

7.3.2 ADAPTING PLANS TO MANAGE RETURNS UNDER DIFFERENT SCENARIOS

A project with the scale and complexity of the NBN will inevitably face challenges during roll-out. A number of uncertainties, including the extent of infrastructure sharing, the response of service providers and end users, and the cost and pace of deployment will only be resolved once construction is underway and services are being delivered. As such, Government needs to give NBN Co discretion, and be prepared to intervene itself, to manage the returns of the company over time. There are some actions the Government can take now to remove regulatory barriers and improve the ability for NBN Co to gain commercial access to facilities that could be useful to NBN Co's roll-out.

Recognising the ability to manage the risk of the NBN over time

Deploying a large-scale fibre network is different to other large capital projects such as new mines, ports or plants. Mines, ports and plants tend to be one-off projects with complex interdependencies and can be challenging to stage. In contrast, the NBN roll-out is a highly repetitive project, albeit with local tailoring. The work required to deploy fibre to each premises, or to build a wireless tower, is very similar as the roll-out progresses street by street and town by town. This repetition has real benefits for managing project costs, in comparison with one-off projects. There are significant opportunities to trial and improve deployment techniques to improve performance over time. In addition, a large number of civil works contractors and equipment vendors will want to be part of a project of this scale. This helps create competitive tension between suppliers to drive productivity improvements and bring costs down. Furthermore, the repetitive nature of the work is conducive to benchmarking of contractor performance to improve price and performance over time and encourage innovative techniques such as 'pre-connectorising'.

Thus NBN Co has the ability to manage the risk of cost over-runs during roll-out. If costs blow out in early deployments, steps can be taken to find more efficient ways to deploy for the majority of the roll-out. If technical problems emerge, they can be addressed early on for the remainder of the roll-out. Of course, deploying a satellite is completely different, with the impact of a failure at launch very hard to mitigate.

NBN Co and the Government can also take more fundamental steps to improve the returns over time if costs are higher or take-up lower. While each of these steps relax some element of Government's objectives or aspirations, they are consistent with the overall objective of dramatically improving the speed and affordability of broadband. We focus on 3:

- **Tailor the roll-out schedule.** The scenarios above apply a uniform roll-out, where fibre is deployed uniformly to higher and lower density areas, and areas with different competitive environments (HFC, multiple DSLAMs, one or no DSLAMs). NBN Co could adapt this roll-out to focus first on areas where the rate of take-up will be greatest or where the cost of deployment is lowest.
- **Slow down the roll-out.** If applications are not evolving rapidly enough to stimulate demand for fixed-line products, the rapid rate of roll-out over 8 years could be slowed down. The number of FTTP trials and deployments being announced in other nations mean that a host of innovative content and applications will become common and the demand for high-speed broadband will increase each year.
- **Allow HFC and VDSL to meet the coverage objective.** If deployment were significantly delayed or over budget, then there is scope to alter some of the Government's policy settings to speed up roll-out or improve NBN Co's economics. These include using VDSL in apartment blocks, and reusing HFC infrastructure—at least as an interim solution beyond the 8-year roll-out timeline.

If returns exceed expectations then NBN Co and Government could consider extending the fibre footprint to cover additional premises.

Removing regulatory barriers to network roll-out

The details of the nature, number and location of facilities which NBN Co will need to deploy cannot be determined until NBN Co has settled its technology and network topology choices. However, the Implementation Study can broadly state that:

- It is desirable to utilise existing underground facilities where there is sufficient availability and the terms are commercially attractive;
- There are likely to be substantial areas where aerial deployment is the only feasible or affordable option;
- Aerial deployment will likely include deployment of aerial subscriber cables to individual premises;
- We envisage roll-out of ONTs would be conducted on a demand-driven basis as premises are cut-over by the relevant retail service provider, which will obtain the consent of the owner of the premises.

Where possible, it is desirable that NBN Co carries out its network roll-out on a co-operative basis with state and local government. However, given the large range of local authorities within the fibre footprint, it would not be surprising if disputes arose in some areas. In the absence of voluntary agreement, NBN Co would need to rely upon the regime contained in Schedule 3 of the *Telecommunications Act 1997*.

The cost implications of delay or prevention of network roll-out in various areas could be substantial. Enhancing the powers and immunities regime in Schedule 3 could be achieved without the delays and uncertainty implicit in the legislative process by amending of the *Telecommunications (Low-impact Facilities) Determination 1997* (the *Determination*) to add additional Low Impact Facilities, being facilities that NBN Co could more easily roll-out without obtaining state and local government approval. Adding the following items would facilitate NBN Co's roll-out:

- All forms of overhead or aerial fibre optic cabling and any ancillary facilities, including aerial lead-ins to individual premises. We note the legislative constraint that prevents this from being extended to cables of a diameter greater than 13 mm. Ideally this would be removed; nonetheless, inclusion of fibre optic cabling up to that diameter is a worthwhile step;
- ONTs and housings;
- Pole infrastructure;
- Pole-mounted housings;
- All facilities ancillary to these facilities.

Ultimately, NBN Co will be best placed to advise Government on the precise nature of the equipment it intends to deploy.

Recommendation 55. That Government, in consultation with NBN Co, expand the definition of Low Impact Facility in the *Telecommunications (Low-impact Facilities) Determination 1997* to include facilities likely to be included in NBN Co's roll-out; that Government consult NBN Co to determine the appropriate items for inclusion in the revised definition.

Access to facilities

Part 5 of Schedule 1 of the *Telecommunications Act* creates a right of access to carriers' existing duct and tower infrastructure for the purpose of rolling out additional telecommunications network infrastructure. The mechanism governing the access regime in Part 5 of Schedule 1 of the *Telecommunications Act* is similar to the 'negotiate-arbitrate' model in Part XIC of the *Trade Practices Act* that the Government is currently endeavouring to reform. Similar reforms would be appropriate to enhance the utility of the *Telecommunications Act* scheme.

NBN Co's roll-out would be further facilitated if this regime were extended to the infrastructure of non-telecommunications utilities.

Such an expansion may have significant cost implications for NBN Co. We note that:

- Access to electricity poles would be vital for efficient aerial deployment;
- Deployment through sewers has been adopted in international roll-outs;
- Gas pipes have been used for fibre deployment in international roll-outs.

Access to utilities' infrastructure is therefore critical for developing a credible alternative to ducts owned by telecommunications carriers.

Consideration should be given to the interaction between any expanded scheme and the operation of Clause 11 of Schedule 3, which sets out carriers' obligations to seek agreement with public utilities in relation to network deployment and maintenance activities.

In addition, relevant infrastructure constructed in greenfields, such as ducts, may be owned by property developers or local authorities. At present, the access regime contained in Part 5 of Schedule 1 does not extend to such facilities. To facilitate potential deployment of NBN network infrastructure in these areas, which under our recommendations will occur where premises are not deemed 'adequately served' by the ACCC, it is important that this be remedied.

Recommendation 56. That Government reform the process of seeking access to infrastructure of telecommunications carriers under Part 5 of Schedule 1 of the *Telecommunications Act 1997* such that:

1. The ‘negotiate-arbitrate’ model is replaced with a model consistent with the changes to the access regime in Part XIC of the *Trade Practices Act 1974* proposed in the *Telecommunications Legislation Amendment (Competition and Consumer Safeguards) Bill 2009*;
2. This reformed right of access is extended to grant NBN Co access to infrastructure potentially relevant to its network deployment, including ducts, poles and pipes belonging to non-telecommunications utilities and other parties, such as owners of ducts in greenfields.

To use the expanded access regime proposed above to utilise relevant infrastructure, NBN Co will need information about the extent and nature of such infrastructure. The Implementation Study notes that legislation to effect this is presently before the parliament to enable NBN Co to procure such information.

Recommendation 57. That Government require telecommunications carriers, non-telecommunications utilities and other owners of relevant infrastructure, such as owners of ducts in greenfields estates, to provide to Government such information on their networks, infrastructure and operations as Government requests from time to time for purposes directly related to the deployment of the NBN; that Government provide such information to NBN Co on a confidential basis for purposes directly related to the deployment of the NBN, subject to appropriate safeguards around commercially confidential information.

8 Funding the NBN

SUMMARY

- To implement its policy objectives and use its resources efficiently, Government should retain full ownership of NBN Co until roll-out is complete; this includes not issuing equity in return for vended-in assets.
- The peak Government funding requirement will be approximately $26 billion in Year 6—this would be a temporary funding need since subsequent to this peak, NBN Co is expected to be able to support private sector debt of up to $32 billion by year 15.
- Government should be prepared to adapt its funding strategy over time to uncertainties in the capital market and changes in project returns, for example by varying the amount of Government equity or debt, providing guarantees or exploring use of project finance.
- Government's intention is to privatise NBN Co after roll-out is complete. Acquiring a stake in NBN Co could appeal to a wide range of investors. Given the size and complexity of NBN Co's business however, flexibility should be maintained in the timing and structure of that privatisation, for example by privatising the active and passive assets separately.
- Funding certainty is important for NBN Co's ability to engage with customers and suppliers, and can be implemented by Government entering into a formal funding agreement with NBN Co.

Government has outlined specific goals for funding the NBN initiative:

- The funded entity (NBN Co) should build and operate the network on a commercial basis at arm's length from Government;
- Government would welcome private investment and it is anticipated that NBN Co will undergo privatisation, within 5 years following the completion of roll-out, subject to market conditions.

In addition, the implementation approach should limit the use of Government funding where possible.

Determining an appropriate funding model for NBN Co means assessing the extent to which private sector funding can be used over time at reasonable cost and in a way that is consistent with policy objectives—and hence identifying the remaining amount that is to be funded by Government. This funding model will need to be adapted according to changing market environments and project performance scenarios.

A funding mix that is consistent with policy objectives depends on multiple factors: the costs and requirements of different funding types, the changing risk and return profile of the NBN project over time, and changes in the market environment over the life of the NBN.

This chapter has four sections:

8.1 Determining a funding model for NBN Co

8.2 Adapting the funding model over time

8.3 Creating funding certainty for NBN Co

8.4 Funding methodologies and assumptions.

8.1 Determining a funding model for NBN Co

An appropriate funding model for NBN Co is one in which Government achieves its policy objectives and uses its resources efficiently. This can be achieved through the use of Government equity to fund NBN Co during the first 5 years of roll-out. In later roll-out (years 6–9), the company could begin to take on substantial volumes of private sector debt, as cash flows become available to support it. Government intends to privatise NBN Co, however, flexibility should be maintained in the timing and nature of privatisation.

Exhibit 8–1 and the following pages describe the recommended funding model. This is based on the Funding Reference Scenario described in the business case (Chapter 7). This scenario reflects a unilateral build and mid-case demand and take-up. The actual returns could be higher if a favourable agreement is reached to share existing infrastructure on economic terms. Alternative scenarios are explored in Section 8.2.

The following subsections discuss the sources of funding before examining the path to privatisation:

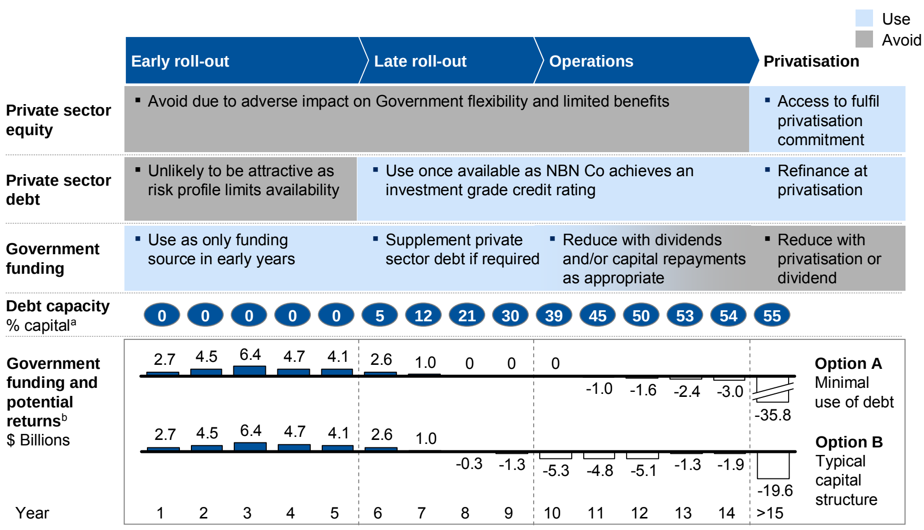
8.1.1 Retaining full ownership of NBN Co until roll-out is complete

8.1.2 Taking advantage of private sector debt

8.1.3 Optimising Government funding to meet NBN Co's requirements

8.1.4 Privatising NBN Co.

Exhibit 8–1. Recommended funding approach



a. Proportion of debt capacity to total capital (debt and equity)

b. Privatisation occurs at year 15 based on DCF of future cash flows (equivalent to 7.7x EBITDA). Option A—debt maximised to meet funding requirement only. Option B—debt maximised to meet a debt to total capital ratio of 50% by year 15

Note. Based on funding reference scenario

SOURCE: Implementation Study

8.1.1 RETAINING FULL OWNERSHIP OF NBN CO UNTIL ROLL-OUT IS COMPLETE

Government should retain full ownership of NBN Co until roll-out is complete. Private sector investors will require a high return on their investment due to a different assessment of the risks and rewards of the NBN initiative to Government (e.g. different perceptions regarding Government's commitment to completing the project and of appropriate compensation for risks). In addition, taking on private sector equity will be detrimental to the pursuit of the Government's policy aims that include social objectives such as achieving widespread coverage and increasing competition. These considerations relate to both traditional methods of raising equity as well as issuing equity for vended-in assets.

As a new start-up with capacity to take on private sector debt at the appropriate time, NBN Co will be able to achieve some of the benefits of private sector equity. Government should restrict NBN Co's ability to raise private sector equity before the end of roll-out.

Recommendation 58. That Government retain full ownership of NBN Co until roll-out is complete; that this include not issuing equity in return for vended-in assets.

Acknowledging the high cost of private sector equity

Private sector equity investors require high levels of return to compensate for project risks. Throughout the build-out phases, required returns for private sector equity are higher than the expected project returns (Exhibit 8–2). Private sector equity will be less costly as time goes on and project risks decline.

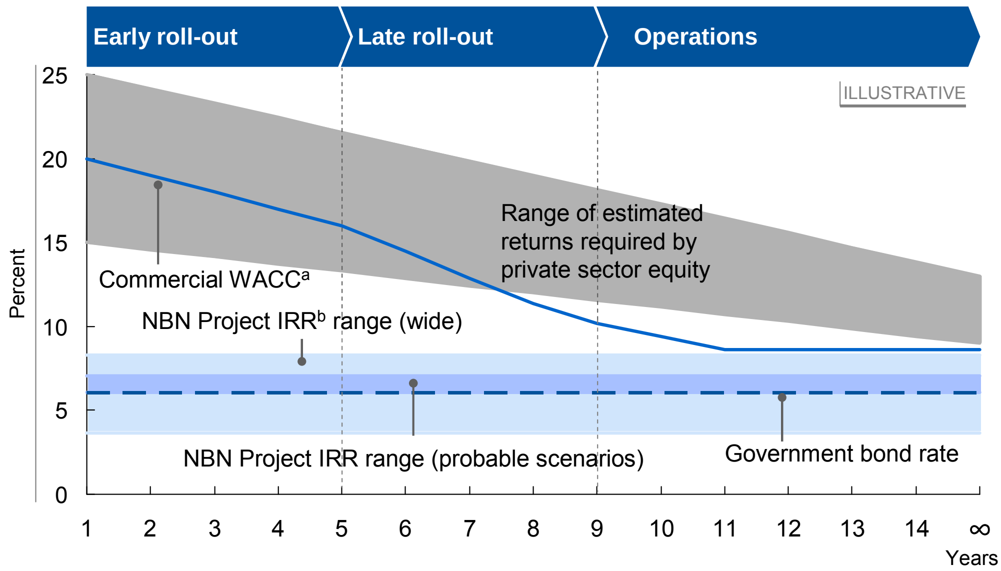
Estimating required returns in roll-out phases

Private sector equity investors would be expected to require returns of 15–25 percent during early roll-out which is 9–20 percent above the NBN project returns generated under a range of conservative business case scenarios. This assessment is based on three approaches:

- Current market experience in Australia shows equity investors in recent infrastructure projects have required a 15–22 percent return on an IRR basis when investing before the beginning of construction;[172]

[172] Discussions with investors mid-2009 indicate that required equity returns increased from around 14–15 percent before the economic downturn to well over 20 percent. Also, evidence from similar projects confirms the increase in expected equity returns (e.g. a small transport project in late 2009 with limited demand risk had an equity IRR of 20.5 percent)

Exhibit 8–2. NBN project IRR versus required returns for private sector equity



a. WACC based on the cost of private sector debt and private sector equity, post tax
b. Based on full range of scenarios outlined in Chapter 7, likely scenario range is darker, post tax
SOURCE: Implementation Study; Bloomberg

- International experience with infrastructure investors and operators substantiates the premium required of 5–10 percent over the return generated by a mature infrastructure asset to cover construction and ramp-up risks;[173]
- Implementation Study market soundings with Australian investors further confirm the high costs of equity in early project phases and highlight the limited amount of liquidity and interest in an investment in the early roll-out phase:
  – One investor would only consider an investment during the NBN roll-out as a part of its venture capital allocation rather than as a part of its infrastructure assets allocation. The expected return for a venture investment during the early phases would be around 20–25 percent. The amount invested by the venture capital group would be 10 to 20 times smaller (around $100 million) than if the investment was made by the infrastructure group after the end of roll-out;
  – Another investor highlighted NBN Co would need to compete for venture capital with risky technology projects. Venture capital investors typically try to realise returns from a few investments in their portfolio which are high enough to compensate for the losses created by the others.[174] Such investors also tend to have a shorter investment horizon. NBN Co does not fit these requirements as its

[173] ABN Amro 2008, *Concrete Attractions: Transportation Sector*

[174] An equity investor tells us: ‘Out of 10 investments, 6 will be lost, 2 might break even and we are hoping the last 2 will generate a good return for the whole portfolio. For infrastructure investments, we need all 10 investments to make a return’

returns are constrained by regulation and will come over a relatively long time period.

In addition, returns required for early investments are particularly high due to the history of some telecommunications investments in Australia, as shown in Exhibit 8–3.

The risk premium demanded by private sector equity should decline as the roll-out nears completion as uncertainties around construction costs, business establishment and customer migration, subside. Nonetheless, the cost of equity for late roll-out remains higher than for the operations phase.

The high returns required during roll-out per Exhibit 8–2 show that private sector equity investors are pricing a high level of risk. The uniqueness of the project, the long roll-out period, the technology, competition and regulatory risks are all factors that can explain the high required returns. Perceived risks will decline over time due to the repetitive nature of the work during roll-out and actual deployment resolving uncertainty around build cost and pace of customer take-up and migration.

Government will view the project as less risky than private sector investors. Government is better placed to gauge its own commitment to the project, and to understand any regulatory uncertainty. Government's view of appropriate compensation for these risks will also differ from that of the private sector. The NBN initiative is designed to meet a

Exhibit 8–3. Investor attitudes towards telecommunications investments

The record of telecommunications and network investment has left investors keen to minimise risk

- Failures in the sector have led to a cautious or negative perception
  - In 1999, One.Tel contracted Lucent Technologies to build a $10 billion mobile network using 100 percent vendor finance. The company also had bank finance. One.Tel's collapse affected retail and institutional investors.
  - In 2002, Nextgen Networks aimed to provide an $850 million competitive backhaul network. Equity investors were Leighton Contractors and Macquarie Bank. Debt finance was provided by a consortium of banks with project debt underwritten by Deutsche Bank. A price war resulted with administrators being called in—with secured creditors owed $281 million. An investor said 'I still have scars from the Nextgen sale'.
- Investors have structured capital contributions to reduce risk
  - The Austar and Powertel roll-outs featured agreements allowing the companies to draw on project finance once certain milestones were achieved such as contracts with customers, kilometres of cable laid or buildings wired, or positive cash flows.
  - Telstra heavily utilised debt in the construction of the Australia-Japan Submarine cable by signing up sponsors to use the cable before raising finance.

Source: Esty, B 2002, *Harvard Business School Case Study: Australia-Japan Cable: Structuring the Project Company*; Madden, G 2003, *World Telecommunications Markets,* Edward Elgar Publishing, Inc. Northampton, MA; Rochfort, S 2003, 'Leighton back for more with Nextgen buy', *Sydney Morning Herald*, 26 December number of objectives that are not purely commercial, including a coverage target and desired competition structure, as well as achieving socio-economic benefits in areas such as health and education. Government would appropriately see value in such impact—a private owner would not.

Calculating cost of equity in the operations phase

As the project transitions to the operations phase, construction and migration risks are less material and hence the returns required by private sector equity investors are likely to fall. This analysis, based on current market conditions, show a cost of private sector equity between 9–12 percent in the operations phase.

An example of a fibre roll-out that used private sector equity is Reggefiber in the Netherlands (Exhibit 8–4). Partnering ensured lower risks which flowed through to a lower cost of capital. This provides a reference point for the NBN in its lower-risk operations phase, albeit with very different circumstances.

Exhibit 8–4. Differences in cost of equity: Reggefiber case study

Capital cost for a fibre roll-out is 7–12 percent if risks are low or well mitigated

In the Netherlands, Reggefiber's fibre access network—Glashart—was established by investment firm Reggeborgh in 2005. The incumbent, KPN, joined the venture in 2008 by acquiring 41 percent of shares, with an option for up to 60 percent.

Glashart is currently deploying FTTP in 33 municipalities and aims to cover 2 million premises by 2013, i.e. 27 percent of Dutch homes. The company offers open access to active operators (ODF access), who in turn can offer wholesale broadband access to service providers, or provide end-user service themselves.

Most risks have been mitigated. Glashart has:

- Limited demand risk by working with community organisations and city councils to recruit customers. It has committed to roll-out where 40 percent of inhabitants are interested
- Partnered with the incumbent to enable migration from the existing copper network
- Worked within a clear regulatory framework. The OPTA (Dutch telecommunications regulator) ruled on the acceptable rate of return when KPN joined the venture.

OPTA considers 7–10 percent project IRR 'reasonable' given a WACC benchmark of 7–12 percent. This is equivalent to a 12.5 percent return on equity for Reggefiber (taking into account the effect of debt).

Source: Reggefiber 2009, *About Reggefiber*, viewed 1 March 2010, <http://www.reggefiber.com>; KPN 2009, *Presentation fiber update conference call*, 15 December, viewed 1 March 2010, <http://www.kpn.com/corporate/en/ir-3/Presentations/Other-presentations.htm>; Netherlands Competition Authority 2009, *KPN – Reggefiber: Case 6397*, viewed 1 March 2010, <http://www.nmanet.nl/nederlands/home/Besluiten/Besluiten_2009/6397BCM.asp>

Avoiding the reduction in Government flexibility brought on by private sector equity

Beyond its high cost, private sector equity has other drawbacks during roll-out including the restrictions it places on Government's flexibility. Government needs to maintain flexibility as an owner to ensure its policy goals are achieved despite significant uncertainties in the project and market. However such flexibility is a risk for private sector investors. Such investors will naturally attempt to reduce risk or demand a high price for their investment. To take on private sector investors, Government would need to lock in many choices that could more advantageously be made in the future, including aspects of the regulatory framework and NBN Co's incentives and ultimate structure.

Government's intention that NBN Co be incentivised to deliver competition and social policy goals will impact the commercial returns of the company. For example, satellites will need to be launched to serve rural areas that may not generate a positive economic return. Similarly, the Implementation Study recommends that NBN Co set access network prices in a uniform manner such that within the footprint of any individual technology, the same service will be offered at the same price in different regions to drive take-up. A profit-maximising private sector investor would not necessarily follow such an approach.

Taking such actions with private owners on board could create conflict. The need to report to private owners and to justify actions taken to secure policy goals would distract management attention from daily operations. Minority shareholders are likely to seek rights and protections that would frustrate the achievement of these goals.

Private sector equity investors would require Government to lock in the regulatory regime for NBN Co. This would remove the ability to react to potentially large changes in the telecommunications industry as it shifts from a vertically integrated model to a wholesale, open-access model.

Finally, Government could choose to change NBN Co's structure in response to changes in the industry or to change the competitive industry structure prior to a full privatisation. This could include separating the active and passive parts of the business. Private owners could complicate this process, or even frustrate it entirely, by seeking to use minority rights to earn a premium from any restructure or to prevent it from occurring.

Replicating the benefits of private sector equity

NBN Co may be able to capture some of the efficiency benefits traditionally associated with private ownership by taking on private sector debt and capitalising on the opportunity to create a performance based culture. However, given the policy objectives that NBN Co is expected to fulfil, the company may not be able to replicate fully the benefits of full private ownership.

A number of empirical studies show that private companies tend to be more profitable[175] and grow faster than state owned enterprises.[176] Private firms have the ability to focus on profit maximisation for shareholders and thus have a clear mandate to maximise revenues and scrutinise capital expenditure.

The commercial discipline provided by private sector debt when introduced will help NBN Co capture some of these benefits. The presence of private lenders provides a check on management to encourage the company to act efficiently.

As a start-up with no legacy culture, NBN Co does not suffer from inefficiencies that can build up over many years. NBN Co's board and management have track records in the private sector and have the opportunity to institute a culture of cost saving and value creation. Thus NBN Co has an opportunity to emulate many of the motivations of a private firm.

8.1.2 TAKING ADVANTAGE OF PRIVATE SECTOR DEBT

Private sector debt would provide NBN Co with financial discipline and would reduce Government's funding requirement. The amount of debt that can be raised by NBN Co increases over the course of the project. Under the Funding Reference Scenario, as cash flows become available and grow, NBN Co will be able to support up to $25 billion in private sector debt by year 12. Given the size of the NBN initiative and constraints in the domestic debt market, NBN Co will need to access international debt markets.

Debt costs have been very volatile over the last two to three years. As such, they are discussed as a key uncertainty in Section 8.2.

> **Highlight.** NBN Co could begin to take on private sector debt once cash flows become positive in late roll-out. The company is likely to obtain an investment grade credit rating and be able to support $25 billion in debt by year 12.

Understanding the benefits of private sector debt

Taking on private sector debt will increase the financial discipline required of NBN Co. Private sector debt lenders' due diligence investigations will add robustness to NBN Co's business case. Lenders will also require that NBN Co fulfil a number of obligations to continue lending on the agreed terms. These would include achieving business plan targets, meeting debt service payments and complying with financial covenants.

175 Vining, A & Boardman, A 1989, 'Ownership and performance in competitive environments: a comparison of the performance of private, mixed and state-owned enterprises', *Journal of Law and Economics*, vol. 32, issue 1, pp. 1-33

176 Erlich, E, Gallais-Hamonno, G, Liu, Z & Lutter, R 1994, 'Productivity growth and firm ownership: an analytical and empirical investigation', *Journal of Political Economy*, vol. 102, issue 5, pp. 1006-38

Government will need full transparency into any conditions imposed or representations made in relation to debt-raising by NBN Co.

Private sector debt helps to focus management attention. It can encourage the company to act efficiently by limiting free cash flow and focusing management on the most important projects. As a contractual commitment that can result in bankruptcy if broken, private sector debt is an important motivator of commercial performance. While such commitments are beneficial, they may also limit flexibility as private debt holders will attempt to limit the risk of their investment by constraining the behaviour of management.

Using private sector debt also reduces the need for Government funding. While Government debt is less costly than private sector debt, private sector funding confers the benefits of greater financial discipline and a reduction in the use of Government funds, consistent with Government policy. Even though the debt would be held by a Government-owned entity, it is held by an independent company and secured against that company's assets and cash flow, so is not classified as Government debt.

Understanding debt market sources and capacity

NBN Co has a choice between multiple sources of debt capital. To reach the amount of debt funding contemplated, both bank debt and capital markets will need to be accessed. Project finance debt would be insufficient on its own. Finance from vendors and export credit agencies is limited to the physical equipment purchased for the network roll-out. The limited capacity of the Australian debt markets would likely force the company to tap international markets.

The debt capacity available to NBN Co is conditioned by the credit rating achieved (Exhibit 8–5 explains credit ratings). Although private debt lenders may only require NBN Co to sustain a rating over BBB–, a rating of A– or above is preferable when accessing large amounts of debt.

> **Highlight.** An investment grade rating is required to ensure significant amounts of debt financing. A minimum of BBB– is required for bank debt and A– or higher is needed for amounts over approximately $5 billion.

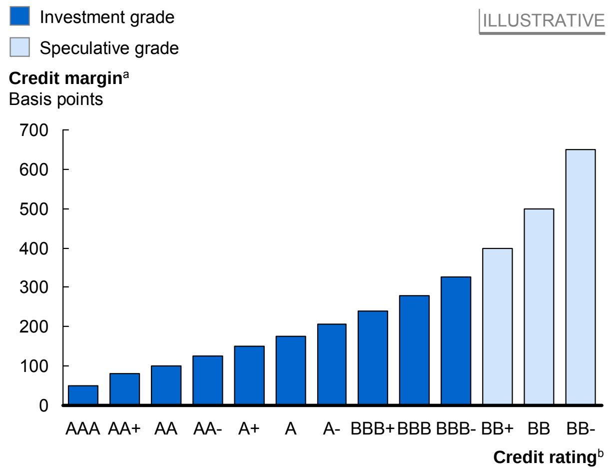
NBN Co could raise debt financing in the form of project finance debt or corporate debt. Project finance debt is generally used for greenfield infrastructure projects. It enables debt to be raised against projected cash flows and would allow NBN Co to borrow before it is able to service the debt from current cash flows (see Exhibit 8–6 for details on project finance). By contrast, corporate debt is the traditional source of financing for established operators and would become available when NBN Co generates positive net cash flows.

Exhibit 8–5. Credit ratings in brief

What are credit ratings?

- Give independent opinions about the ability and willingness of an issuer to meet its financial obligations in full and on time
- Take into account the impact of foreseeable events
- Are relative not absolute measures of default probability
- Assess business risk via qualitative analysis of industry characteristics, countries of operation and risk compared with peers
- Assess financial risk via quantitative and qualitative analysis of accounts, cash flows, capital structure and liquidity. Key ratios include:
  - EBIT(DA)/interest
  - Debt/Total Capital
  - Debt/EBIT(DA)

How are risks segmented and ranked?



a. Indicative ratings, based on ranges for 3-year credit margins for Australian corporates, speculative grade ratings are estimated
b. Credit ratings extend beyond those shown, with higher margins for C and D rated debt
SOURCE: LoanConnector; Standard and Poor's Global Credit Portal

Given the financing needs of the NBN initiative, the market for project finance debt in Australia is likely to be too small to allow NBN Co to access the amount of financing required before corporate debt becomes available. Furthermore, the fact that lenders need to limit their exposure to each issuer would act as an additional constraint on the amount of private sector debt financing NBN Co could raise domestically.

Debt market soundings suggest that the maximum amount of project finance debt NBN Co could raise would be in the $2–5 billion range. One of the largest project finance deals in recent years was for the $3.5 billion Victorian Desalination Plant (Exhibit 8–6). It was supported by international interest from major water companies such as Suez Environnement and their connections to international banks.[177] The project also benefitted from a government guarantee to make up any shortfall in syndication of the debt due to the nature of the financial markets following the collapse of Lehman Brothers. Ultimately, the guarantee was not used.

Raising private sector debt later in the roll-out through corporate debt markets would allow NBN Co to raise larger amounts of debt financing at better terms. There are two main sources of capital: bank debt and debt capital markets.

177 The private partner was Aquasure, consisting of Suez Environnement, Degremont, Thiess and Macquarie Capital Group. Partnerships Victoria 2009, *Victorian Desalination Plant: Project Summary*, viewed 18 February 2010, <http://www.partnerships.vic.gov.au/CA25708500035EB6/0/8ACBA1C56F57CF23CA25736E0001DCE8>

Exhibit 8–6. Project finance characteristics

Project finance techniques are used extensively for infrastructure financing

- Project finance deals:
  - Tie provision of finance to management of the project by establishing a separate project company with the project manager or sponsor providing most of the equity
  - Operate with a high ratio of debt to equity
  - Limit recourse of lenders in the event of default
  - Enter into comprehensive arrangements with suppliers and customers
- Benefits for infrastructure financing:
  - Debt can be raised before the entity is profitable, funding capital expenditure during construction
  - Risks can be shifted to project participants who can control them
- Drawbacks for large scale projects:
  - Lenders must approve significant project changes
  - Extensive documentation, including very tight covenant packages can distract management and reduce flexibility
  - Interest costs are high because debt is raised in the early, risky phases
  - Bank fees for lower rated companies are typically 2–3 percent of issued amount
  - Every lender requires due diligence and these costs are ultimately borne by the borrower (e.g. for a project like the Victorian Desalination Plant, about $20 million per consortium) and can delay the approval of financing
- Example: Wonthaggi desalination plant, Victoria, 2009
  - One of the largest project finance deals in the world at $3.5 billion in construction costs
  - Two bidders—AquaSure and Bass Water
  - Needed to raise $830 million of equity and as much debt as possible. Both raised around $2 billion of debt during the economic downturn. A debt funding shortfall of $1.7 billion remained.
  - Driven by the financial crisis, the Victorian Government promised to be lender of last resort if debt syndication was unsuccessful and also offered ongoing refinancing liquidity and market disruption support. Ultimately the guarantee was not used.
  - The backing of international sponsors such as Suez Environnement enabled AquaSure to raise the remaining debt finance two months after financial close in September 2009. The debt syndication was $900 million oversubscribed.
  - Twelve banks arranged debt financing with a seven year tenor and pricing as follows: years 1–5 at 350 basis points, years 6 and 7 at 375 and 400 basis points.

Source: *Infrastructure Journal*, 25 November 2009, ‘Australian desalination plant syndication closes’, online; *Infrastructure Journal,* 9 November 2009, ‘Australian desal syndication significantly oversubscribed’, online; *Filtration+Separation.com*, 25 November 2009, AquaSure secures financing for a 3.5 billion Victorian desalination plant, viewed 18 February 2010, <http://www.filtsep.com/view/5525/aquasure-secures-financing-for-a35-billion-victorian-desalination-plant>

The Australian bank debt market is limited compared to the size of NBN Co's potential needs, as identified in the Implementation Study market soundings. The market volume for bank debt for companies carrying lower ratings (BBB and below) is similar to the volumes available for project finance debt. There is greater market capacity and appetite for higher rated issuers (A– and above).

The Australian bond market is also limited in its ability to support large projects. The domestic corporate bond market is less than half the size of the US and UK equivalents even when adjusting for relative sizes of the economies.[178]

Debt market soundings suggest that the total domestic debt capacity, including bank debt and capital markets, for a company such as NBN Co, is probably around \$9–15 billion.[179] Based on investment metrics, NBN Co could potentially support far more than this amount (\$25 billion in year 12 under the Funding Reference Scenario). Domestic market capacity could, however, be reduced by a potential lack of appetite for the telecommunications sector.

NBN Co will therefore need to consider raising debt on international markets (e.g. Eurobonds) in addition to domestic debt-raising. However, for large amounts of debt, international investors are likely to require that NBN Co have a rating of at least A– or an established brand name with investors outside Australia. NBN Co will only be able to tap this resource once the company is firmly established and generating strong cash flows and a solid investment grade rating has been secured.

When tapping international debt markets, NBN Co will also need to take into account currency risk. As international lenders will provide debt in foreign currencies, NBN Co will require a currency swap to avoid taking on the risk of fluctuations in the relative value of these currencies. Typical costs for these swaps are below 15 basis points, although at some points in the economic cycle there can be disturbances in the market around specific maturities (e.g. costs for 5 year maturities have spiked to about 30 to 40 basis points). Availability of swap contracts does not seem to be a constraint based on market soundings although large amounts may require the participation of several banks and need to be spread over several days or weeks.

NBN Co could procure equipment from overseas suppliers supported by guarantees from export credit agencies (ECAs), which would reduce the cost of debt and increase its availability. Where an ECA guarantees the debt of the importer, the financial institutions providing the debt will generally reduce the pricing for that debt to that appropriate for the rating of the export credit agency.

[178] Between 1994 and 2009, debt capital market deals averaged 3.3 percent of GDP for the US and UK, and only 1.5 percent for Australia, assuming debt capital markets include corporate high-yield and investment-grade bonds and medium-term notes for non-bank, non-government issuances (Dealogic; Global Insight 2009, *World Market Monitor*)

The recent Victorian Desalination Plant project included an export credit facility of $300 million guaranteed by Korea Export Insurance Corporation (KEIC) to fund the equipment supplied to the project. Although the details were not publicly disclosed, it can be expected that improved pricing was attained given KEIC is rated A.

NBN Co may be able to secure private sector debt through vendor finance. In such an arrangement, NBN Co would purchase goods or services and receive finance for the quantum of the purchase or possibly more. Supported by Chinese development banks, large suppliers of optical network services such as Huawei and Zhong Xing Telecommunication Equipment Company (ZTE) have a history of providing significant levels of vendor finance, including a $1 billion credit line to America Movil and $750 million to Reliance in 2009.[180]

The amount of vendor financing and ECA guarantees available to NBN Co are limited to the amounts of physical equipment purchased. Thus the maximum amount of vendor finance would be $11–12 billion or 25–30 percent of project total cost. The impact of ECAs would only relate to the equipment purchased outside Australia. NBN Co needs to balance the benefits of receiving an ECA guarantee or vendor financing with other factors such as equipment cost and quality when choosing a supplier of equipment.

Sizing private sector debt

The amount of private sector debt that NBN Co can support over the course of the NBN project is based on the cash flows of the company. As discussed in the previous subsection, market capacity, and the risk appetite of debt investors might limit the amount of debt that the company can actually raise.

NBN Co will be able to support large amounts of debt, from $25 billion in year 12 to $32 billion in year 15.[181] The debt capacity of NBN Co is primarily based on the estimated cash flows of the project and their ability to service debt, including repaying it over a reasonable period in a downside scenario.

Discussions with debt market participants confirm that debt financiers want to limit their exposure to roll-out risk. Potential debt financiers will likely wait until NBN Co has proven cash flows before lending significant levels of debt. Therefore, it is preferable and practical that NBN Co wait until EBITDA is positive to raise corporate debt.

179 One bank's domestic debt stood at $8.5 billion, which they view as close to the limit; others mentioned $15 billion as being possible

180 Lunden, I 2009, 'Vendor Financing: Loan Wars', *Total Telecom*, 27 February, viewed 18 February 2010, <http://www.totaltele.com/view.aspx?ID=451120>

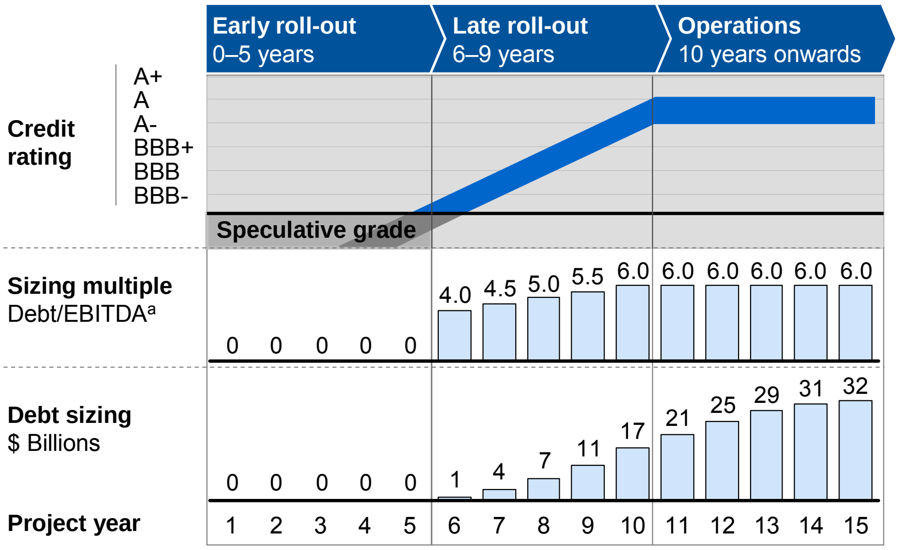
181 Under the Funding Reference Scenario

The calculations of NBN Co's debt capacity are based on the maximum amount of debt that would allow the company to target a BBB–/BBB rating when it starts raising debt and an A–/A rating when debt requirements become too large for the BBB market.

Discussions with rating agencies[182] and private sector lenders suggest NBN Co could achieve these target ratings and support a debt to EBITDA ratio equal to 4 times the last reported EBITDA midway through the roll-out phase, increasing to 6 times by the operations phase. This ratio is supported by the analysis of infrastructure companies that have an average debt to EBITDA multiple of over 6 times. Once the project is in the operations phase, NBN Co would have a risk profile closer to that of an infrastructure company than a telecommunications company. However, NBN Co will still be exposed to some market risk during the roll-out.

In assessing this ratio versus the target rating, there are likely benefits of NBN Co's implicit Government support. Having Government as a sole shareholder, the nature of NBN Co's business and its importance for the country supports a higher rating than the stand-alone financial analysis suggests.[183]

Exhibit 8–7. Debt sizing multiples



a. EBITDA adjusted for any capitalised operating costs (e.g. project management fees during roll-out)
Note. Assumes Funding Reference Scenario
SOURCE: Implementation Study; Bloomberg; market soundings

[182] Standard and Poor's 2009, *Criteria methodology: business risk/financial risk matrix expanded*; Moody's 2007, *Global telecommunications industry rating methodology*; Moody's 2009 *Regulated electric and gas networks rating methodology*

[183] Moody's 2005, *The application of joint default analysis to government related issuers*

Australian infrastructure companies are highly geared, with a typical debt multiple of around 7 times EBITDA while telecommunications companies have a more conservative level of debt with average debt multiples of approximately 1–2 times EBITDA. (See Section 8.4)

Exhibit 8–7 shows the results of our debt sizing analysis which has been validated against EBITDA ratios from recent infrastructure market transactions.[184] It shows that NBN Co could achieve a target credit rating of A–/A and support up to $32 billion in debt during the operations period.

Our calculation of Government returns assumes NBN Co does not fully utilise this capacity. If corporate debt is used to the maximum level possible to fund roll-out costs, the company will borrow $9.8 billion. $25.9 billion will be borrowed if the NBN Co moves to a typical capital structure of 50 percent debt by year 15.

8.1.3 OPTIMISING GOVERNMENT FUNDING TO MEET NBN CO'S REQUIREMENTS

There are several sources of Government funding that NBN Co could use to meet its funding requirements. These types of lending should be distinguished from any debt issued by Government to fund its investment in NBN Co.

Government equity is required to provide the company with a robust capital structure and encourage private investment. Government debt does not have the benefits of equity from the perspective of private sector investors. The substantive use of grants and subsidies would have a negative impact on the federal budget and also have tax consequences.

> **Recommendation 59.** That NBN Co be funded with Government equity until NBN Co can support private sector debt without explicit Government support and achieve an investment grade credit rating; that private sector debt be permitted to be accessed to repay Government capital while maintaining an investment grade credit rating.

Understanding Government guidelines

Consistent with Government's objective that NBN Co operates commercially, the ABS has classified the company as a Public Non-Financial Corporation (PNFC). Being classified as a PNFC is important for a number of reasons. First, it sets expectations about the company operating on a commercial basis and limits the use of subsidies. Second, as equity investments in a PNFC are not part of the federal budget, it enables those investments to be evaluated in the context of building an enduring business with direct

184 Debt multiple and pricing comparisons refer to post economic downturn transactions. Comparisons sourced from Merrill Lynch Equity Research 2009, *Australian Infrastructure*, Bloomberg, LoanConnector, Infrastructure Journal, company filings

Exhibit 8–8. PNFC characteristics and their application to NBN Co

PNFC characteristics	Application to NBN Co
■ The Australian Bureau of Statistics (ABS) determines whether the company is a 'market operator' – Responds to market forces – Is not influenced by the receipt of grants, subsidies, donations or explicit guarantees – Recovers a considerable proportion of its production costs through sales income – Has the goal of profitability in the long term, and covers capital and other costs	■ NBN Co will independently respond to market forces: – Board and management will have commercial objectives – NBN Co will be separately accountable for its actions, obligations and contracts – NBN Co's independence will not be compromised by subsidies—the company is not likely to require large subsidies and any subsidies will be focused on creating commercial incentives ■ NBN Co will cover capital and other costs and will be profitable in the long run: – Once mature, NBN Co will have substantial profit margins – NBN Co will be a source of financial gain to its owner—likely cases show a return on investment above Government cost of capital

Source: ABS 2009, Standard Economic Sector Classification of Australia, cat. no. 5232.0, Canberra

Exhibit 8–9. Guidelines for NBN Co

Guidelines for:	Detail
Government Business Enterprise (GBE)	■ Must add shareholder value by earning a 'commercial' rate of return, recovering the costs of resources employed and working towards financial targets set by Government on a return on assets basis ■ Must have a target 'optimal' capital structure—ideally reaching an investment grade credit rating and imposing financial discipline ■ Provision is made to agree on a structure 'in light of… firm specific factors'
Competitive neutrality	■ Applies to any Government owned 'significant business'[a] ■ Must pay taxes equivalent to any privately owned business ■ Must be under the same regulatory regime as competitors ■ Must provide a commercial rate of return on assets ■ Debt, including Government debt, should be sized and priced commercially ■ Pricing should reflect the market—cross subsidisation should be limited

a. Government business enterprises are defined as significant for the purposes of applying competitive neutrality. To be a business an entity must charge for goods and services, have actual or potential competitors, and have a degree of independence in production, supply and price

Source: Department of Finance and Administration 2004, Australian Government Competitive Neutrality Guidelines for Managers February 2004, Financial Management Guidance No. 9, Canberra returns rather than being evaluated as part of annual federal budget expenditure. To continue to operate in a manner consistent with that classification, the guidelines outlined in Exhibit 8–8 should be adhered to.

As a Government owned enterprise, NBN Co is also subject to a number of other guidelines as outlined in Exhibit 8–9.

Providing NBN Co with sufficient Government equity

Government equity is needed to fund the initial investments during early roll-out. It is also needed to provide NBN Co with a healthy capital structure—robust enough to navigate any financial difficulties and help raise debt financing.

Government has indicated that it will need to raise the required funds before investing them in NBN Co. It is envisaged that Government will issue debt to raise these funds, which will then be invested in NBN Co as equity.

The capital structure is one of the factors evaluated when rating a company (e.g. debt/total capital ratio). A significant amount of Government equity helps to achieve the targeted investment grade credit rating. Based on Standard and Poor's indicative ratios for corporates and NBN Co's business risk profile, a debt/total capital ratio of about 50–60 percent seems appropriate to achieve a financial risk profile consistent with an investment grade rating. This suggests that approximately $14.2–17.8 billion[185] of equity funding would be required in the first 10 years to ensure NBN Co's debt/total capital ratio is in line with the average for investment grade infrastructure companies.

In addition, NBN Co will need to satisfy other factors (e.g. debt to EBITDA) which may mean that higher initial Government funding is required. If the private debt funding environment is sufficiently strong, some of this Government funding may be able to be returned through the repayment of capital. Under the Funding Reference Scenario, $25.9 billion in Government funding is needed, suggesting that the majority of this funding is required to be in the form of equity as it is needed before private sector debt is available. However this is a temporary peak funding requirement—in excess of $10 billion could be returned to Government as capital repayments by year 11 and $20 billion by year 15 (Exhibit 8–1).

Government's use of equity to fund all or most of NBN Co's capital expenditure during early roll-out also demonstrates to lenders that Government is committed to making the NBN a success, and provides an implicit guarantee that will help NBN Co raise private sector debt as discussed further in Section 8.2.3.

185 Based on a total funding requirement of $35.6 billion

Using Government debt

As well as, or instead of, the Government investing equity in NBN Co, it could provide a loan to NBN Co. Although this form of funding does offer some accounting advantages, it has a number of disadvantages relative to other forms of funding.

Depending on NBN Co's corporate structure, it may be able to pay interest and repay principal on Government debt at a time when it is unable to pay dividends on equity, and it may be able to claim interest payments as a deduction against its taxable income. From a whole of Government perspective Government debt is also lower cost than private sector debt due to Government's low cost of funds.

Under Government guidelines, including those relating to competitive neutrality, any debt provided to NBN Co should be on commercial terms, partly to ensure that NBN Co does not obtain an advantage in its cost of funding over the market.

Market soundings indicate that private sector debt would need to have precedence over Government debt for private sector lenders to be interested in NBN Co. Further, Government debt, even on such a subordinated basis, would not particularly strengthen NBN Co's credit profile, in contrast to Government equity.

In accounting terms, a Government loan to NBN Co would be an asset included in the calculation of the Government's net debt. In other words, if Government raises debt and lends to NBN Co, it could be treated as neutral toward Government's net debt position. However, if Government debt is subordinate to private debt, in certain circumstances it may take on economic characteristics of equity. This classification would not permit the Government debt to be offset.

Restricting the use of grants or subsidies

As an alternative funding mechanism, Government can provide grants or subsidies to GBEs, for example to support ongoing investments and operations in business segments that would not otherwise make an adequate return.

Although NBN Co will be required by Government to invest in areas of business that may not make a fully commercial return (such as satellites and backhaul), these are one-off investments and will not require grants or subsidies to ensure continued commercial incentives to operate these businesses. Under the Funding Reference Scenario, NBN Co will have EBIT margins of 39 percent once roll-out is complete.[186] Even under more adverse scenarios, this margin drops to 29 percent,[187] which would still enable the business to be viable on its own. As a result, grants or subsidies should not be required to support NBN Co.

186 EBIT margin as at year 12

187 Based on theoretical worst case scenario, explained in Chapter 7

Grants and subsidies incur an immediate tax liability at the company rate of 30 percent and also have a negative impact on the federal budget. Although such a tax payment would accrue to Government, it directly affects how NBN Co's returns are reported. Grants and subsidies are like an equity investment that is immediately written off, and as such, are inferior to Government equity which retains the potential of a return on investment.

> **Highlight.** Grants and subsidies are not necessary to provide the required incentives to NBN Co to invest in non-commercial elements of the network build and have negative budget impacts and tax consequences.

A significant and ongoing subsidy could compromise NBN Co's PNFC classification. To be classified as a PNFC, NBN Co must be a 'market operator'. Under the Standard Economic Sector Classifications of Australia guidelines, a market operator is not to be 'influenced by the receipt of material financial support in the form of transfers such as grants and donations'. In practice, a subsidy would need to support a significant amount of NBN Co's operating costs over a long period for PNFC classification to become an issue.

There may however be instances where Government chooses to provide a specific grant for policy reasons. For example, wireless operators who may tender to build the fixed-wireless component of the network, could be supported with a grant or subsidy. Alternatively, Government may choose to run this tender through NBN Co, in which case the cost of this portion of the network would become part of NBN Co's equity funding. It is worth nothing that the Funding Reference Scenario assumes the conservative position that NBN Co will be required to deploy the wireless network itself.

8.1.4 PRIVATISING NBN CO

Government intends to privatise NBN Co fully within 5 years from the completion of the network roll-out. Of course, as soon as any shares are issued to a private investor, NBN Co has been technically privatised, although may still be majority owned by Government. In this section, privatisation refers to the full sell-down of Government's equity interests in NBN Co. A successful privatisation would require NBN Co to have a stable and proven outlook and for there to be a favourable market for privatisation. The specific path to privatisation and the way to structure the privatisation should be determined based on investors' appetite and preferences at the time. This requires flexibility.

> **Recommendation 60.** That flexibility be maintained in the timing and structure of privatisation of NBN Co: prime determinants of timing should be favourability of market conditions and readiness of the company for private ownership.

Assessing the impact of privatisation assumptions on Government return

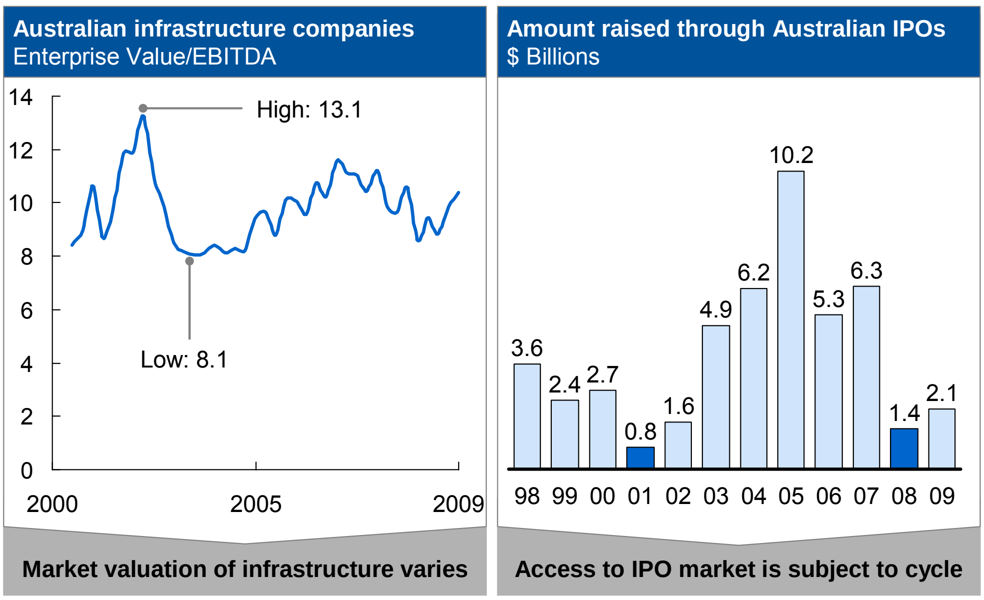
Equity markets are cyclical and volatile. Market valuations can vary substantially as economic conditions and investor perceptions of future prospects change. In addition to valuation levels, access to the capital markets can also be constrained during an economic downturn.

Equity markets have fluctuated over the past decade. A steady rise in the late nineties prompted by high technology and 'dotcom' valuations was followed by a sharp decrease in the aftermath of 9/11. In the mid 2000s, cheap credit and rising asset valuations fuelled another bull market before the arrival of the recent economic downturn.

Over this period, average valuations for the Australian infrastructure sector have varied between 8.1 and 13.3 times forward EBITDA (see left part of Exhibit 8–10). Access to capital has been volatile with the IPO market nearly shutting down following the last two economic downturns (see right part of Exhibit 8–10).

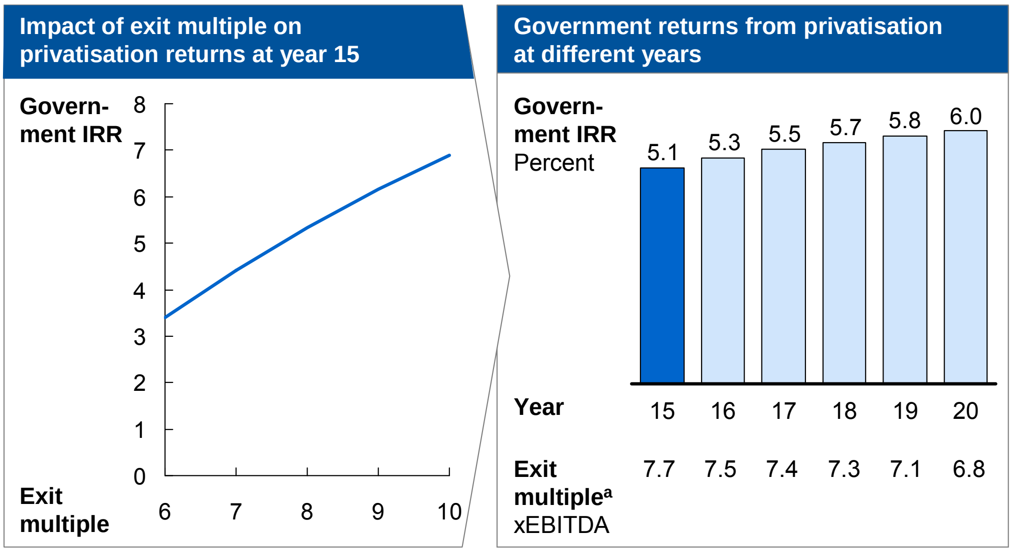
Depending on its objectives at the time and the importance of maximising privatisation proceeds, Government should be prepared to adjust the timing of privatisation given the volatility of equity markets and the uncertainties around preparing NBN Co for privatisation.

Exhibit 8–10. Equity market fluctuations and exit value



SOURCE: Bloomberg; Dealogic; company reports

Exhibit 8–11. Sensitivity of Government returns to privatisation assumptions



a. Based on exit multiple of 7.7 times EBITDA at year 15, derived from a DCF of future cash flows discounted at 9%.
SOURCE: Implementation Study

Government returns will be sensitive to the timing of privatisation. For example, in the Funding Reference Scenario, Government IRR with privatisation is 5.1 percent[188] (equivalent to a project IRR of 6.3 percent). This Government return would rise from 5.1 to 6.0 percent if privatisation was pushed back from year 15 to year 20 (everything else remaining equal), as shown in the right part of Exhibit 8–11.

The most critical assumption is the exit valuation achieved by Government if NBN Co is privatised. As shown in the left part of Exhibit 8–11, across a range of exit EBITDA multiples from 6 to 10 times, Government's return under the Funding Reference Scenario ranges from 3.4 to 6.9 percent. Although the valuation will be determined by NBN Co's future cash flows post-privatisation, Government should keep some flexibility around the timing of privatisation to take advantage of the most attractive pricing environment when selling its stake in NBN Co.

Exhibit 8–11 shows that privatisation could dilute Government's return. For example in the Funding Reference Scenario (with a 6.3 percent project IRR) Government equity IRR decreases from 6.5 percent with no privatisation to 5.1 percent if privatisation occurs at year 15. This is because the assumed private sector WACC (of around 8–9 percent) exceeds the project IRR.

[188] Note that this IRR includes the dilutive effect of privatisation. Without privatisation, Government IRR is 6.5 percent

Alternatives will exist for Government to reduce its effective equity stake in NBN Co and to bring further capital market discipline to NBN Co management. For example, NBN Co could increase its leverage by maximising private sector debt. By year 15, NBN Co will have an estimated debt capacity of $32 billion. However, it will have raised less than $10 billion in debt if it raises private sector debt only for new capital expenditure beyond Year 6 but not to facilitate reductions in share capital. Instead of selling its equity stake, Government could refinance NBN Co and, in the extreme, extract an estimated further $22 billion by maximising private sector debt.

Another option would be for NBN Co to progressively increase the use of debt as its cash flow increases. After year 9, this incremental debt capacity could be used to facilitate reductions in share capital, subject to the availability of debt financing on these terms. In this way NBN Co could move toward a more typical capital structure of 50 percent debt, assuming a sufficient quantum of private sector debt was available in the market. Exhibit 8–1 compares this approach (Option B) with a more conservative use of debt to fund capital expenditure costs (Option A). Using this approach, Government could receive $20 billion before privatisation (as opposed to $8 billion), but privatisation proceeds would be consequently lower, reducing from $35.8 to $19.6 billion.

Conceptually, this could be seen as NBN Co 'buying back' equity. In practice, this could take the form of reductions in share capital. The result would be NBN Co having a typical capital structure and therefore operating on a more level playing field with other operators.

Waiting until NBN Co has a stable and proven outlook

Given Government's intention is to privatise NBN Co, waiting until the business has reached the operations phase would achieve the most attractive valuation for Government. This is because the returns expected by investors decrease over time as cash flows increase and become more predictable. Market soundings also suggest that infrastructure investors are looking for low risk investment opportunities such as regulated utilities while their investment mandate prevents them from having large exposures to assets with significant risks.

Accordingly, NBN Co needs a stable and proven outlook to be an attractive investment opportunity for private sector equity investors. NBN Co can prove that it has such an outlook by demonstrating:

- A stable business model and proven operational track record;
- A stable regulatory regime and established competitive structure;
- A clear governance structure.

NBN Co should have a proven operational track record and a stable business model prior to privatisation

Before investing, private sector investors generally want to be confident that construction risks are no longer material. Investors are also looking for assurance that operational and technological risks are under control. Current market soundings suggest that a key concern for investors is the competitive interplay between fixed and mobile technologies.

Private sector equity investors will also require proof that NBN Co has a clear business model with the right commercial incentives and transparent pricing for each service (e.g. passive and active layer). If, for example, the independent review of competition prior to privatisation (Chapter 10) recommends a separation of NBN Co into Active Co and Passive Co, privatisation proceeds would be maximised by waiting until the separation is effective and each business has a stable and established record. Ideally, investors would like to see three to five years of stable, satisfactory performance with independently audited financial statements prior to investing.[189] Thus a privatisation would most likely be at least 5 years after the roll-out is completed and any separation is effective.

The regulatory regime and competitive structure should be well established

The market's competitive structure and regulatory regime should be well established prior to privatisation. Equity investors will want clarity in regard to which parts of the value chain will be open to competition to assess the cash flows and value of NBN Co. The extent to which the company has a monopoly over the network layers will impact its value: specifically, the decision as to whether to require NBN Co to structurally separate must be taken well before privatisation.

Investors will also want to know the framework and conditions that determine which areas of the business (if any) will receive future Government support.

Another key consideration will be the impact of regulation on NBN Co's financial performance. Private sector investors will be wary of investing in NBN Co if it is exposed to an adverse change in regulation in the short term. This concern should be minimised by having a proven regulatory framework in place. A review process with a clearly established timeline and methodology would help to reduce this perceived risk.

The competitive state of the industry will be a recurrent concern for equity investors. Many of these concerns will be mitigated if Government only considers privatisation late in the operations phase. The recommended competition review can help to remove uncertainties around the level and scope of competition ahead of any privatisation.

[189] Implementation Study market soundings; consistent with information typically provided in company prospectuses prior to transactions

Investors should be convinced there are no governance issues or risk of political interference

NBN Co already has a clearly-defined company structure and an independent Board of Directors in place. However, some equity investors have raised concerns about the potential influence Government could have on the company, in particular by enforcing decisions about pricing or service requirements that are not purely commercial.

To avoid any potential discount on NBN Co's valuation or limiting investors' interest, Government should clarify its position in relation to NBN Co regarding ownership and control beyond privatisation and policy goals should be explicitly codified.

The risk of policy goals impacting investors' returns (e.g. by forcing NBN Co to undertake activities that are not purely commercial or by limiting pricing flexibility) can be mitigated by the definition of a clear mandate for NBN Co and well-defined licence requirements.

Finally, a Government sell-down could have consequences on NBN Co debt holders. It could result in a full debt refinancing at the time of privatisation or in an increased cost of debt financing for NBN Co as its credit risk may be deemed higher without Government as shareholder. In the event of a full privatisation and complete Government exit, NBN Co may be perceived as losing the implicit backing of a high quality sponsor.

Government should address the risks of seeing NBN Co's debt downgraded at privatisation. Government should provide an indication of its plans to debt providers regarding the timing of privatisation. This allows lenders to 'price' this event and assess consequences early on. Guaranteeing that a good investment grade rating will be achieved ahead of privatisation also reduces potential lenders' concerns that their investment in NBN Co could become a low investment grade or speculative grade investment. Finally, lenders might be interested to know who new investors might be so they can limit aggregation risk.[190]

Choosing a path to privatisation and targeting investors

Various types of investors may be interested in participating in NBN Co's privatisation. Given NBN Co's size, Government should choose a privatisation strategy that maximises the value of NBN Co by appealing to a broad pool of investors. Separating NBN Co into Active and Passive companies and retaining the ownership of backhaul assets within Government is likely to attract a wider pool of investors than an integrated NBN Co. A separation could also reduce potential difficulties due to NBN Co's size.

> **Highlight.** Separating NBN Co into Active and Passive companies could make privatisation easier given a greater ability to target different investor needs.

190 Size of exposure of a bank to a single customer

NBN Co can be sold to different types of investors

NBN Co is an investment opportunity for a wide range of potential investors. Given the large size of the project, its privatisation requires attracting several types of equity investors, both domestically and abroad. Government should keep all options open at this early stage and consider both private placement and an initial public offering.

Institutional investors such as infrastructure funds, superannuation, pension and sovereign wealth funds have shown a strong appetite for regulated businesses with a long term investment horizon. This appetite stems from an increase in the long term liabilities which need to be covered such as pension plans. With an aging population, Australian funds face the need to find domestic assets that face similar economic exposure to their growing liabilities. Most international funds target OECD countries for their investments and Australia is an attractive member of this group given its growth characteristics.

Historically, retail investors have also demonstrated appetite for Australian infrastructure and telecommunication companies, through direct participation in public offerings such as Telstra or SP Ausnet, or in listed infrastructure funds such as Spark Infrastructure or Macquarie Airports (MAp).

Privatising an integrated NBN Co is challenging

The size of NBN Co when it is ready for privatisation could create some challenges if Government is looking for a full exit in one tranche.

Government might not find enough external capital to sell its full stake if relying only on sales of an unlisted NBN Co to infrastructure funds. Currently, it is difficult to anticipate any of the largest pension funds or sovereign wealth investors committing to more than $1–2 billion each. It is also unlikely that NBN Co would secure investments from more than 3 or 4 of these investors as experience points to difficulties in getting competing funds to invest together. It would also be difficult to satisfy typical negative control requirements for investments in unlisted entities for all investors (e.g. board representation). In addition, some of these investors could already be exposed to NBN Co as lenders, which would reduce the exposure they might be willing to take as equity investors. These difficulties might reduce as asset allocations for infrastructure assets go up, the number of pension and sovereign funds increases and their average size grows.

A full initial public offering (IPO) of NBN Co would be one of the largest in Australia's history. With an enterprise value of $41 billion,[191] NBN Co would be an ASX 20 company today.

Based on the experience of previous large privatisations such as Telstra and CBA, Government may choose to complete the IPO in several tranches. However, a sale in

191 Based on Funding Reference Scenario assumptions and 7.7 times EBITDA or 9 percent discount of free cash flows and privatisation at year 15

several tranches could negatively impact NBN Co's valuation. Investors are generally wary of the risk of political intervention in companies where governments are large shareholders and hence may price NBN Co at a discount because of this. Investors also take into account the risk created by 'share overhang' as Government can decide to sell a large block of shares at an inappropriate moment, creating downward pressure on the stock price. This happened with Telstra shares when the Government's holding was transferred to the Future Fund, and with CBA following its privatisation.

An IPO may reduce interest from institutional infrastructure investors. Institutional investors tend to invest in unlisted assets for their infrastructure portfolios and listed entities for their equity portfolios. Once NBN Co has been listed it will not be in scope for many infrastructure portfolios and would be competing for a place in equity portfolios alongside many other listed companies from the infrastructure and telecommunications sector.

An integrated NBN Co would blend businesses with quite different risk and return profiles—this could lead to the whole being valued at less than the sum of the parts. Investors looking for growth would likely be disappointed by the regulated growth profile of the company. Investors looking for stability, such as pension and superannuation funds would find the market risks on the active layer less attractive.

Separated Active and Passive companies are attractive to different types of investors

NBN Co possesses characteristics of both a regulated infrastructure company and a market based telecommunications operator. Separating NBN Co into two entities could increase investors' appetite at the time of privatisation.

A Passive Co—excluding the unprofitable backhaul assets—would be a strong fit with infrastructure investors' portfolios. NBN Passive Co would be a regulated business, with low variability of cash flows and stable returns determined by what constitutes a fair return on its capital base. Its national presence makes it highly correlated to the Australian economy. The expected long asset life provides investors with a long duration asset which can match long duration liabilities such as retirement annuities. Finally, the ability to increase prices offers a good hedge against inflation.

In addition, a Passive Co may support higher levels of leverage (relative to its size) than an integrated NBN Co. Increasing leverage before privatisation would reduce the amount of equity needed from private sector investors, increasing the chance of a full exit for Government.

By contrast, an Active Co would compete in the telecommunications market and would offer the potential for strong revenue growth, at the cost of higher risk associated with ongoing management of products, pricing and upgrades. Based on the competitive situation at the time, it could be sold to the public via an IPO, to other industry participants directly, or retained by Government.

A separation of NBN Co into two entities would however have tax consequences. In particular, a future transfer of assets from NBN Co to another entity (such as the separation of active assets from passive assets) could give rise to a stamp duty liability in respect of the assets transferred.[192]

The Government should maximise flexibility in future planning and minimise the risk of a stamp duty liability. Government could negotiate with the States and Territories to request a specific exemption in relation to the stamp duty that may arise at privatisation or in respect of reorganisations prior to privatisation. Alternatively, Government could explore legislative mechanisms to exempt NBN Co from the application of stamp duty in the event of separation.

> **Highlight.** Any future transfer of assets (such as in a restructure) may result in a substantial stamp duty liability unless Government negotiates an exemption with the States and Territories.

NBN Co may not benefit from the most common sources of relief from stamp duty. As NBN Co is intended to conduct its business competitively, it is unlikely that NBN Co will be entitled to the exemptions that the Crown enjoys. The various forms of corporate reconstruction relief currently provided by the States and Territories—by statute or by way of grace and favour relief—may not provide comprehensive relief for NBN Co. These reliefs envisage transfers of assets between members of a private corporate group and do not envisage Government as an owner. Furthermore, some of the jurisdictions do not provide relief for transfers to and from trusts, should such a structure be used.

Setting up the appropriate structure for privatisation

Many infrastructure investment vehicles are structured to maximise attractiveness to a wide range of investors. A managed investment trust with a stapled structure is attractive to investors as it is more tax effective than a traditional company structure (Exhibits 8–12 and 8–13).

Government will need to decide whether it is prepared to consider a structure that may reduce tax proceeds, in order to attract additional domestic and overseas investors. It should then evaluate whether the relative returns from maintaining income from taxes under a traditional company structure outweigh gaining a potentially higher price at privatisation by using a more typical structure for NBN Co.

> **Recommendation 61.** That NBN Co be directed to evaluate alternatives for a corporate structure that preserves flexibility and considers transaction costs at privatisation.

[192] Assuming Passive Co is the successor of NBN Co and only the Active assets are transferred to a new Active Co., the stamp duty liability could reach $230 million (e.g. average of 5.5 percent times $4.2 billion, which is the book/gross value of the active assets in year 15)

NBN Co has currently been set up as a company with no assets. At privatisation, private sector investors in NBN Co—especially foreign investors—are likely to have a preference for an investment in a stapled trust structure. Setting NBN Co up in a way that is attractive to investors would prevent NBN Co from being at a disadvantage at privatisation relative to other investment options.

A single trust in isolation would likely be treated as a company and not treated as a transparent vehicle. This would defeat the attractiveness of using a trust structure. A stapled structure may be attractive, in which case NBN Co would carry on the operation of the business while certain assets would be held in a trust. The trust would only be allowed to carry on investment type activities, such as leasing of assets to obtain rental income.

Certain provisions could however prevent the establishment of a stapled trust structure after NBN Co acquires assets. For example, there are provisions in the income tax law that may prevent the transfer of assets into a trust from achieving the transparent treatment for the trust. In addition, the transfer of assets from a company into a trust may trigger stamp duty. Ideally, a stapled trust structure should be set up before NBN Co acquires or develops substantial assets.

Highlight. Setting up a Managed Investment Trust at the outset to hold the NBN assets is likely to maximise value and attractiveness to a wide range of investors at the time of privatisation.

When considering the consequences of making an investment in NBN Co more attractive for investors, Government should consider the trade-off between future tax proceeds and privatisation proceeds. To assess the value of a stapled structure for investors, Government needs to understand the difference in cost for investors, both domestic and international, of maintaining a traditional company structure and implications for privatisation proceeds. Government should assess the costs in particular for likely NBN Co investors such as superannuation funds and foreign infrastructure investors. The cost difference between a stapled trust structure and a company structure is driven by the differences in tax regimes between these two structures. As the tax framework will evolve between now and the time of privatisation, this cost cannot be calculated accurately today.

Exhibit 8–12. Example of typical infrastructure structures

Stapled trust structure and shareholder loan arrangement

A trust is a common infrastructure investment vehicle. A trustee holds the assets on behalf of the beneficiaries. A trust deed governs its operation. It is treated as a transparent vehicle for tax purposes: that is, tax is levied in the hands of the investor rather than at entity level.

Using a trust structure for infrastructure assets has advantages:

- Recently enacted Managed Investment Trust provisions potentially provide a concessional tax rate of 7.5 percent for foreign investors on income of the trust and gains on exit. The *Tax Laws Amendment (2010 Measures No. 1) Bill* 2010, released on 10 February 2010, expands these rules;
- When a trust's accounting profit exceeds its taxable income position, this excess may be paid out as a 'tax-deferred' distribution. A company would pay out this excess as an (assessable) unfranked dividend. The tax deferred distribution is effectively a return of the investor's principal on their investment, and would reduce the investor's cost base. Once reduced to nil, further tax deferred distributions would give rise to a gain which may be a concessionally taxed capital gain for individuals or superannuation funds. This is particularly relevant during a project's early operations.

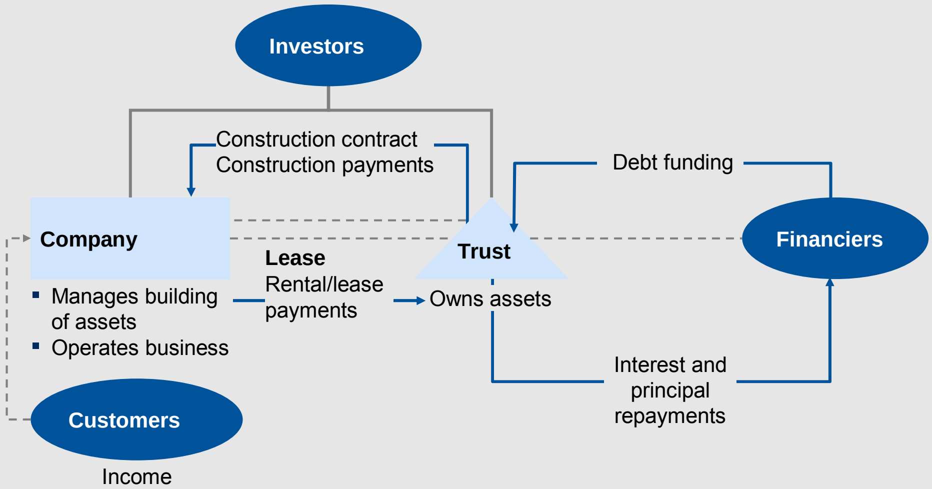
For a trust to achieve these advantages, it must not carry on trading activities. In a stapled structure a trust merely holds the assets, and a company carries on business operations.

Examples of 'stapled' trust structures in the Australian infrastructure sector include Transurban, Macquarie Infrastructure Group, Spark, and DUET.

The treatment of trust tax-deferred distributions may be replicated through a shareholder loan arrangement in relation to a company structure. In this arrangement, part of the investor's capital is contributed in the form of a shareholder loan. However the benefits are limited:

- Foreign investors would pay tax at 30 percent versus 7.5 percent;
- Distributions can only be made up to the value of the loan;
- Charging of interest on the shareholder loans may be undesirable for investors because such interest would be taxable in the hands of the investors (or subject to withholding tax) during the early years of the project when the company is in a tax loss position.

Typical infrastructure investment structure



Source: Implementation Study

Exhibit 8–13. Key attributes of infrastructure projects

		Construction	Ramp up and early operations	Mature operations
Typical profile of an infrastructure project through its life cycle	**Cash available for distribution to investors**	▪ None – Funding used to construct asset	▪ Some	▪ Significant
	Accounting profit position	▪ Minimal profit or loss – Interest is capitalised	▪ Generates profits ▪ Accounting profits lower than cash profits (due to non-cash deductions such as depreciation)	
	Taxable profit position	▪ Losses (due to deductions for interest during construction phase)	▪ Losses (due to depreciation deductions and carry forward tax losses)	▪ Profits
Tax and distribution treatment for various structures	**Managed Investment Trust in a stapled structure**		▪ Investors can receive tax deferred distributions[a]	▪ Domestic investors taxable at marginal tax rates ▪ Foreign investors may be taxable at 7.5%
	Company		▪ Investors receive taxable unfranked dividends[b]	▪ Investors receive franked dividends (tax paid at company level at corporate tax rate, currently 30%)
	Shareholder loan[c]		▪ Investors receive taxable Interest payments[b] ▪ Return of principal not assessable (unless principal exhausted)	

a. These distributions would be either non-assessable or, if the principal on the investor's investment is exhausted, subject to capital gains tax

b. Taxable at investors' marginal tax rates for domestic investors or subject to withholding tax for foreign investors

c. Either in a company or in a stapled structure

SOURCE: Implementation Study

8.2 Adapting the funding model over time

The previous section proposed a funding model for NBN Co. This model is subject to a number of variables and a long time horizon. These variables can positively or negatively affect the project's funding requirements. Given these uncertainties, a funding approach is required that monitors uncertain elements and develops contingencies to ensure funding requirements are met in the most advantageous way.

Government may need to adapt its approach over time to deal with changes to the funding requirement. Government equity or debt could be used to fulfil an increase in the funding required. In the event that Government wishes to further reduce its funding requirement, it may need to explore the use of project finance. Under current modelling and market conditions, project finance is unlikely to reduce Government funding requirements. However, Government should monitor market conditions and progress in NBN Co's business plan to determine if such a solution could be advantageous in the future if debt markets improve. The use of Government guarantees could aid Government in gaining increased levels of private sector debt with the required quantum and tenor to enable a reduction in Government's funding requirement.

Three subsections follow:

8.2.1 Planning for uncertainties in the project and market

8.2.2 Avoiding project finance under current conditions

8.2.3 De-risking NBN Co for private lenders.

8.2.1 PLANNING FOR UNCERTAINTIES IN THE PROJECT AND MARKET

NBN Co is expected to become a high earning business in the long term. However, there are many uncertainties that could influence the funding required to reach this end state or impact Government's returns at privatisation. This subsection highlights key areas of uncertainty and defines their potential impact on the funding profile of the NBN.

Planning for uncertainties in the project

Variables relating to the costs of rolling out the NBN and attracting revenues from customer take-up could increase or decrease funding requirements in the near term.

Various cost and revenue scenarios are outlined in Chapter 7 with the impact on Government's funding requirement and returns covered here. This analysis assumes that NBN Co attains an investment grade credit rating and raises the maximum amount of private sector debt to fund capital expenditure costs.

Taking on debt will leverage the project IRRs discussed in Chapter 7. Leverage works both ways—if the project IRR is below the after tax cost of debt, the effect of debt will be to reduce equity returns to Government; if the project IRR is above the after tax cost of debt, the use of debt will increase Government equity returns.

Under a conservative business case scenario, the Government funding requirement is in the vicinity of $26 billion. In the Funding Reference Scenario, the basic wholesale service is priced at $35, with the mid-case for demand. Construction costs remain at the high end of the plausible range but do not blow out (see cell numbered ‘1’ in Exhibit 8–14).

Highlight. Under a conservative business case scenario, Government’s funding requirement is in the vicinity of $26 billion. This requirement is temporary as from this peak, NBN Co should be able to support substantial private sector debt

Agreement could be reached for the use of Telstra’s infrastructure, reducing the costs of roll-out. Alternately, NBN Co may be able to build the network more cheaply by realising scale benefits, driving ongoing productivity gains, bringing new deployment techniques to Australia such as micro-trenching or negotiating cheaper use of aerial deployment (see cells numbered ‘2’ and ‘3’ in Exhibit 8–14). As most of the costs of construction arise before NBN Co can take on private sector debt, reductions in these costs would also reduce the Government funding requirement. If market conditions remained the same as in the Funding Reference Scenario, these scenarios would reduce the funding requirement.

Under the best case, the network is built cheaply and there is also a high level of market demand. The lower costs of the roll-out combined with a greater ability of NBN Co to service these costs with either revenues or private sector debt results in a Government funding requirement of $23 billion. Note that due to the majority of roll-out costs being incurred before revenues or private sector debt is available, an increase in revenues does not substantially reduce the funding requirement (see cell numbered ‘4’ in Exhibit 8–14).

However, conditions could also be worse than modelled in the Funding Reference Scenario. In the worst case, fibre deployment costs blow out and lower demand causes a significant decrease in revenues. Under this extreme scenario, Government’s funding requirement is $32.6 billion (see cell numbered ‘5’ in Exhibit 8–14). However, as discussed in Chapter 7, this is not a plausible scenario in practice as Government would adapt the pace and nature of roll-out to keep returns higher and the funding requirement lower.

Exhibit 8–14. Government funding requirement per scenario

Government equity IRR (without privatisation)
Funding reference scenario
Government funding needed ($ Billions)
n Scenario discussed in body text

Revenue scenarios	Fibre deployment cost blowout	Build cost at higher end of plausible range	Reasonable infrastructure sharing	Build cost at lower end of plausible range
Higher demand ▪ $35 basic service	$30 4.9%	$26 7.0%	Funding variable 7.9%	$23 8.8% 4
Mid-case demand ▪ $35 basic service	$30 4.2%	**$26** 6.5% 1	Funding variable 7.3% 2	$24 8.3% 3
Mid-case demand ▪ $30 basic service	$32 3.9%	$28 6.2%	Funding variable 7.0%	$25 8.0%
Lower demand ▪ $30 basic service	$33 3.1% 5	$28 5.6%	Funding variable 6.4%	$25 7.5%

Build cost scenarios

Note: Assumes Government IRR is based on underlying project IRR discussed in Chapter 7, modified by the leveraging (or diminishing) effect of debt finance. The maximum private sector debt is used in all scenarios to the fund roll-out. Dividends paid to Government from operating cash flows.

SOURCE: Implementation Study

Planning for the impact of a migration agreement

The amount and structure of potential agreements with Telstra must be factored in when determining NBN Co's funding requirement. Due to the commercial sensitivity and the uncertainty surrounding such agreements, the mechanics of any such deal are not discussed in detail.

There are three primary areas that could be covered by a deal with Telstra as identified in Telstra's Terms of Engagement with NBN Co announced on 18 December 2009. These are:

- Access to passive infrastructure around ducts, pits and exchanges;
- Access to Telstra's backhaul network;
- Migration of Telstra's traffic from the copper network to the new fibre network.

The impact of an agreement on passive infrastructure and backhaul has been considered above. In terms of an agreement for migration of customers, it would only be considered if it creates value for NBN Co by increasing the revenues to NBN Co during roll-out relative to a compete scenario.

The impact of such an agreement on the Government funding requirement will be determined by a number of factors:

- The size of the payment required;
- Whether the payment is upfront or staged;
- The size and speed of the resulting increase in revenues for NBN Co.

Government would need to fund an upfront payment any time in the first 5 years as NBN Co would not be able to sustain debt. By contrast, a significant proportion of a staged payment could reasonably be assumed to be in line with expected customer migration, only falling due once NBN Co was able to support private sector debt. Thus NBN Co would be able to fund part of a staged payment without Government support. However, it is likely that a staged payment would be larger in size than an upfront payment.

The additional revenues that would result from a migration agreement would enable NBN Co to pay for more of the roll-out costs itself, avoiding additional injections of Government equity. The earlier arrival of revenues would also enable NBN Co to raise private sector debt earlier, which could be used as a substitute for Government funding of roll-out costs. In order for a deal to impact the Government funding requirement positively, these beneficial cash flow effects would need to exceed the size of the cash payment.

Planning for debt market uncertainty

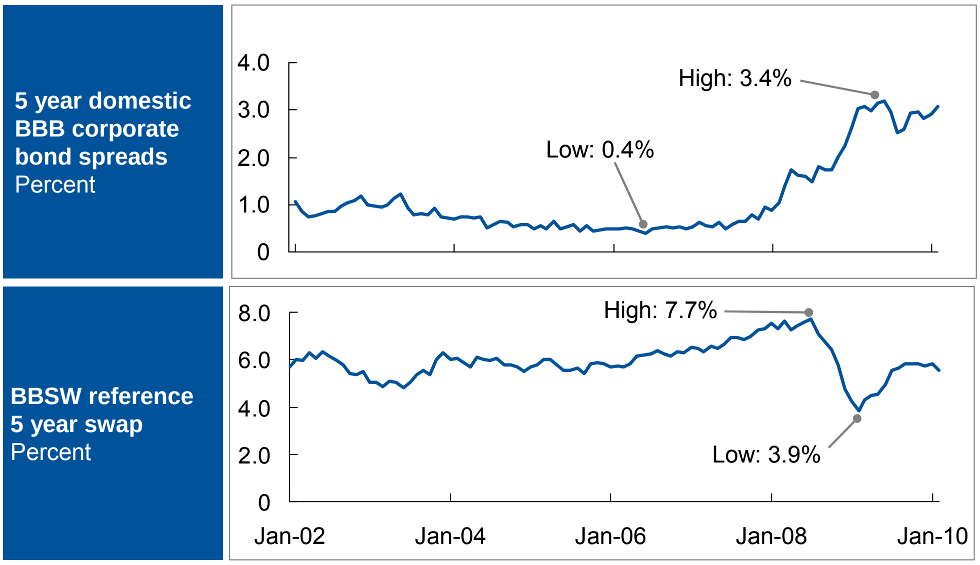
Debt markets are subject to fluctuation. These fluctuations could impact the price and availability of private sector debt at the times when NBN Co needs to access it. We estimate the interest costs for NBN Co could vary from $4.6–5.9 billion cumulatively between years 1 and 15 of the NBN project.[193]

> **Highlight.** Changes in debt markets could vary interest costs by $1.3 billion between years 1 and 15 of the NBN project.

The cost of debt can vary over time either because of changes in the Government risk-free rate (base rate) or because of changing credit spreads. Over the last eight years the Bank Bill Swap (BBSW) 5 year swap reference rate which we have used as a benchmark has varied between 3.9 and 7.7 percent (Exhibit 8–15, bottom). When considering credit spreads, the variability has been even higher. In particular, in the last 18 months, spreads for BBB rated debt have risen from a low of 0.4 percent in 2006 and 2007, to 3.4 percent at the peak of the crisis (Exhibit 8–15, top). Although spreads have started to stabilise in the last few months, they are at a much higher level than historically (by over 2 percent) and it is difficult to predict if credit spreads will stabilise at a given level and what this level will be.

[193] Based on peak private sector debt funding of $9.7 billion (Option A from Exhibit 8–1)

Exhibit 8–15. Uncertainty in debt pricing



SOURCE: Bloomberg

A further source of uncertainty is the volume of debt financing that will be available in the market when it is required by NBN Co. In addition to its impact on debt pricing, the global economic downturn has caused a strong decrease in the volumes of debt financing, both in corporate debt and in project finance. Exhibit 8–16 shows the impact of this uncertainty on the market for private sector debt. Given the size of its debt finance requirement, NBN Co's ability to raise private sector debt could be impacted by a lack of liquidity in the future.

As an example of the difficulties NBN Co could encounter, according to reports, the Dutch company Reggefiber (described in Exhibit 8–4) has been unsuccessful in raising external financing so far (up to the end of 2009). The company's shareholders, KPN and Reggeborgh, have been forced to step in to provide temporary financing. Looking ahead, Reggefiber expects to secure external financing in the first half of 2010. In particular, the European Investment Bank (EIB) is considering lending €130 million to the project as it supports the renewed Lisbon Strategy to roll out high-speed Internet in the EU.

Exhibit 8–16. The global debt market

The liquidity crisis has left lasting impacts on the global debt market

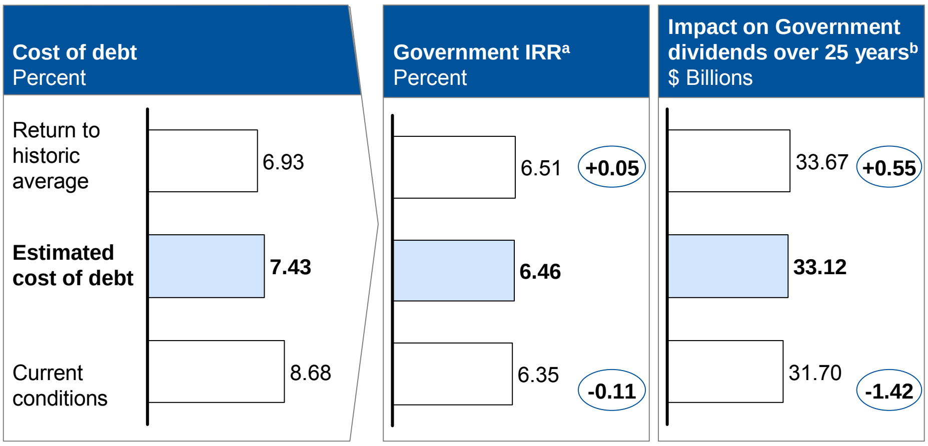
- Market capacity has dropped but is likely to return
  - The global economic downturn put pressure on banks to strengthen their balance sheets resulting in a tendency to avoid financing new projects
  - Banks initially withdrew from, or reduced exposure to, non-core markets which limited the availability of international bank finance. However international banks' interest in Australia has renewed and capacity is likely to increase
- Risk appetite has dampened
  - Following the crisis, banks have refused to take on significant market risks in project finance. Failures in the Australian infrastructure market due to overestimated demand such as the Sydney Cross City and Lane Cove tunnels, BrisConnections, and Babcock & Brown Power have increased the perception of market risk
  - Debt multiples have dropped, tenors have reduced, and covenant packages have tightened. Although competitive pressure may lead to a relaxation of these standards over the medium term, it is likely that concerns about market risk will remain for some time.
- Pricing (margins and fees) has undergone a structural change
  - Before the crisis, Australian banks could raise medium term funding relatively cheaply (10–15 basis points premium over short-term rates) and didn't appear to worry about matching funding tenors to lending tenors (borrowing short-term and lending long-term, termed maturity transformation)
  - However, bank regulators see maturity transformation as one of the causes of the crisis, and are seeking to restrict it, and Australian banks are now limiting the term of their loans to 5–7 years
  - From mid-2007, banks' medium-term funding premiums rose to over 200 basis points (although they have fallen back under 150 basis points), and banks are passing on these costs to customers. Banks' term funding premiums may reduce as market sentiment towards banks improves, but loan pricing is likely to remain high and uncertainty of funding risks will be passed to borrowers through market disruption provisions for some years.

Source: Implementation Study; CBASpectrum

The Funding Reference Scenario assumes the interest rates of private sector debt would be 175 basis points over the base rate if NBN Co is rated BBB and 125 basis points over the base rate for an A rated company. Given the recent uncertainties around the cost of debt financing, two alternative scenarios have been considered: the 'return to historic average' scenario assumes that prices return to their long term average levels while 'current conditions' provides a higher estimate based on recent market levels:

- The 'return to historic average' scenario assumes typical spreads for BBB rated debt around 125 basis points over the risk-free benchmark rate and 75 basis points for A rated debt

Exhibit 8–17. Impact of cost of debt on Government returns



Note: Based on funding reference scenario assumptions, maximised debt up to funding requirement. WACC held constant for each scenario at 9%
a. Note, project terminal value assumed to be the same for all scenarios at $61 billion in year 25
b. Dividends does not include terminal value – i.e. assumes no privatisation event
SOURCE: Implementation Study

- The ‘current conditions’ scenario assumes typical spreads for BBB rated debt of around 300 basis points and 125 basis points for A rated debt.

These scenarios have a relatively minor impact on Government’s IRR.

The higher cost of debt of the ‘current conditions’ scenario results in a slightly lower IRR for Government. Assuming the Funding Reference Scenario and the maximised use of commercial debt to meet the funding requirement, Government equity returns would improve by 0.05 percent if the costs of debt returned to ‘historic average’ levels. Conversely, if debt costs continue at ‘current conditions’, Government’s equity return would decrease by 0.11 percent. These small changes translate into a more significant impact on Government equity dividends over 25 years as shown in Exhibit 8–17.

8.2.2 AVOIDING PROJECT FINANCE UNDER CURRENT CONDITIONS

Project finance is debt that can be raised against projected cash flows, allowing a company to borrow before it is able to service the debt from current cash flows. Raising project finance from the private sector is unlikely to reduce Government funding requirements if used during roll-out. For project finance to have a beneficial effect on Government’s funding requirement, the following elements need to be in place:

- Project finance must be available—lenders need to be willing to provide the sufficient quantum of debt, at a tenor that would enable a refinancing once NBN Co has the capacity to support corporate finance.

- Refinancing must be possible—NBN Co must have enough corporate debt capacity to refinance the project debt into corporate debt. This debt must be available at reasonable cost and lenders must be comfortable with the timeline for amortisation.
- NBN Co must have enough corporate debt capacity to cover roll-out costs after refinancing.

If these elements are not in place, project finance will not decrease Government's funding requirement and could increase the overall cost of the project. If the debt is not available for a tenor sufficient to reach the point at which corporate debt is available for refinancing, or if the capacity of this corporate debt is not large enough to refinance and pay for roll-out costs, Government funding will need to be used.

Assuming that NBN Co could raise project finance of $4 billion in year 4 at a cost of an additional 75 basis points, refinancing in years 6, 7 and 8, (as corporate debt capacity becomes available), the requirement for Government funding actually increases by $0.7 billion.

Changes in the market, or in NBN Co's performance, will affect the availability of project finance and the ability to use this debt to reduce the Government funding requirement. A return to pre-economic downturn debt markets would increase the amount of debt that investors would be willing to lend NBN Co and improve the terms under which this debt capacity could be used as project finance. An improvement in NBN Co's expected performance above the Funding Reference Scenario would increase, or bring forward, positive EBITDA, thus increasing debt capacity.

For project finance to reduce Government's funding requirement, private lenders would need to:

- Allow a long tenor to allow refinancing into corporate debt
- Allow NBN Co to take on corporate debt underneath project finance debt

Assuming that NBN Co could raise project finance of $4 billion in year 4, at a cost of an additional 75 basis points, refinancing in years 9 and 10, and that this facility did not preclude the company from raising additional corporate debt in the intervening years, the requirement for Government funding could be reduced by $3.5 billion. Notwithstanding this analysis, the Implementation Study does not expect project finance to be available or attractive relative to waiting for investment grade debt in year 6.

8.2.3 DE-RISKING NBN CO FOR PRIVATE LENDERS

The appetite of the market will define the amount of debt available to NBN Co. Government can take steps to increase the availability of debt and potentially reduce the costs of that debt, by giving some form of guarantee to reduce the risks faced by lenders.

Lenders will be concerned that the occurrence of any of the risks that NBN Co faces (Chapter 7) will lead to it being unable to meet its debt obligations (likely to be primarily due to insufficient cash flow). This default risk can be addressed by means of an explicit Government financial guarantee or by guaranteeing revenue. These forms of Government support are discussed below.

If used improperly, Government guarantees could breach Government policy guidelines such as competitive neutrality and could affect NBN Co's classification as a Public Non-financial Corporation. However, steps can be taken to reduce the risk.

Highlight. The decision to give a Government guarantee is an important choice that will materially affect the cost and availability of private sector debt.

Providing an explicit Government financial guarantee

A relationship with Government can significantly impact a company's credit rating. In determining the effect of Government support on a 'Government Related Issuer' a credit rating agency will take into account both the seriousness of the relationship between Government and the issuer and the co-variance of credit risk between the two parties. To ascertain the first factor, the agency will examine a number of areas including the ownership stake Government has in the issuer, the existence of an explicit policy mandate to support the issuer, and any special legal status afforded to the issuer. The second factor will be determined by examining questions such as whether Government and the issuer are exposed to common credit risks, and have the same revenue base.

The impact of a Government guarantee depends on whether it is explicit or implicit. In assessing any implicit guarantee and its impact on credit risk, credit rating agencies will examine the nature of the relationship between Government and the issuer and the underlying risks. Subject to the underlying risk profile of the business, an implicit guarantee could upgrade an issuer's credit rating by up to two notches.[194] The Implementation Study has assumed an implicit guarantee in assessing the price and credit rating of debt.

[194] One 'notch' is the difference between two consecutive credit ratings. For example, a two notches upgrade means a company rated BBB could be upgraded to A-, and a company rated A- could be upgraded to A+

An explicit guarantee could confer NBN Co the benefit of Government's AAA credit rating or one notch below. For example, if NBN Co were to have a credit rating of BBB with no form of Government support, an implicit guarantee could result in a credit rating of A- while an explicit guarantee could result in a rating of AA+.

Although it is likely that NBN Co will benefit from the implicit guarantee as the Government is its main investor, many market participants have mentioned an explicit guarantee would considerably ease the task of raising private sector debt in early roll-out. The Australian Government Guarantee Scheme[195] for Large Deposits and Wholesale Funding is a successful example of a guarantee arrangement that has allowed authorised deposit taking institutions to raise debt despite difficult market conditions.

From a budgetary and financial management accountability perspective, an explicit guarantee would need to be approved by the Minister for Finance[196] and would require disclosure as a Budget Risk. Current Government policy is that a Commonwealth guarantee should not be issued until it has been determined that all other options available have been exhausted.[197]

Guaranteeing revenue

Guaranteeing a minimum level of revenue would reduce a major source of NBN Co's business risk. Lenders are likely to take a conservative view of NBN Co's initial revenue projections, particularly in the light of their recent experiences with revenue projections for Sydney's Cross City and Lane Cove tolled tunnels, both of which went into receivership because actual revenues fell substantially short of projections. This guarantee would give substantial comfort to private sector lenders and investors, enabling them to reduce their return requirements and to increase their level of funding.

Guarantees are seen as a form of financial support under Government Finance Statistics. NBN Co's PNFC status would be inconsistent with long term reliance on a revenue guarantee or a financial guarantee that transferred market risks to the Commonwealth. However, it is unlikely that NBN Co will require a level guarantee large enough to trigger a review of its PNFC status.

Under competitive neutrality guidelines, NBN Co should not gain an advantage over the market by virtue of its Government ownership and as such would need to compensate Government on a commercial basis for the use of any guarantee.

195 For details, viewed 19 February 2009, <www.guaranteescheme.gov.au>

196 Under *Financial Management and Accountability Amendment Regulations* 2009, Regulation 14

197 Department of Finance and Deregulation 2003, *Guidelines for Issuing and Managing Indemnities, Guarantees, Warranties and Letters of Comfort*, Canberra

8.3 Creating funding certainty for NBN Co

Government will need to play a significant role in providing funding for NBN Co. Under a range of conservative business case scenarios, this funding requirement is projected to be in the range of $21–28 billion.[198] This will require increasing allocated funding substantially above the $2.4 billion currently available in the Building Australia Fund.[199]

NBN Co and the market need certainty that the required funding will be made available. Suppliers and partners need to know that NBN Co is able to meet its contractual obligations on time. The management need such certainty as a basis for decisions and planning.

A formal agreement such as a share subscription agreement between Government and NBN Co would provide this certainty. As an additional indication of funding certainty, Government could consider using or replicating the funding mechanisms in the Building Australia Fund. This would provide additional transparency and would reduce the administrative complexity of going through a legislative process for each year's appropriation.

Recommendation 62. That Government and NBN Co enter into formal agreements for security of funding.

Two subsections follow:

8.3.1 Highlighting the benefits of funding certainty

8.3.2 Putting in place funding certainty for NBN Co.

8.3.1 HIGHLIGHTING THE BENEFITS OF FUNDING CERTAINTY

Creating certainty in the market and within NBN Co has positive effects for the NBN initiative:

- Long term contracts with suppliers and customers become possible. Funding certainty decreases counterparty risk and thus enables NBN Co to enter more favourable contracts with suppliers and partners;
- Funding certainty increases the availability of private sector debt. As stated in the previous sections, it is expected that private debt lenders will require that NBN Co has a high credit rating before they agree to lend. Funding certainty substantially lessens the financial risk of the company and thus enables the company to sustain a higher rating than would otherwise be possible. Ratings agencies view liquidity risk

[198] Assuming debt markets allow NBN Co to raise the maximum amount of private sector debt
[199] Discussions with Government departments

as one of the main risks during roll-out. They will take into account both actions and statements made by Government, in making a credit rating assessment for NBN Co;

- Government's intentions are clearly communicated to other network operators. Secure funding sends a signal to the market that the NBN will be built as planned and that any contractual negotiations should be conducted on that basis. Similarly, correct signalling will encourage competitors to develop a long term competitive response to NBN Co's entrance rather than a short term strategy that could harm the overall industry;
- NBN Co's directors are able to act commercially and fulfil the policy aims of Government. Under a funding agreement, continued funding would be contingent upon the completion of agreed milestones that would further policy goals. Thus the directors of NBN Co would be commercially justified in ensuring that these policy goals were met.

8.3.2 PUTTING IN PLACE FUNDING CERTAINTY FOR NBN CO

Government can create funding certainty by entering into a formal agreement with NBN Co. Government should also consider the optimal way to ensure the necessary funding is appropriated.

Putting in place a formal agreement between Government and NBN Co

One way to create funding certainty for NBN Co is to commit Government to a funding agreement. This could be a share subscription agreement, under which Government agrees to the provision of a fixed amount of funding as consideration for shares in NBN Co. The market would recognise a funding agreement as providing certainty for NBN Co as it would be an enforceable contract between the company and Government.

The key advantage of such an agreement is that it would enable Government to use funding as a discipline linked to progress towards objectives. Funding would be made available by Government up to pre-agreed limits in accordance with NBN Co's corporate plan. Government could structure this agreement to ensure the flexibility to alter its funding commitment as NBN Co's funding requirements develop.

A funding agreement requires either written approval from the Minister for Finance or a sufficient appropriation of funds by Parliament.[200] While Government may own 100 percent of the equity in NBN Co, debt providers and major contractors and suppliers will

[200] Under Regulation 10 of the *Financial Management and Accountability Regulations* 2009, any Government commitment not authorised by the provisions of an existing or proposed law requires written authorisation from the Minister of Finance

place reliance on the funding agreement in entering into contracts. As such, an agreement would be useful early in the life of NBN Co before an Appropriation Bill is passed.

Creating an appropriation structure that increases funding certainty

Government can use an annual or standing appropriation to fulfil its obligations under a funding agreement. If NBN Co is meeting its obligations under such a contract, Government will be bound to provide the agreed funding whether it has been appropriated or not. As such, Government should consider options to ensure that the necessary appropriations have been made.

Under an annual appropriations mechanism, the estimated funding requirement for the following year is included in an Appropriation Bill and passed at Budget or Additional Estimates each year. Under this mechanism, Government requires Regulation 10 approvals for any multi-year commitments to NBN Co as they are not covered by that year's appropriation legislation. Significant administrative complexity can arise due to an ongoing need to estimate and justify the expected funding requirement for the following year. Government would also need to seek appropriations on numerous occasions.

By contrast, a standing appropriation provides appropriation authority outside the annual process. Standing appropriations are a class of special appropriations that enable the appropriation of funds for indefinite periods. Commitments made under a standing appropriation are not subject to Regulation 10 approval. The majority of standing appropriations deal with outflows of funding for purposes such as unemployment benefits and pensions.

This mechanism has been used in the past to fund major projects by appropriating the necessary funds into a special account created by legislation. Examples of this type of appropriation include the Federation Fund Account, which funded substantial capital projects throughout Australia to mark the centenary of Federation, and the National Heritage Trust of Australia Account which gave grants for the Murray Darling Project. More recently, the Building Australia Fund, the Education Investment Fund and the Health and Hospitals Fund, have been created as special accounts under the management of the Future Fund Board.

The use of a special account has a number of benefits for the NBN initiative:

- It enables Government to match funding to NBN Co's needs more easily. The level of uncertainty surrounding the roll-out could create a situation in which funding requirements could change from those estimated year to year. The non-lapsing nature of appropriations in a special account enables the Commonwealth to contribute funding to NBN Co as and when required;
- It enables Government to match funding to NBN Co's performance more easily. Linking funding to specific milestones is easier with a special account because the

necessary funding is ready to be deployed even if NBN Co achieves the milestones earlier or later than expected;

- It improves the transparency of funding. Private sector investors and suppliers take confidence from the public demonstration of commitment from Government. While the presence of a special account does not affect the legal position of Government towards NBN Co, having the funds committed may increase confidence within the market.

8.4 Funding methodologies and assumptions

This section contains a technical explanation of methodologies used to calculate the cost of capital for the NBN and an outline of companies deemed comparable in relevant respects thereby allowing the Implementation Study to apply certain funding estimates.

Two subsections follow:

8.4.1 Cost of capital

8.4.2 Comparable companies to NBN Co.

8.4.1 COST OF CAPITAL

Methodology

The Capital Asset Pricing Model (CAPM) provides a means for estimating the cost of equity. The CAPM provides a theoretical basis for determining a discount rate that reflects the equity risk of a particular investment or business operation. In simple terms, the CAPM states that the returns expected by an equity investor reflect the risk of the underlying investment. The value of this risk is the risk-free rate of return plus a risk premium that reflects the risk the investor bears relative to the general market risk. The required rate of return for equity holders (K_e) is determined using the formula below:

$$K_e = R_f + \beta \times R_M$$

where:

R_f is the risk-free rate of return;

R_M is the equity market risk premium;

β is the risk factor of the investment or business operation, reflecting the unique risk of the investment (beta).

Assumptions

Estimating the inputs to the CAPM formula involves a large degree of subjectivity. Therefore, the basis of each assumption is set out below:

- Risk-free rate;
- Market risk premium;
- Beta.

Risk-free rate

The risk-free rate reflects the return an investor can achieve on a financial instrument with no default risk. In selecting a risk-free rate, the Implementation Study uses a blended risk-free rate that reflects the return on the current 10 year Government bond and the expected long term return on the 10 year Government bond at valuation date.

A risk-free rate of 5.5 percent is applied, reflective of the three-month average[201] of the 10 year Government bond rate as reported by the Reserve Bank of Australia.

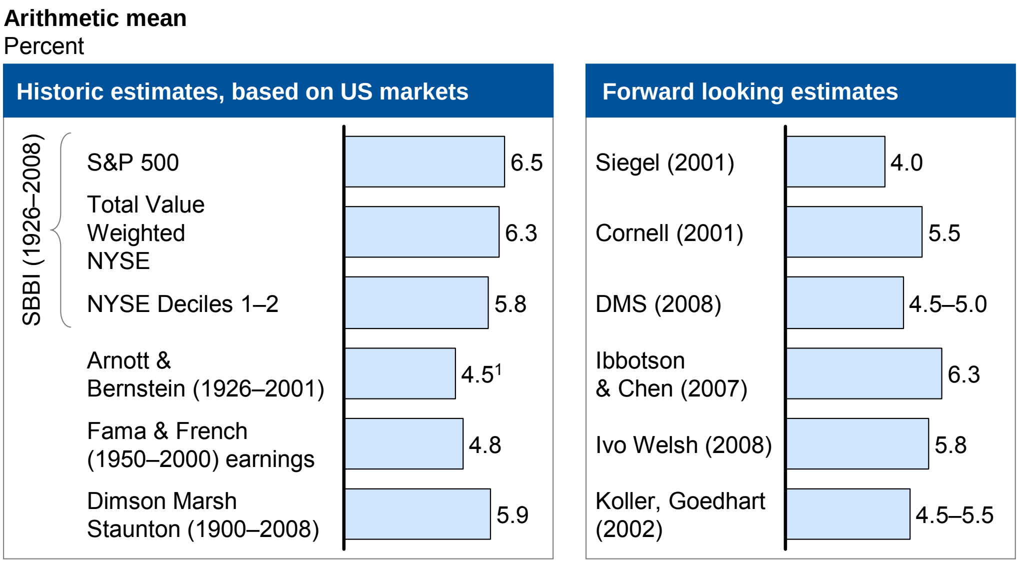
Market risk premium

The market risk premium reflects the excess return that a market portfolio of assets generates over the risk-free rate. Two alternative approaches exist for computing the equity risk premium:

- Historic: the equity risk premium is computed based on historic equity returns less historic risk-free rates;
- Forward looking: the equity risk premium is estimated based on forward looking models, surveys, etc.

Exhibit 8–18 gives an overview of several available estimates, using both methods.

Exhibit 8–18. Market risk premium estimates



SOURCE: Ibbotson 2009, *Stocks Bonds Bills Inflation Valuation Yearbook 2008*; Pratt, S and Grabowski, R 2008, *Cost of capital*; Welch, I 2008, *The consensus estimate for the equity premium by academic financial economists in December 2007*; Credit Suisse *2009, Global investment returns yearbook 2009*

201 November 2009 to January 2010

The Implementation Study uses a range from 5 to 6 percent consistent with the research above.

Beta

The beta factor is a measure of the risk of an investment or business operation, relative to a well-diversified portfolio of investments. In theory, the only risks captured by the beta factor are those risks that the investor cannot eliminate through diversification, referred to as systematic, non-diversifiable or uninsurable risk. The concept of the beta factor is central to the CAPM, given that beta risk is the only risk that investors price into their required rates of return.

The beta for equity securities is measured statistically by regressing the returns on an equity market index, such as the All Ordinaries (Accumulation) Index, against the share price returns of the relevant stock. The market portfolio has an equity beta of 1.0. A beta greater than 1.0 implies that the returns on a stock are, on average, more volatile, and hence the stock is riskier than the market. A beta of less than 1.0 implies the reverse.

Betas derived from share market observations represent equity betas, which reflect the degree of financial gearing of the company. Consequently, it is not possible to compare the equity betas of various companies without taking into account their gearing levels. To strip out the impact of financial gearing from the equity beta, the following formula is applied:

$$\beta u = \frac{\beta_L + \left[\beta_D \times \left(\frac{D}{E}\right) \times (1-t)\right]}{1 + \left(\frac{D}{E}\right) \times (1-t)}$$

where:

βu is the unlevered (asset) beta;

β_L is the levered (equity) beta;

β_D is the beta of debt;[202]

t is the corporate tax rate;

D/E is the debt-to-equity ratio of the relevant equity security.

[202] In our calculations, we assume debt Betas of 0.27 for investment grade companies and 0.37 for speculative grade companies. See Chapter 10 in Koller, T, Goedhart, M & Wessels, D 2005, *Valuation: Measuring and Managing the Value of Companies 4th edition*, John Wiley & Sons, New Jersey

Exhibit 8–19. Asset betas

Companies	Country	Equity Beta	Asset Beta	Debt / (Debt + Equity)	Credit rating
Telecommunication companies, median			**0.66**	**34%**	
AT&T	US	0.79	0.68	32%	A/A2
Belgacom	BE	0.49	0.46	23%	A+/Aa3
BT Group	GB	1.13	0.75	55%	BBB
Cable & Wireless	GB	1.00	0.96	20%	BB-/Ba3
Deutsche Telekom	DE	0.55	0.44	52%	BBB+/Baa1
France Telecom	FR	0.55	0.46	47%	A-/A3
Singapore Telecommunications	SG	0.88	0.82	14%	A+/Aa2
Telecom Corp. of New Zealand	NZ	1.08	0.86	37%	A/A3
Telefonica	ES	0.71	0.59	37%	A-/Baa1
Telenor	NO	1.00	0.85	30%	A-/A3
Telstra	AU	0.52	0.47	29%	A/A2
Verizon Communications	US	0.73	0.65	37%	A/A3
Domestic infrastructure, median			**0.77**	**52%**	
Australian Infrastructure Fund	AU	1.05	0.99	14%	N/A
MAp Group	AU	1.10	0.76	61%	BBB-
Transurban Group	AU	0.60	0.54	37%	N/A
Connecteast Group	AU	1.08	0.80	57%	N/A
Transfield Services	AU	1.04	0.72	74%	N/A
Macquarie Infrastructure Group	AU	0.98	0.82	46%	N/A
Challenger Infrastructure	AU	0.99	0.58	79%	N/A
Toll Holdings	AU	0.80	0.78	18%	N/A
Domestic utilities, median			**0.49**	**59%**	
AGL Energy	AU	0.62	0.60	15%	BBB
Origin Energy	AU	0.71	0.71	21%	BBB+/Baa1
Infigen Energy	AU	1.09	0.76	61%	N/A
Envestra	AU	0.96	0.50	74%	BBB-/Baa2
Spark Infrastructure	AU	0.66	0.48	57%	Baa1
SP Ausnet	AU	0.50	0.40	67%	A- / A1
DUET Group	AU	0.84	0.47	78%	BBB-
Hastings Diversified Utilities	AU	0.52	0.47	46%	N/A
International utilities, median			**0.60**	**44%**	
Snam Rete Gas	IT	0.39	0.38	34%	N/A
Enagas	ES	0.84	0.65	44%	AA-/A2
Fluxys	BE	0.63	0.58	32%	N/A
Terna	IT	0.53	0.46	43%	A+ / A2
National Grid	GB	0.62	0.44	62%	A-/Baa1
Elia	BE	0.44	0.33	73%	A-
Oest Elektrizitatswirts	AT	0.86	0.76	24%	A- / A2
Red Electrica	ES	0.74	0.60	37%	AA- / A2
Aguas De Barcelona	ES	1.03	0.97	37%	A- / A2
Hera	IT	0.80	0.60	51%	A- / A2
United Utilities	GB	0.69	0.46	63%	A-
EVN	AT	0.78	0.64	42%	A- / A2

Source: Bloomberg; company reports

To determine the applicable equity beta for NBN Co, firstly a range of asset betas from market sources and an analysis of potential comparables is derived. The range of asset betas used is between 0.50 (consistent with the ACCC's asset beta assumptions for the telecommunications sector[203]) and 0.65 (based on our analysis of comparables detailed in Exhibit 8–19). The equity beta is estimated based on a typical capital structure for the industry. The Implementation Study assumes Debt/(Debt+Equity) ratios between 50 and 60 percent.

Cost of equity calculation

Exhibit 8–20 shows the details of our calculation of NBN Co's cost of equity in its operations phase.

Exhibit 8–20. Cost of equity

	Low	High	Comments
Asset beta	0.50	0.65	
Debt/(Debt+Equity)	50%	65%	Target capital structure
Gearing (D/E)	100%	186%	
Corporate tax rate	30%	30%	
Debt Beta	0.27	0.27	Investment grade
Equity Beta	**0.66**	**1.14**	[1]
Market risk premium	5.0%	6.0%	[2]
Risk-free rate	5.5%	5.5%	[3]
Cost of equity	**8.8%**	**12.4%**	[1] * [2] + [3]

Source: Implementation Study

203 See page 76 of ACCC 2009, *Assessment of proposals National Broadband Network Process: Report to Expert Panel Appendices*, Canberra

8.4.2 COMPARABLE COMPANIES TO NBN CO

Exhibit 8–21. Comparables valuation multiples and Debt/EBITDA ratios

Company	Country	Net Debt/ Forecast EBITDA	EV/EBITDA Historic	+ 1 year	+ 2 years
Telecommunication companies, median		**1.5**	**5.4**	**5.1**	**5.0**
AT&T	US	1.9	5.4	5.6	5.4
Belgacom	BE	1.7	5.2	5.5	5.5
BT Group	GB	4.1	6.3	4.3	4.3
Cable & Wireless	GB	0.7	5.3	4.6	4.3
Deutsche Telekom	DE	3.4	4.9	4.3	4.3
France Telecom	FR	3.3	4.4	4.9	4.9
Singapore	SG	0.9	12.0	9.8	9.4
Telecom Corp. of New Zealand	NZ	1.1	4.1	3.9	3.8
Telefonica	ES	3.5	6.1	6.3	6.2
Telenor	NO	0.3	6.1	6.1	6.6
Telstra	AU	1.4	5.4	5.1	5.0
Verizon Communications	US	1.4	5.4	5.0	4.8
Domestic infrastructure, median		**6.8**	**13.9**	**12.8**	**12.6**
Australian Infrastructure Fund	AU	1.0	n/a	8.5	7.8
MAp Group	AU	7.6	2.7	15.2	14.1
Transurban Group	AU	7.3	22.2	21.1	20.9
Connecteast Group	AU	14.1	59.3	29.6	22.4
Transfield Services	AU	6.3	13.4	11.3	11.4
Macquarie Infrastructure Group	AU	4.2	n/a	12.5	7.4
Challenger Infrastructure	AU	9.6	14.3	13.2	13.8
Toll Holdings	AU	0.5	10.2	8.9	7.8
Domestic utilities, median		**5.4**	**12.5**	**9.4**	**9.0**
AGL Energy	AU	0.6	27.3	8.4	7.7
Origin Energy	AU	-0.2	12.5	10.0	7.8
Infigen Energy	AU	4.9	9.4	9.1	8.9
Envestra	AU	7.0	9.6	9.4	9.0
Spark Infrastructure	AU	8.2	n/a	14.5	15.2
SP Ausnet	AU	6.0	12.8	11.3	10.7
DUET Group	AU	6.8	11.8	9.3	8.5
Hastings Diversified Utilities	AU	4.0	20.2	9.4	9.7
International utilities, median		**5.6**	**9.2**	**9.0**	**8.4**
Snam Rete Gas	IT	5.5	12.0	9.6	7.6
Enagas	ES	5.7	9.3	8.3	7.3
Fluxys	BE	3.4	8.0	7.9	7.6
Terna	IT	5.6	9.2	9.1	8.4
National Grid	GB	9.7	9.9	9.0	8.7
Elia	BE	11.6	7.8	15.7	14.9
Oest Elektrizitatswirts	AT	3.6	9.7	9.7	10.2
Red Electrica	ES	5.7	10.2	9.4	8.5
Aguas De Barcelona	ES	1.2	6.6	6.5	6.2
Hera	IT	4.6	7.0	5.9	5.4
United Utilities	GB	9.5	8.7	8.4	9.3
EVN	AT	5.5	9.9	9.6	8.5

Source: Bloomberg; company reports

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C Ensuring a competitive telecommunications industry

Superfast broadband infrastructure has the potential to enable a new generation of services. Some of these we know, some we can imagine and some we are yet to discover. Government must ensure that the NBN's design, regulatory framework and impact on the broader telecommunications market structure support the development and widespread adoption of innovative services.

Although the underlying infrastructure of the NBN provides the technical capabilities to power this transformation, enabling competition and a healthy market structure are critical to delivering long-term outcomes. Government has a significant role to play in ensuring that the new industry evolves into a sustainable and dynamic structure in which service providers compete to drive long-term innovation, technological progress and cost efficiencies.

Across the different phases of implementing the NBN, the key challenges faced will change, reflecting the growth of the network and the evolution of market structure. Policy mindsets will have to adapt in response (Exhibit C–1).

Exhibit C–1. NBN challenges and proposed policy mindset over development phases

	1 Build the NBN and transition the industry	2 Prepare for privatisation	3 Sustain a world-class competitive telecommunications industry
	2009 NBN Co established	**2018** Roll-out complete	**2023** Privatisation
Key challenges to overcome	▪ Huge and complex engineering project ▪ Strength of Telstra's position ▪ Migration of customers	▪ Conflict between coverage and competition goals and maximising profitability and proceeds from privatisation	▪ Regulating a monopoly to deliver fair prices and innovation
Overarching policy mindset	▪ Suspend further fixed-line infrastructure-based competition to reshape industry BUT invest in future proofing for future competition	▪ Make adjustments for post- roll-out and privatisation competition	▪ Prevent NBN Co from engaging in undesirable monopoly conduct

SOURCE: Implementation Study

It is only natural that in the short-term the emphasis be on how to build the network and transition the industry (the first phase). The NBN is a huge and complex engineering project, which will be challenging to implement operationally at a national scale, and under pressure to generate a revenue stream by activating customers as soon as possible. It is also important during this initial phase to ensure that the framework of pricing regulation is consistent with Government's objective of providing affordable superfast broadband services to all Australians.

Even at the early stages of establishing the NBN however, Government's policy framework must anticipate the market structure and competition outcomes that it seeks to achieve in the longer term (Phases 2 and 3). In particular, Government needs to prevent NBN Co from making decisions that may facilitate network deployment in the short-term but ultimately frustrate Government's long-term policy objectives.

Part C consists of two chapters:

- Chapter 9 sets out the risks to creating a vibrant NBN-enabled market and delivering on Government's competition policy objectives in the long-run
- Chapter 10 proposes a suite of measures to mitigate these risks and deliver the desired competition outcomes.

9 Understanding adverse competition scenarios

SUMMARY

- The innovation path for services and business models enabled by new, long-lifespan technologies is uncertain. Decisions made today around implementing the NBN need to anticipate a range of possible innovation paths and should support the development of a vibrant market along any of these paths in the long run.
- NBN Co's open-access, wholesale-only status is not sufficient to preclude the development of adverse competition scenarios. Concentration of ownership in backhaul and/or content can stifle market dynamics. Fierce competition with limited investments in infrastructure can stifle innovation.
- Allowing the NBN fibre infrastructure to achieve monopoly status across most of the fibre footprint is desirable at the passive layer over the long term for reasons of investment efficiency, provided it is capable of supporting sufficient active-layer competition.
- Allowing monopoly status to extend into the active layer is also acceptable in the short-term to ensure a level playing field for retail providers, and to give NBN Co flexibility on service pricing. However, this presents longer-term risks of adverse monopoly conduct by NBN Co that must be guarded against.

Enhancing competition is one of the objectives of the NBN initiative. It is the rationale for NBN Co's open-access, wholesale-only model. The NBN is intended to foster a healthy service provider market by providing equivalent access to world-class broadband infrastructure. While this approach resolves the issue of equivalence at the retail level, adverse competition outcomes may still develop over the long asset lifespan of the passive fibre infrastructure.

This chapter lays out the risks to creating a vibrant NBN-enabled market and delivering on Government's long-run competition policy objectives. It is organised in five sections:

9.1 Acknowledging uncertainty in the evolution of broadband markets

9.2 Recognising future retail market structure challenges

9.3 Ensuring scope for competitive investment in service innovation

9.4 Anticipating potential adverse monopoly conduct by NBN Co

9.5 Learning from international experience.

9.1 Acknowledging uncertainty in the evolution of broadband markets

The NBN initiative constitutes a significant national investment and the lifetime of the passive infrastructure will be very long. It is important, therefore, that the project be designed not just with the next decade in mind but with a view to the long-term future of Australian telecommunications.

This section explains the need to recognise the uncertainty in the future evolution of telecommunications and allow for flexibility to respond to changes in technology and competitive dynamics. Two subsections follow:

9.1.1 Factoring in the pace of change in technology and applications

9.1.2 Imagining different futures with many possible business models.

9.1.1 FACTORING IN THE PACE OF CHANGE IN TECHNOLOGY AND APPLICATIONS

Constant change is a cornerstone of telecommunications. Innovation in technology and applications is fast-paced and quickly diffused into society, transforming the way we live and work. Consider the music industry's shift to online distribution platforms. Although the iPod was introduced less than a decade ago, digital distribution is now the focus of the industry, with iTunes accounting for 25 percent of industry revenues[204] and still growing strongly within a declining industry revenue pool.[205]

Innovation enables market entrants to adopt new business models that translate into new products and services for end users. Some of the most influential companies today are based on Internet services like search engines, and have started to innovate in areas previously the domain of incumbent telecommunications companies. For example, Skype now offers voice-over-IP services which have the potential to displace carriers' voice revenues. This is a recent and rapid development; Skype was founded less than a decade ago, whereas Telstra has provided voice services for over a century.

The direction of this innovation is difficult to predict. When long-lifespan infrastructures have been rolled out in the past, the full extent of the innovation they would unleash has never been accurately predicted. The copper network originally deployed for voice communications and the coaxial network originally deployed for TV broadcasting are

[204] Huges, N 2009, 'iTunes a quarter of music sales; Apple a third of Wi-Fi use', *AppleInsider*, 18 August, viewed 16 February <http://www.appleinsider.com/articles/09/08/18/itunes_a_quarter_of_music_sales_apple_a_third_of_wi_fi_use.html>

[205] Pfanner, E 2010, 'Music Industry Counts the Cost of Piracy', *International Herald Tribune*, 21 January

now used for IP-based communications between machines not envisaged during their original planning.

Similarly, the full extent of the innovation potential created by NBN's fibre infrastructure cannot be predicted today. All we know is that innovation will take place rapidly, and its impact is likely to be dramatic. It is critical to factor this uncertainty into today's decisions, despite the time-pressure to start providing services and capturing the benefits of the NBN.

Underestimating uncertainty could lead to decisions that may facilitate network deployment, but which ultimately prove short-sighted in constraining the full potential of the new infrastructure. Accounting for uncertainty in the policy framework is the only way to mitigate the risk.

> **Highlight.** The pace of change in technology is rapid and accelerating, making it difficult to predict the innovation path for services and business models enabled by new long-lifespan broadband infrastructure. The decisions surrounding the deployment of the NBN need to account for this uncertainty to avoid constraining future innovation and market evolution.

9.1.2 IMAGINING DIFFERENT FUTURES WITH MANY POSSIBLE BUSINESS MODELS

New broadband services can result from developments at the network, the device, and the applications level, as illustrated in Exhibit 9–1 for premium video content delivery. These three different innovation paths both compete and coexist—different services exploit different paths, and some sophisticated service offers exploit all three simultaneously.

Network-based innovation path

New services may result from developments at the active layer of the network. A clear, recent example of this innovation is the use of ADSL transmission of data through the non-voice spectrum on copper telephone lines, requiring direct physical access to the copper. In countries where the copper was not open-access, many incumbents resisted the implementation of ADSL due to concerns that VoIP would cannibalise their PSTN revenues.

Exhibit 9–1. Different innovation paths deliver premium video content today

Innovation path	Service category	Example
Network-based	IPTV	Telstra T-Box, TPG TV
Device-based	Smart set-top box	Apple TV, Foxtel iQ
Applications-based	Video portal	Hulu, YouTube

Source: Implementation Study

Similar possibilities exist on optical fibre. Just as data transmission over copper uses electromagnetic spectrum, so too is the case for fibre. This can be used in a variety of innovative ways. For example, many carriers today use different wavelengths in the access network for carrying data, television signals and, in some cases, voice. In the future, the flows of light could be manipulated in different ways to meet different user requirements—for example, the use of quantum states for cryptography, which has already been demonstrated at scale.[206]

This innovation path is driven and controlled by the active network operator. A retailer seeking to deploy new services requiring new active network capabilities must either persuade the current active layer operator to implement these new capabilities on their active equipment, or else gain access to dark fibre on which the retailer can add its own, enhanced active equipment. Seen from a different perspective, this means that a wholesaler holding a monopoly over the active layer of the network has the power either to block or to enable innovation that requires upgrades to active equipment. Active-layer competition, enabled by either wavelength unbundling or physical unbundling, may be necessary to resolve this issue (Chapter 10).

Device-based innovation path

Devices can also enable new services using an existing network. In this case, the service is network-independent, and is enabled and controlled by the industry participant offering the devices and managing the necessary platform.

An example of this path is network gaming on consoles—for example, the Xbox, where Microsoft's servers connect multiple providers together around the world, using a variety of network types to complete the connections. A recent example in the communications space is the Nexus One smartphone from Google, which can be used on many networks and provides a full range of services and applications.

Applications-based innovation path

Finally, applications can be deployed that use existing networks and devices. This has been the prevailing mode of innovation to date in the Internet age, as web-based services have grown at unprecedented rates, the most recent spectacular example being Facebook, which acquired over 100 million users in its first 5 years of operation.[207] Consumers equipped with standardised devices and Internet connections are able to access a wide range of services.

[206] Pease, R 2008, 'Unbreakable' encryption unveiled', *BBC News*, 9 October 2008, viewed 16 February 2010, <http://news.bbc.co.uk/2/hi/science/nature/7661311.stm>

[207] Facebook 2010, *Company Timeline*, viewed 16 February 2010 <http://www.facebook.com/press/info.php?timeline>

This mode of innovation is compelling as it allows new services to be deployed with minimal investment: potential users have already purchased the necessary hardware (and, in some cases, software), and the application can be delivered almost instantly over a broadband connection. This method of distribution is ubiquitous for static media content, asynchronous communications (such as email), and e-commerce platforms (for example, eBay). However, it does reach limitations of standard hardware and connections for applications such as voice (where quality of service is essential) and rich media delivery (for example, IPTV).

Preparing for multiple innovation paths

Predicting which of these paths will dominate is very challenging, as demonstrated by numerous examples of inaccurate expert predictions made over the life of the computing sector. There are myriad scenarios for the market structure and business models that could emerge throughout the lifetime of the fibre infrastructure. The Government must ensure that its substantial investment does not presuppose a specific outcome and foreclose alternate scenarios.

> *There is no reason anyone would want a computer in their home*
>
> Ken Olsen, founder of mainframe-producer DEC, 1977.[208]

Over the history of communications technology, the dominant mode of innovation has shifted several times. In the 1960s and 1970s, the advances in telecommunications were predominantly in the core, with the advent of digital switching and fibre backbones. The 1980s saw the advent of faxes and faster modems; devices which unlocked new modes of communication within the limitations of a voice-optimised network. Since the 1990s, applications have flourished as the Internet and mass computing have enabled global entrepreneurship.

Many commentators believe that the future lies in devices and applications acting in concert, with a ‘dumb IP’ pipe providing the linkages between these. This is certainly plausible. However, networks could continue to play a critical part in future services. There are efforts in progress at several universities which consider a world beyond today’s unmanaged Internet.[209] Issues such as net neutrality, investment incentives and traffic volumes are emerging, as the current ‘best efforts’ architecture becomes increasingly central to billions of lives around the globe. There is no consensus on how the global network should, or will, evolve.

A new network such as the NBN should anticipate multiple paths of industry evolution. Industry consultation, debate, and public scrutiny should continue as the initial

[208] Crovitz, G 2009, ‘Technology predictions are mostly bunk’, *Wall Street Journal*

[209] For example, Stanford University’s Clean Slate interdisciplinary research program <http://cleanslate.stanford.edu>

specifications for NBN services are developed. If poorly defined, these specifications could limit or bias the innovation paths through which new applications are developed, favouring some providers or business models and distorting healthy market competition. There is also a risk of diverging from global standards.

Highlight. Innovations enabled by NBN could develop along different paths that result in different business models for the market participants in the future. Choices today that limit the range or bias the possible development of broadband models can distort the natural evolution of a healthy competitive market, preventing innovation throughout the life of the infrastructure.

9.2 Recognising future retail market structure challenges

Even with the requirement that NBN Co operates on an open-access, wholesale-only model, future adverse competition scenarios can still unfold if additional measures are not implemented. The following five subsections explain what those scenarios are and how they can develop:

9.2.1 Recognising that backhaul concentration could stifle competition

9.2.2 Recognising the importance of interconnection arrangements

9.2.3 Contemplating the possible failure of Layer 3 markets

9.2.4 Recognising the potential impact of content concentration

9.2.5 Recognising the risk of retail margin erosion limiting innovation.

9.2.1 RECOGNISING THAT BACKHAUL CONCENTRATION COULD STIFLE COMPETITION

As we discuss in Chapter 6, backhaul is a key network element to support retail products. A controlling position in backhaul markets may result in a controlling position over all NBN-enabled services in the regions served by that backhaul. Given the significant numbers of monopoly links in regional areas today, creating an affordable transit backhaul network will be critical to ensuring nationwide competition.

However, backhaul-related risks to healthy retail competition remain even once affordable, open-access backhaul is available. As we discuss in Chapter 6, if Telstra is granted access to connect below NBN Co's POIs using its own backhaul network, it will gain a cost advantage over other retailers. Hence the Implementation Study recommends that such access not be permitted. There are also many duopoly links, where NBN Co will not initially deploy backhaul, and there is risk of uncompetitive pricing in these areas—particularly given the vertically integrated business models of the two largest backhaul operators. As noted in Chapter 10, the Government should ensure that the backhaul market is monitored to ensure availability of affordable backhaul to NBN customers—for example, by permitting NBN Co to provide additional backhaul links in the future.

9.2.2 RECOGNISING THE IMPORTANCE OF INTERCONNECTION ARRANGEMENTS

Currently, ISPs seeking to connect their customers to other networks must employ a combination of peering and transit arrangements. Today, Australia has a bifurcated peering landscape, where four large service providers peer with each other, and the remaining providers peer mainly through multi-lateral peering (MLPA) at Internet Exchange (IX) fabrics (WAIX in Perth, for example). However, the scale of the major providers necessitates the purchase of significant transit capacity by smaller operators.

Transit capacity is a significant cost driver for ISPs. While prices continue to decline (currently suggested to be below $200 per Mbps depending on the purchasing scale[210]) this is offset by the steep upwards trend of customer consumption patterns and pressure on ISPs to provide increasingly generous download quotas. It has been highlighted as a barrier to providing affordable, high bandwidth services. The implications of these costs vary depending on the business model in question. For retail service providers, they raise the cost of Internet traffic. For content or application providers, they increase the economic hurdles to reaching end-users. The NBN will impact each of these providers in different ways.

Content providers should have more options to create high-bandwidth links with end users under the NBN construct. The NBN Co's Layer 2 offering should enable Layer 3 wholesale providers to offer direct-to-end-user connectivity, and the multi-operator home environment will allow wholesale providers to deliver content to the premises without being the primary phone and Internet carrier. For the delivery of rich, premium content and services to end-users, this environment should be better-suited than today's commercial landscape.

While Internet service providers will also benefit from these greater opportunities to tailor their customer-facing connections, it will still be their responsibility to secure connections to other providers and to the global Internet. Given the recommendation that the NBN not participate at Layer 3, there is no practical mechanism for NBN Co to intervene in the current peering and transit market beyond the provision of affordable Layer 2 transit backhaul services on currently uncompetitive links.

Nonetheless, the Implementation Study believes this limited intervention is appropriate, as the peering environment has been strengthening locally, and international transit pricing is falling steadily. In addition, NBN Co's intervention in the transit backhaul market is likely to drive further third party investment in the Layer 3 market.

[210] Stakeholder interviews

9.2.3 CONTEMPLATING THE POSSIBLE FAILURE OF LAYER 3 MARKETS

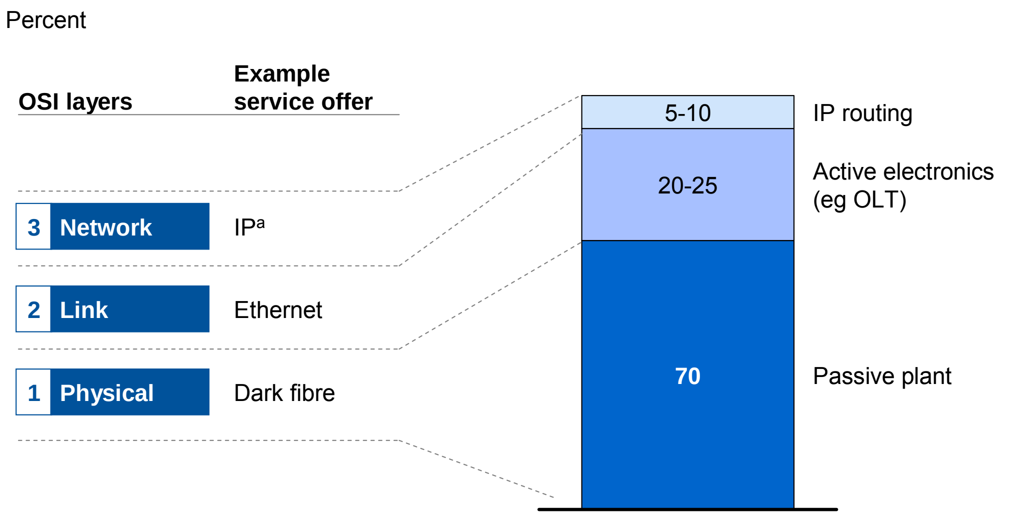
The NBN will make available all the necessary Ethernet network elements to create a Layer 3, likely IP, network at reasonable cost. The cost of routers and switches to create a national Layer 3 network is difficult to estimate without defining a specific configuration, but is an order of magnitude less than deploying active electronics (Exhibit 9–2). The levels of investment are expected to be viable for many participants in the Australian market. Regional operators could create Layer 3 functionality for a fraction of this amount.

It is reasonable to expect that given the low barriers to entry, wholesale Layer 3 providers will emerge—either as standalone businesses, or as wholesale arms of retail providers. Furthermore, national networks will not be required on day one. As NBN Co begins to commission POIs, Layer 3 operators can deploy equipment progressively, managing their investment and optimising their model as the NBN grows. In addition to wholesale providers, it is likely that there will be sufficient competition between Layer 3 retailers to ensure customers have access to a wide range of IP-enabled services. End users will receive better services, and more choice, in either case.

There are several participants in the Layer 3 wholesale market today, although mainly in the enterprise space, with national mass-market access offers served primarily by Telstra and Optus. These resale DSL services are no longer compelling for retailers—customer numbers at the largest provider, Telstra Wholesale, are declining rapidly.[211] Pricing and specifications of these wholesale products are unattractive to vertically integrated retail ISPs, who prefer to operate their own DSLAMs over unconditioned local loop (ULL) services. These wholesale products are typically intended for resale as Internet lines; there are no truly viable options for niche service providers to reach the home directly via a managed IP service

[211] Telstra 2009, *Annual Report 2009*

Exhibit 9–2. Cost elements for providing national Layer 3 connectivity



a. Routing costs are highly dependent on network specifications and market share of operator
SOURCE: Implementation Study cost modelling; industry interviews

A diverse, mass market, national Layer 3 market could be slow to emerge. Most operators of Layer 3 networks initially will be retail ISPs and telecommunications carriers, who will focus on using their own IP services to deliver today's retail offers of broadband, voice, and TV. As a result, some services which require bespoke, new IP services—for example, home health monitoring that depends on real time class of service—may not be delivered immediately.

However, these services should in most cases be complementary to today's ISP and telecommunications services, and carriers could be expected to pursue these wholesale opportunities over time. A worst case scenario is possible if Layer 3 becomes commoditised, consolidated, and dominated by one or two national providers. In this case, a small number of concentrated providers could exercise control over the product offerings at Layer 3, and potentially foreclose retail competition. If Layer 3 competition is limited in particular regions, those areas would suffer from a

We're going to have quite a concentrated market at Layer 3 which will raise regulatory questions. Layer 3 infrastructure has to be built by someone - Telstra and Optus Wholesale are almost guaranteed - but beyond that it's quite tricky to see who would be prepared to build a Layer 3 network.

David Kennedy
Research Director, Ovum[212]

[212] Crozier, R 2009, 'Ovum queries Layer 3 outlook under NBN mode', *itNews*, 7 December, viewed 15 February 2010, <http://www.itnews.com.au/News/162276,ovum-queries-layer-3-outlook-under-nbn-model.aspx>

poorer set of available options. Limited competition would also limit the prospects for ASPs and other non-carrier operators.

Should the Government conclude in the future that a Layer 3 market is not functioning, to the detriment of innovation and end-user benefits, intervention may be justified. One option would be to address shortfalls through regulation—for example, obliging retail service providers to offer a Layer 3 service which can support applications deemed important to the public interest. Another option, given the relatively low cost of deploying a national Layer 3 network, would be for Government to tender for the deployment of a Layer 3 service with Government as an anchor customer. Such a network could support public services such as health and education, as well as serving ASPs who are unable to source the wholesale services they require in the market.

At this stage, such measures would be premature. Ongoing ACCC monitoring of this market will enable Government to identify any further interventions that are necessary to foster healthy competition.

Highlight. It will be hard to judge the health of the Layer 3 market for some time, as it is currently nascent, and is dependent on emerging services such as smart grids and other ASP services. It will be difficult to create a simple test, such as market concentration. This market should be monitored and an expert review commissioned if it appears that further intervention is required.

Recommendation 63. That the Government request the ACCC to monitor and report annually on the market for Layer 3 telecommunications services.

9.2.4 RECOGNISING THE POTENTIAL IMPACT OF CONTENT CONCENTRATION

As the NBN creates a level playing field for network connectivity, content could become a basis for retailer differentiation. Content has been critical in other markets to promote consumer take-up and differentiate fibre from legacy broadband networks. For example, in the USA, Verizon is able to deliver a pay TV offering over its FiOS network which contains the same core content offers as Comcast’s cable network. Australia’s content market is concentrated; there is a risk that today’s incumbent content owners may translate this concentration into a strong influence over the market for retail telecommunications services delivered over the NBN. The importance of content as a strategic tool has been seen in Singapore, where the English Premier League rights are a significant driver of consumer preference, and have been hotly contested between Singtel and StarHub.[213]

213 ipTVnews 2009, ‘SingTel wins rights to English Premier league’, *ipTVnews*, 2 October, viewed 16 February 2010,

Business models for the delivery of content—particularly premium video content—may change radically over the period of the roll-out. It is difficult for the NBN to influence today's content market dynamics, but it can ensure that the conditions exist for future content business models to emerge. In practice, this means supporting open-access platforms wherever possible, for example, in any TV/video distribution services contemplated. This principle should be incorporated in the formulation of the NBN services portfolio as detailed in Section 3.2.

Beyond the NBN, a range of other regulatory issues will also strongly influence the sustainability of competition in the content and application markets supported by the network. These include net neutrality (content non-discrimination), local content laws, cross-media ownership restrictions, anti-siphoning regulations, spectrum planning and broadcast licensing.

9.2.5 RECOGNISING THE RISK OF RETAIL MARGIN EROSION LIMITING INNOVATION

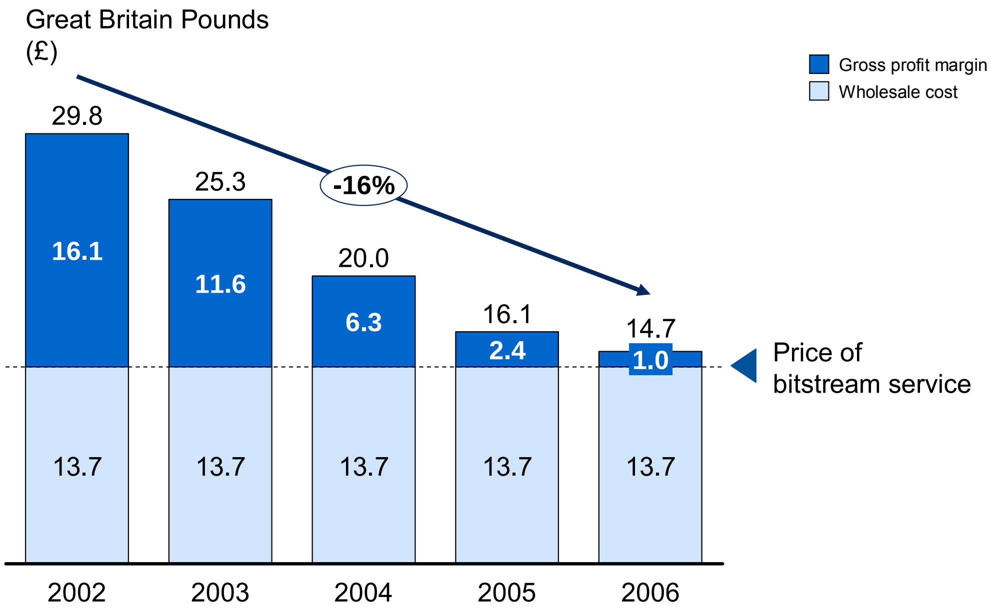
The desire to facilitate competition by smaller service providers on an equivalent basis, if taken to the extreme, could stifle innovation by allowing insufficient scope for product differentiation. If the wholesale product is already highly specified, the retail service provider is likely to become a reseller, providing marketing, sales, billing, and support services, but limited value-add in service functionality—a model currently seen in the electricity retailing market.

A likely outcome under this scenario is strong price competition, with the benefit of cheap products for consumers, but the risk of stagnation in the market due to the lack of sufficient returns to fund innovation.

The UK market experienced such an aggressive, resale-driven market between 2002 and 2006, as shown in Exhibit 9–3. During this time, innovation and network upgrades were limited, and price-based competition prevailed. Tiscali, Wanadoo, and Pipex all emerged as competitors to BT, with offers positioned largely on price rather than features, and usage caps employed to reduce entry-level price points.

<http://www.iptv-news.com/iptv_news/october_09/singtel_wins_rights_to_english_premier_league>

Exhibit 9–3. Effect on margins of competition in UK DSL Internet market



SOURCE: Ofcom; Implementation Study

While such an outcome may seem superficially attractive for consumers in the short-term, the lack of investment in technological innovation and upgrades in such a dynamic industry would quickly lead to Australia falling behind other developed nations. Ultimately, such unsustainable competition is likely to end in consolidation and the erosion of the short-term advantage to consumers.

The risk of a commodity resale service price war in the retail market can be mitigated by preventing NBN Co from operating at Layer 3 (at least initially) and providing service providers with a portfolio of Layer 2 Ethernet products instead, to enable them to manage their own routing, backhaul capacity, CPE, and interconnect arrangements. Today, we see ULL operators using ULL to deploy IPTV and sophisticated VoIP solutions including hardware. Those same services could be deployed over the NBN using Layer 2 services and the available ports on the ONT. There will then be scope for premium service providers to differentiate themselves from low-cost operators that just sell best-efforts Internet connectivity at the lowest possible price.

Given the uncertain nature of telecommunications market evolution, such a premium strategy will not necessarily be available to retail providers. For example, this strategy would be frustrated if the evolution of the market led to a scenario where innovation had moved predominantly to the cloud—to managed standalone applications—or to devices, with a limited intermediary role for the retailer. The best way to judge whether a healthy market is evolving will be to compare the services available in Australia to international markets, to verify that separation of Layer 2 and Layer 3 services in the industry structure is not preventing the deployment of value-creating services. For example, retail providers around the world may deploy useful services which remain unavailable in Australia due to a lack of appropriate network services at economic prices.

Highlight. NBN Co's open-access, wholesale-only status does not preclude the development of suboptimal downstream market structures. A suite of measures will be required to pre-emptively mitigate the risk of these outcomes, and to ensure that the evolution of the NBN ecosystem is closely monitored.

9.3 Ensuring scope for competitive investment in service innovation

In scale and scope, the NBN initiative surpasses most other fast broadband network initiatives around the world. Moreover, both the market context and approach to the roll-out in Australia are substantially different to those seen in other countries. Telstra is pre-eminent in the telecommunications sector, and has unmatched resources to support building a position in the new industry structure. These unique circumstances must be considered when understanding how competition and a vibrant retail market structure can best be promoted through the NBN in the long term.

Two subsections follow:

9.3.1 Choosing the mode of competition for broadband infrastructure

9.3.2 Accepting a single passive infrastructure for the long term.

9.3.1 CHOOSING THE MODE OF COMPETITION FOR BROADBAND INFRASTRUCTURE

Next-generation broadband access networks are being deployed in many countries around the world. There are broadly two different ways in which competition is being safeguarded in those markets:

- Alternative network infrastructures with vertical integration;
- Open access to a shared passive network that stimulates competition at the active layer.

Alternative network infrastructures with vertical integration

Competition between alternative networks has stimulated the roll-out of next generation broadband infrastructure in several countries around the world. If multiple, competing networks exist in the same area, such as copper and hybrid fibre coaxial (HFC), the operator of one network may invest in an upgrade to enable services more appealing to consumers, thus placing pressure on the second operator to upgrade the alternative network so that its services remain competitive.

Alternative network competition has emerged in countries where legacy cable television networks operate in parallel with the copper telephone network, such as the United States. At the time these cable or HFC networks were deployed, they were dedicated to providing pay TV and did not compete with telecommunications networks. Technical advances soon followed which allowed Internet and voice services to be delivered in conjunction with television over the same HFC infrastructure. Cable and telecommunications companies found themselves competing to provide substitutable services, and were compelled to match each other's performance improvements.

Exhibit 9–4. United States: Access holiday increases returns for fibre roll-out

Case study: United States	
Cable companies move into broadband Internet and voice	Comcast launched its cable modem service, Comcast@Home, in 1996. By 2000, cable providers had around a third of the broadband market, and were gaining share in voice. Through the mid-2000s, triple-play offers from the cable networks posed a significant competitive threat to the telephone companies. Their response was to offer broadband and TV services which could not be delivered over full copper loops from the exchange.
Access holiday instituted	In 2004, the Federal Communications Commission (FCC) announced that, to create greater incentives for investment, new mass-market fibre roll-outs need not be unbundled, other than for voice services.[a] This access holiday contrasts to the strong unbundling requirements placed on existing copper networks under the 1996 US Telecommunications Act.[b] The FCC held that competition from HFC and copper infrastructure meant that the access holiday could provide incentives without unduly reducing competition.
Verizon and AT&T deploy fibre	The combination of competitive pressure from cable operators and the regulatory holiday spurred fibre roll-outs by the two largest United States telecommunications companies, Verizon and AT&T. Verizon began deploying its US$23 billion FiOS FTTP network in 2004, initially delivering up to 50 Mbps download speeds and 20 Mbps upload speeds. The same year, AT&T began its U-Verse FTTN deployment, using VDSL technology capable of delivering download speeds of 18 Mbps and upload speeds of 1.5 Mbps.
Roll-out reaches 15 percent of homes	In total 17.2 million or 15 percent of US had been covered by FTTP deployments by September 2009—compared to 180,000 homes with FTTP access at the time the access holiday was enacted. Actual take-up of services stands at 5.3 million homes connected to FTTP, with 1.5 million connected in the twelve months to September 2009. [c] The Verizon network has now passed 14.5 million premises, or ~45 percent of Verizon's total network footprint.[d] AT&T's FTTN network passed 17 million households as of the beginning of 2009, with plans to pass 30 million by the end of 2011.[e] Roll-outs of both AT&T and Verizon have primarily targeted high value (i.e. income) households.
Subsidies to improve regional services	Government announced US$7.2 billion in 2009 to bring high-speed broadband to unserved and underserved areas. This will be delivered over 2 years through the Departments of Commerce and Agriculture as part of the Obama Administration's economic stimulus package.[f]

a. FTTP deployments are only required to provide an unbundled voice service where the roll-out is in a brownfield area. In the case of 'hybrid' networks such as to the building/node/curb (FTTB, FTTN and FTTC), where there is a copper line to the end user, the incumbent must provide an unbundled voice service regardless of whether the roll-out is in a greenfield or brownfield area.

b. Hundt, R 2000, You say you want a revolution: A story of information age politics, Yale University Press,

c. FTTH Council, North American fiber to the home connections surge past five million, media release, Houston, 29 September 2009

d. Verizon 2009, *FiOS Fact Sheet,* media release, New York, 30 June 2009

e. AT&T, AT&T to invest more than $17 billion in 2009 to drive economic growth, media release, Washington, D.C., 10 March 2009

f. United States Office of Management and Budget 2009, Analytical perspectives: Budget of the U.S. Government, fiscal year 2010, Washington, D.C.

Source: Telecommunications Industry Association, Screen Digest, Implementation Study

As the speeds available over cable started to outstrip those achievable on copper, telecommunications operators responded by deploying more optical fibre, terminating ever closer to customers' premises to deliver competitive performance over an ever shorter 'last mile' of copper. AT&T, for example, deployed extensive FTTN infrastructure, employing a very short copper run for services including IPTV (Exhibit 9–4). The latest generation of HFC software upgrades, DOCSIS 3.0, have delivered speeds high enough to force US telecommunications companies, such as Verizon, to start providing optical fibre directly to the premises.

An important enabler of this vertically-integrated competition was regulatory certainty. Both providers were given certainty by the Federal Communications Commission (FCC) that there would be no requirement for competitor access to their networks. While this compromised competition within each platform, it enabled both providers to formulate investment cases with confidence, and invest significantly in their deployments.

There are several downsides to granting such monopoly guarantees without coverage obligations. One is cherry-picking, in which providers seek to serve only the most profitable areas and households. The second is rent-seeking (charging high prices), which can reduce penetration of services. While it is not apparent that the US has suffered from constrained deployment or take-up, the FCC has signalled an intent to encourage even broader roll-out of superfast services with its 100 Squared initiative. This initiative aims to deliver 100 Mbps to 100 million premises in the US.[214]

Competition between alternative network infrastructures can also be created by horizontally separating a provider who operates two parallel networks. For example, separation of the HFC and copper wireline businesses of Portugal Telecom (PT) in that country led to strong infrastructure-based competition and an anticipated coverage of 25 percent of the population with FTTP by the end of 2009, as described in Exhibit 9–5.

Open access to a shared passive network stimulates competition at the active layer

Open-access requirements compel the infrastructure owner to grant all downstream service providers, including its own retail or downstream businesses, access to its network on equivalent terms. The goal of open-access policies is to create a level playing field that promotes competition rather than allowing a passive infrastructure owner to leverage market power to foreclose downstream competition, an incentive that inevitably exists for bottleneck asset owners. To reduce incentives to frustrate the requirement of equivalent access, a number of governments around the world are also considering or have implemented vertical separation of the incumbent telecommunications company.

214 Atkins W 2010, 'FCC wants 100 Mbps Internet speed by 2020', *iTWire*, 17 February, viewed 18 February 2010, <http://www.itwire.com/your-it-news/home-it/36911-fcc-wants-100-mbps-Internet-speed-by-2020>

Exhibit 9–5. Portugal: Horizontal separation leads to infrastructure competition

Case study: Portugal	
Voluntary spin-off of the HFC network	In response to a hostile takeover bid, incumbent telecommunications provider Portugal Telecom (PT) voluntarily spun off its HFC business in 2006 to create the new cable company ZON Multimedia. ZON inherited PT's HFC network, covering 80–85 percent of the population. This voluntary separation was expected to create value as an alternative to the bid by rival Sonaecom
Infrastructure competition leads to fibre deployment	ZON became a strong competitor to PT's wireline services. Aiming to capture greater market share, it upgraded its transmission system using DOCSIS 3.0 technology, delivering up to 200 Mbps to end users. Unable to match these speeds with copper services, PT began an aggressive FTTP deployment across the country, with the aim of passing 1 million homes (25 percent of the population) by the end of 2009[a]. PT has focused its roll-out on regions where penetration is expected to be 30 percent or more, which are generally business and high income residential areas.
No major government involvement	The Portuguese Government made €100 million available in subsidies for FTTP roll-out, but there was little take-up of the offer because of attached facilities-sharing requirements. There are no official government fibre coverage aims as of 2009.
Multiple providers deploying FTTP	Facing increasingly compelling service offerings from ZON and PT, Soneacom has now begun a rival FTTP roll-out. However, fibre providers are having difficulty differentiating their services given the availability of 200 Mbps cable Internet and IPTV over DSL.

a. Portugal Telecom, PT aims to cover one million households with fibre by the end of 2009, media release, Lisbon, 14 May 2009

Source: Implementation Study

The principal drawback of this approach is that it can be challenging to stimulate investment in open-access passive infrastructure. Such investments are capital-intensive and face significant revenue risk if downstream operators do not commit decisively to deploying electronics and selling services. Government subsidy has typically been required to stimulate the construction of open-access fibre infrastructure, with two models prevailing: sponsorship of an incumbent telecommunications provider to undertake the deployment; or the establishment of a new vehicle to build and operate the network.

Japan and South Korea have both achieved impressive coverage through cooperation between Government and the incumbent provider. In 2008, 24 percent of Japanese households had fibre connections, after the incumbent provider, NTT, was granted tax concessions and other incentives to roll out fibre, and was subjected to an open-access regime that was designed to enable commercial returns (Exhibit 9–6).

In Korea, substantial direct government investments through the incumbent, Korea Telecom (KT), stimulated the country's rise to first place globally on broadband and fibre penetration (see Section 9.5). A similar approach has been adopted by Malaysia under the Malaysian High-Speed Broadband Plan.

Exhibit 9–6. Japan: Government supports NTT fibre roll-out

Case study: Japan	
Incumbent fibre roll-out with subsidies	Japan has the world's fastest average broadband speeds and second highest penetration of FTTH (to Korea) at 11.3 subscriptions per 100 people—24 percent of Japanese households.[a] The majority of this fibre roll-out has been established by the incumbent NTT, taking advantage of a package of tax incentives including accelerated depreciation and deductions for business users, as well as low-cost loans.
Already vibrant broadband market built on access regime	Access to copper was mandated in 1999, with prices set low to reflect the marginal economics of operating and maintaining a fully depreciated network. These moves spawned strong competitors in the DSL market and took Japan from broadband penetration of below 1 percent in 1999 through to 68 percent today.[b] Competitive pressures from DSL, cable and smaller fibre deployments compelled NTT to roll out its FTTP network. Today, fibre is the dominant mode of broadband access in Japan, having overtaken cable in mid-2008.
Open access but with high prices	While NTT is required to grant open access to its fibre network, prices set by the regulator are high enough to guarantee returns on the investment and prevent competitors from undercutting NTT's retail price. Regulated wholesale fibre access prices at 5,200¥ (A$60) per user per month are 4–5 times greater than copper local loop, reflecting that the network is not yet fully depreciated. This leads to retail prices of ~A$75 per month for an uncapped 100 Mbps connection. The Japanese regulatory agencies take an active approach focused on market outcomes, and plan to reassess the access regime and prices in 2010.
Incumbent maintains high market share	While granting open access to its dark fibre, NTT provides retail services and therefore competes against its wholesale customers. As a result, it has strong incentives to maintain retail market share through price and non-price levers and has successfully used them to maintain over 70 percent retail market share of FTTH, with the remainder consisting primarily of customers connected to competing networks—primarily by maintaining small differences between wholesale and retail prices, limiting the margins available to access-seekers.
Ubiquitous coverage	Through subsidies and incentives, the government aims to have FTTH available to over 90 percent of Japanese premises by 2010 as part of its U-Japan Internet policy (U for ubiquitous)[c].

a. FCC 2009, *Next generation connectivity*, report prepared by Y Benkler, Harvard University Berkman Center for Internet & Society, Cambridge, MA. The apparent discrepancy is the result of inclusion of 3G wireless services in the household data

b. Ibid

c. Japan Ministry of Internal Affairs and Communications 2006, 'Approaches to nationwide installation of broadband', Communications News, 8 December, viewed 15 December 2009, <http://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/Releases/NewsLetter/Vol17/Vol17_17/Vol17_17.html>

Source: Implementation Study

Separate start-up networks are being pursued by the New Zealand and Singaporean governments. New Zealand intends to create a series of regional fibre operating companies with partial Government ownership, and is still at the stage of consultation and requesting tenders.

Singapore's Next Generation Network, on the other hand, applies government investment to structurally separated, privately held, passive and active infrastructure companies (Exhibit 9–7).

Exhibit 9–7. Singapore: blank sheet investment, structurally separated from Day 1

Case study: Singapore	
Government funds fibre roll-out	The Singapore Government announced in 2005 its Next Generation Nationwide Broadband Network: a ubiquitous FTTP network to be rolled out across the island nation as part of the Intelligent Nation 2015 plan. Public investment of US$1 billion has been earmarked to fund the roll-out through a series of 'blank sheet' companies.
95 percent coverage by 2012 at 1 Gbps	Singapore's deployment plan aims to have 95 percent coverage of premises with 1 Gbps (1000 Mbps) FTTH connections by mid-2012, with 60 percent coverage by the end of 2010 [a]. These coverage goals are aided by the fact that Singapore is a city-state, reducing the tail end of low density, high cost deployment areas.
Vertically separated from day 1	The companies deploying the FTTP network were created as two vertically separated entities to ensure open access: NetCo and OpCo. NetCo is responsible for passive fibre infrastructure, and OpCo for active equipment (including OLTs and routing equipment) and the provision of wholesale bitstream services. OpCo's wholesale services support retail providers responsible for developing and commercialising voice, data and video.
Cooperation from incumbents	The tender for NetCo (now called OpenNet) was awarded to a consortium including incumbent telecommunications provider Singtel, which owns a 30 percent stake. Singtel retains ownership of ducts, buildings and civil works and leases them in the short term on a commercial basis to OpenNet, but is required to divest these assets into a third company (AssetCo) by 2014 [b]. The tender for OpCo (now called Nucleus Connect) was awarded to Singapore's number two broadband provider, StarHub. The results of these tenders mean that migration from existing network infrastructure can take place in a coordinated rather than competitive environment.
Construction underway	Construction began in 2009, with projected coverage of 15 percent of Singapore's premises by the end of that year [c].

a. OpenNet Singapore 2009, *Fibre rollout*, viewed 10 November 2009, <http://www.opennet.com.sg/network-rollout/>

b. TelecomTV 2008, 'Separation pangs: Singapore's radical network plan highlights fiduciary issues', *TelecomTV One*, 3 October, viewed 10 November 2009, <http://www.telecomtv.com/comspace_newsDetail.aspx?n=43934&id=e9381817-0593-417a-8639-c4c53e2a2a10#>

c. Chai, W 2009, 'Counting down to superhighway', *The Business Times*, 28 October 2009

Source: Implementation Study

Additional case studies on South Korea, Malaysia, Sweden and New Zealand can be found in Section 9.5.

9.3.2 ACCEPTING A SINGLE PASSIVE INFRASTRUCTURE FOR THE LONG TERM

Although both modes of competition discussed in the previous section are viable, infrastructure competition has drawbacks. It creates competition at the layer where innovation is limited—trenches and cables are commodity products—and results in duplicated infrastructure. For example, many houses in the United States and Europe are connected to two networks—cable and fibre—which deliver identical service offerings. Although they benefit from competition, there is capital inefficiency in providing the multiple physical connections for each household. And despite the large capital investments of network operators, there are still many households in most developed nations which are not connected to a high-speed network.

> **Highlight.** The creation of a single national open-access fibre customer access network is economically efficient, as it avoids wasteful duplication of infrastructure.

It is therefore reasonable to take measures to facilitate the creation of a single, national, economically viable, superfast broadband network. A major risk to creating a viable nationwide network is cherry picking, where private firms could compete with NBN Co selectively in the lowest cost regions. This is because the economics of the NBN vary from most profitable in high density, high usage areas to least profitable in low density, low usage areas.

While the competitive pressure of alternative network builders may seem beneficial, such investments result in duplicated investment while eroding NBN Co's revenue share in the most profitable areas, and will make it more expensive—in present value terms—for NBN Co to reach its coverage goals. Such selective competition is inconsistent with the aspiration of creating an open-access fibre customer access network that extends to less profitable regions, particularly with an objective of uniform pricing of the access network. This issue is discussed further in Chapter 10.

> **Highlight.** Competing networks will erode the economics of the NBN if allowed to cherry pick the most attractive areas.

The long-term implications of network diversity may, however, be difficult to judge—today's duplication may be tomorrow's network-based competition. Twenty years ago, cable and telephone connections clearly did not duplicate one another, as they delivered different and complementary services. With this in mind, we must entertain the prospect that alternative networks may offer useful diversity in future. For example, where NBN Co deploys a shared/split fibre architecture, allowing a competitor to deploy home-run fibre alongside NBN Co's fibre may have future benefits, if a large percentage of the market begins to demand services which cannot be delivered over a shared/split fibre topology. While it is appropriate to allow a monopoly passive fibre network to be built on open-access terms, competitors should still be allowed to construct competing networks on reasonable terms, while meeting similar public interest obligations.

Permitting active- and passive-layer integration in the near-term

If a single, passive architecture is endorsed, international experience suggests that the prospect of active-layer competition becomes critical to the long-term health of the market. However, this objective must be reconciled with near-term market realities. While it is important to enable active competition as new generations of technology become available, offering dark fibre access to facilitate this in the short term has significant drawbacks:

- **Potential scale concentration in the active layer.** Few providers would be able to take up the dark fibre service nationally, resulting in limited competition benefits in the near term. There are also technical constraints to nationwide competition. In areas where a shared/split topology (designed for GPON active layer services) is deployed, local splitter-level monopolies would be created, as there is currently no technology to enable sharing of split feeder fibres across multiple active-layer providers;
- **Reduced flexibility in service pricing.** The NBN Co faces a difficult task in driving take-up for new services, with untested demand and a large capital base on which to achieve a return. Flexibility to differentiate pricing by service and user type will be important to achieving take-up and usage on the network. Offering dark fibre too soon is likely to reduce scope for price differentiation in the market;
- **Inefficiency of multiple wholesalers.** Allowing multiple wholesalers from Day 1 would be inefficient and hard to make work commercially for either Government or a private investor. Active electronics are still a significant percentage of the cost, and are significant per household—especially if duplicated by multiple operators**;**
- **Increased complexity of deployment.** Deploying an active network requires the establishment of fibre exchanges (similar to, although smaller than, today's copper exchanges), and the installation of customer ONTs. Coordinating the passive fibre deployment with the installation of competing active electronics would add substantial complexity to the build;
- **Ability to improve NBN Co's commerciality.** Offering active rather than merely passive services allows the company to differentiate pricing between a greater diversity of products to maximise both penetration and revenue. NBN Co can extract more value from the active layer, at a wider range of price points, and thereby cross-subsidise the passive investment.

Achieving dynamic long-term outcomes at the active layer

As shown in Exhibit 9–8, the active-layer electronics advance far more quickly, and independently of, the underlying fibre asset. Having set the course for a single passive fibre infrastructure, the Government must consider how to achieve appropriate dynamic outcomes—innovation, upgrades, and efficiency gains—at the active layer.

The pace of active layer evolution should not be underestimated. Although the NBN's initial fibre access network data rates of 100 Mbps seem ample today, these speeds may well seem insufficient by the conclusion of the roll-out in 2018–19. For reference, consider that the compound growth rate of home user speeds between 1990 and 2010 doubled roughly every 18 months. Applying this growth rate to a 5 Mbps service as a baseline today (some users receive 20 Mbps or above in Australia, and over 50 Mbps in other countries), this would grow to the full 100 Mbps by 2018.

Previous generations of networking equipment have been superseded every 5–10 years—dial-up modems, DSL, ADSL2+, are all examples of this. There is already evidence of this in PON FTTH. BPON/APON was developed as a standard in 1995, and commercialised shortly thereafter, enabling speeds of up to 622 Mbps (shared across users by optical splitting). In the following 10 years, GPON and EPON standards were developed, offering over twice the speed of BPON, and both have been widely deployed

Exhibit 9–8. Difference in industry characteristics of passive and active

	Passive (fibre, ducts)	Active (electronics)
Cost per premises	▪ $2,000–10,000	▪ $300–500
Asset life	▪ 30+ years	▪ 5–7 years
Degree of differentiation	▪ Low[a]	▪ Medium to high
	▪ **Minimal innovation post-build** ▪ **Enduring natural monopoly** ▪ **Simple to regulate**	▪ **High potential for innovation** ▪ **Competition is viable** ▪ **Challenging to regulate**

a. Depending on network architecture, but once built, passive network unlikely to be upgraded for 30+ years
SOURCE: Implementation Study

around the world.[215] Already the successor technology—offering 10 Gbps speed—is under development, and is likely to be commercially available in a few years.

Assuming an average 7 years between generations of technology, the passive fibre infrastructure is likely to last through at least 5 generations of active technology upgrades. Navigating these upgrade transitions and deciding the economically optimal time to move to a new technology will be challenging in the absence of market mechanisms.

Chapter 10 discusses potential mechanisms for achieving competitive outcomes at the active equipment layer. It is worth noting that access can be granted deeper in the network than bitstream, through wavelength unbundling or direct physical fibre access. Currently, true optical access at the wavelength level is not commercially available for mass market GPON applications, but is technically possible.

[215] OECD 2007, *Developments in fibre technologies and investment*, Directorate for Science, Technology and Industry, Paris

9.4 Anticipating potential adverse monopoly conduct by NBN Co

NBN Co will be a powerful participant in the Australian telecommunications market, and the owner of what will be a future bottleneck asset. At the passive layer, NBN Co is likely to have a monopoly on mass market fibre access. During the time in which it is the sole operator of active electronics on its fibre, it will also be a vertically integrated wholesale monopoly with control over the nature and pricing of the broadband products which power Australia's digital economy.

While NBN Co should be encouraged to use its powerful position to deliver a solution for today, it must not be allowed to become the central obstacle to competition in the future. This is particularly important given the prospect of private ownership, as the unpredictable evolution of the industry will make it more difficult to balance private shareholder interests with public policy goals.

While NBN Co's open-access, wholesale-only nature mitigates some of the risks of the company strengthening its position by interfering in downstream markets, it is by no means a complete or permanent solution to the broader problem of monopoly conduct. This section describes possible modes of NBN Co behaviour that could threaten competition in the future, in three subsections:

9.4.1 Anticipating the risk of an NBN Co monopoly expanding its scope

9.4.2 Anticipating the risk of an NBN Co monopoly operating inefficiently

9.4.3 Anticipating the risk of an NBN Co monopoly failing to innovate.

9.4.1 ANTICIPATING THE RISK OF AN NBN CO MONOPOLY EXPANDING ITS SCOPE

If operating on a purely commercial basis, NBN Co would have incentives to leverage the natural monopoly portion of its business—access and backhaul—to expand the scope of its activities. This could occur along three dimensions:

- **Vertical integration up the logical stack.** As an operator of active electronics at Layer 2, there is scope for NBN Co to offer increasing functionality. Indeed, the demarcation between Layers 2 and 3 is already becoming blurred, with functionality such as Internet Group Management Protocol (IGMP) snooping, which inspects packets to provide TV functionality. This scope creep could result in the company effectively competing against its own customers in the provision of Layer 3 services, exercising undue influence over the availability and pricing of various retail services, engaging in harmful price discrimination and stifling competition from independent Layer 3 platforms;

- **Vertical integration into other markets.** It is possible that NBN Co would pursue opportunities in markets for other network elements, or even devices and content. For example, the company could potentially seek to offer a national backhaul transit product. Such a product would likely meet customers' needs, and represent a value creation opportunity—but would likely exceed the reasonable mandate of NBN Co;
- **Expanding scope of customers.** Although established as a wholesale-only player, NBN Co may seek to sell services to end users—particularly sophisticated large businesses with private networks.

Unless explicitly mandated by Government, each of these modes of expansion should be anticipated and prevented. In some cases, it will be possible to address these issues through simple constraints—for example, a customer test to limit direct selling by NBN Co, as discussed in Section 10.2. In other areas, service unbundling, open-access requirements and measures to eliminate underlying incentives for undesirable conduct may be required. These mechanisms are discussed further in Chapter 10.

9.4.2 ANTICIPATING THE RISK OF AN NBN CO MONOPOLY OPERATING INEFFICIENTLY

NBN Co, as a monopoly after completion of the roll-out and if the copper and HFC networks are deactivated, will lack competitive pressure to optimize its operations. This could lead to several adverse outcomes for the industry:

- **Higher prices charged to operators.** In the absence of competitive pressure, NBN Co will have limited incentive to engage in rigorous cost management. If costs increased, or did not decrease in line with industry best practice, this inefficiency would likely be passed onto customers, subject to the regulatory regime. NBN Co would also have the conventional monopoly incentive to raise prices to the point of profit-maximisation, again subject to the regulatory regime, although this would be mitigated prior to privatisation by a combination of Government ownership and control and transparency around take-up targets. Whether driven by poor cost control or profit maximisation, increased prices would dampen take-up, shrink the revenue pool for retail service providers and reduce the social and economic benefits of the NBN.
- **Poor quality of service.** This is a common concern for monopoly infrastructure providers. There are already a substantial, and growing, number of complaints about telecommunications services under the current market structure—Telecommunications Industry Ombudsman complaints have tripled in the last two

years.[216] During the first decade of operation, the NBN will be activating and provisioning customers continuously, and providing a good service experience will be vital to drive take-up. Once copper deactivation occurs, the pressure to meet service expectations will be greatly reduced.

Both these issues can theoretically be addressed through hard metrics. However, in reality these behaviours are dynamic and rely on actions within NBN Co which are difficult to monitor. Therefore, the focus should be on incentives, such as allowing the company to share in productivity gains, and setting standard SLAs with appropriate penalties and reporting obligations.

9.4.3 ANTICIPATING THE RISK OF AN NBN CO MONOPOLY FAILING TO INNOVATE

Analogies are frequently drawn between telecommunications and non-telecommunications utilities like owners of water, gas and electricity distribution networks. Although there are similarities in their infrastructure-focused role in their respective industries, the reality is more subtle. In providing Ethernet bitstream connectivity, the company necessarily offers a more complex portfolio of services than a traditional utility such as a water or electricity provider. The specification of these products will define the shape of the industry, and the performance of communications services across the nation.

If NBN Co is the sole provider of superfast broadband bitstream services over the long term, it is unlikely that technology upgrades to provide improved services will be implemented at the optimal rate. There are several reasons for this:

- **Demand typically lags the introduction of higher speeds.** Not until sufficient content, applications, devices, and backbone capacity are all available do most users see the value in moving to faster services. It is to some extent a virtuous cycle, once the network investment has been made, but it can be difficult to develop an investment case for an upgrade ex-ante in the absence of competitive pressure;
- **Latent demand is best proved by competition.** Comparing the US and Australia is instructive: the US market has seen unprecedented investment in both passive and active networks, which have been built by private operators competing for customers, funded through private capital and end user revenues. Consumers now perceive real value in Verizon’s fibre TV offering, with penetration at 25 percent for the FiOS TV offer within the coverage area,[217] but this would not have been

[216] ACMA 2009, *Communications report 2008-09*

[217] Spangler, T 2010, ‘FiOS Hits Brakes At End Of 2009’, *Multichannel News*, 26 January, viewed 16 February 2010, <http://www.multichannel.com/article/445901-FiOS_Hits_Brakes_At_End_Of_2009.php>

deployed without competitive pressure from cable TV triple plays. Rich broadband services are proliferating in the US. Conversely, Australia has seen limited investment in fixed access networks and limited service innovation;

- **It is difficult to force upgrades through regulation.** The underlying fibre asset is fairly easy to regulate as most of the investment is upfront and no subsequent decisions are required about new technologies. This situation is similar in principle to that of power lines, and fibre assets can be operated and regulated in much the same way as a traditional utility. Active components (to provide Layer 2 services) are more challenging, and barring substantial advances in regulation, should not be a monopoly if not in Government hands.

Highlight. Endorsing NBN Co as a monopoly operator carries inherent risks that need to be managed to prevent adverse future conduct, namely, NBN Co:

1. Expanding its scope of activities beyond those needed to achieve policy goals;

2. Operating inefficiently;

3. Lacking incentives to innovate.

9.5 Learning from international experience

Exhibits 9–9 to 9–12 provide additional international case examples to those included earlier in this chapter.

Exhibit 9–9. South Korea: Government funds fibre roll-out through low-cost loans

Incumbent fibre roll-out with subsidies	South Korea has the world's leading fibre and broadband deployment due to very high levels of government support—over US$70 billion in low-cost loans and US$1 billion for coverage of regional and remote areas of the country. This is in addition to other direct subsidies, tax breaks, research funding, demand stimulus programs and concessions.
High density living patterns aid roll-out	Over 80 percent of the Korean population lives in high-density urban housing, which reduces the cost of fibre deployment (and broadband generally) relative to other less densely populated areas. Additionally, the local loops within these buildings are owned by building owners rather than the incumbent telephone operator, so attackers can gain access more easily to install competing equipment. Korean consumer behaviour also favours high-speed broadband take-up in a number of respects [a].
Infrastructure competition also important	In addition to government subsidies, vigorous infrastructure-based competition from DSL and cable provided further incentive for incumbent Korea Telecom (KT) to roll out fibre. These broadband technologies were first introduced to the Korean market by competitors Hanaro and Thrunet in the late 1990s. (The two companies merged in 2005 and are now SK Broadband, part of the large SK conglomerate.)
1 in 3 households now have fibre	By 2007, 94 percent of Korean households had broadband access and one third of connections were over fibre. The incumbent retains over 50 percent share of the fixed broadband market.

a. Benkler, Y. et. al. 2009, Next generation connectivity

Source: Implementation Study

Exhibit 9–10. Malaysia: Government and TM form joint venture for fibre roll-out

Limited broadband take-up	Despite government aims to reach 75 percent broadband penetration by 2010, Malaysia has not kept track and has had to revise its targets. Official coverage objectives now call for 50 percent broadband deployment by 2010. However, as of 2009, the figure stands at ~20 percent, with DSL being the primary mode of connection.[a]
JV formed to deploy fibre	To stimulate roll-out of fibre, the government formed a joint venture in 2008 with incumbent Telekom Malaysia (TM) as part of the High Speed Broadband Initiative, which aims to deliver speeds of ‘at least 10 Mbps’ to 1.3 million premises, or 14 percent of the population by 2012 using a combination of FTTH and fibre-to-the-curb (FTTC) with VDSL. These speeds will be increased eventually to 100 Mpbs for consumers and 1 Gpbs for business customers.[b]
Incumbent aligned with government	TM remains 42 percent owned by the Malaysian Government’s public investment vehicle, Khazanah, so the incumbent’s interests are more aligned with those of the government than in Australia. This makes cooperative outcomes more feasible.
Government invests 20 percent of total cost	The total cost of the project is projected at US$3–4 billion, with the government committed to contributing US$700–800 million, in addition to demand-side initiatives such as an e-government portal and connectivity for schools. (Malaysia’s population is 25 million.) A revenue-sharing agreement requires the JV to distribute revenues to the government based on their equity contribution, provided revenue exceeds an undisclosed threshold, but it is expected that the government will make an economic loss on its investment.
Concentrated market structure remains	Although in principle Malaysia has an open-access wholesale regime with regulated pricing and restrictions on bundling, TM continues to hold a market share of over 90 percent. Competitors argue that the government’s acceptance of TM’s tender for fibre deployment has further entrenched the incumbent’s monopoly, a situation they link to the relatively slow growth of broadband penetration in the country.[c]
Broader coverage through separate projects	Since a minority of households will receive fibre connections, a separate government program Broadband to the General Population will stimulate deployment of a combination of DSL and wireless technologies (primarily WiMAX) to deliver speeds of up to 4 Mbps.

a. Keong, L M 2007, ‘Malaysia lowers broadband targets’, *ZDNet Asia,* 11 September, viewed 12 December 2009, <http://www.zdnetasia.com/smb/news/0,39043754,62032069,00.htm>

b. Telekom Malaysia, *High Speed Broadband (HSBB),* viewed 10 November 2009, <http://www.tm.com.my/connecting-you/digital-lifestyle/hsbb/Pages/WhatsHSBB.aspx>

c. Heavy Reading 2009, FTTH review & five-year forecast: The road to PON and next-gen PON

Source: Implementation Study

Exhibit 9–11. New Zealand: Separation then investment via public-private partnerships

No unbundling until 2006	Until 2006, New Zealand was one of the only countries in the OECD not to impose an access regime requiring local loop unbundling of the incumbent's access network, and broadband penetration remained in the bottom third of OECD countries.[a] Following unbundling, the price charged by TNZ for a 2 Mbps DSL connection was cut from NZ$70 to $40 per month in one year.[b] By 2007 consumers were offered speeds and download limits that were 10 times those of 2005 for the same access price.
3-part functional separation	TNZ offered to reorganise voluntarily into wholesale and retail divisions, but to ensure equality of access to unbundled network services the government required further separation of the network assets division (later named Chorus). Three-part functional separation took effect in 2008.
Separation spurs broadband take-up	The performance of New Zealand on international broadband rankings has improved since 2006, with the country leapfrogging Austria, Italy, Spain and Portugal on penetration metrics. Some commentators argue this may be attributable to specific provisions of the separation package, where undertakings were made by TNZ to accelerate broadband roll out. However other players have also invested, including TelstraClear, the New Zealand subsidiary of Telstra, which deployed a new fibre ring connecting towns on the south island following separation.[c]
Government investment to broaden FTTH coverage to 75 percent	Although New Zealand's market reforms improved its broadband performance, the government—backed by industry groups—aims for higher coverage through a next generation network. In 2009 it announced the Ultrafast Broadband Initiative, with a target of 75 percent coverage by FTTH in 10 years. The government plans to invest NZ$1.5 billion and attract matching private sector funds. These 75 percent of premises will have access to 100 Mbps services. A further $300 million will be invested to provide alternative high speed technologies to regional and remote areas, giving 16 percent of premises access to 10 Mbps, 6 percent access to 5 Mbps, and 1 Mbps for the final 3 percent. Government funding will establish Local Fibre Companies (LFCs): public-private partnerships that will roll out the passive infrastructure of the FTTP network. The government intends to hold 25—50 percent of the equity in each LFC, and is willing to accept a 'less than commercial return for an initial period'. It is not yet clear what role TNZ will play.
Mandatory dark fibre access	The government will mandate dark fibre access to the new passive infrastructure to enable an open access network, on which a competitive wholesale and retail markets are expected to grow.
Planning still in early stages	Having been announced this year, the Ultrafast Broadband Initiative is at the stage of early discussions, with no tenders having been issued or any construction yet underway.

a. FCC 2009, Next generation connectivity

b. OECD 2009, 'Broadband statistics: Evolution of a representative broadband subscription over time', *Broadband Portal,* viewed 10 November 2009, <http://oecd.org/sti/ict/broadband>

c. FCC 2009, Next generation connectivity

Source: Implementation Study

Exhibit 9–12. Sweden: decentralised, local government provision of dark fibre

Decentralised local-government approach	In 1994 the Stockholm municipal government funded a dark fibre network for the city in response to the incumbent Telia Sonera's refusal to provide dark fibre access on its existing network. This approach has been extended nationally, driven by the investment of other municipalities and alternative operators such as Bredbandsbolaget. In March 2008, Telia Sonera responded with plans to cover 1.5 to 2 million households (35–45 percent of Swedish households) with FTTH, using VDSL for internal connections within apartment buildings. The basic model of the Swedish municipal network roll-outs is that the municipality builds passive capacity (dark fibre) and leases it to private providers who then compete on active services. The municipalities offer public tenders for the contract to build the fibre network. The process is used both in major cities, like Stockholm, and in smaller municipalities, and leads to a vibrant downstream market, with more than 90 client operators and retail providers leasing access in Stockholm alone.
National funding contributed	In 1999, the Swedish Government committed €600 million to the roll-out of a national fibre backbone by the operator of the national electricity grid. An additional €700 million has been contributed to regional and local broadband projects. Further funding is provided by metropolitan governments and it is estimated that private operators have spent US$1 billion between 2001 and 2007 rolling out fibre.
Coverage has reached 20 percent	Around 20 percent of Swedish households are now covered by FTTP, including apartments that make use of internal VDSL. The overall penetration rate of FTTH in Sweden is 7 percent—the highest rate in Europe, but representing a slow roll-out pace since it has taken 15 years to reach this level.

Source: Implementation Study

10 Securing competition outcomes

SUMMARY

- NBN Co should operate as transparently as possible, subject to requirements of commercial confidentiality. This includes publishing data on roll-out progress and service performance levels and engaging in regular industry consultation.
- NBN Co should offer services on a wholesale-only, open-access and equivalent basis. It should structure its services and pricing to facilitate vigorous retail competition on a level playing field, for example by offering services on a modular basis and locating POIs at points where there are multiple backhaul providers.
- NBN Co should enable development of the wireless broadband market by offering fit-for-purpose access and transit services to wireless base stations within the FTTP footprint on a commercial basis and extending transit backhaul links to existing towers and new tower sites where requested by the fixed-wireless NBN provider(s).
- Government and the ACCC should ensure that the fibre topology implemented by NBN Co supports both physical and wavelength unbundling in the future, to enable active-layer competition.
- Government should discourage inappropriate ‘cherry picking’ of attractive markets by other carriers building superfast broadband networks. This can be achieved by imposing technical standards to ensure these networks are compatible with NBN infrastructure, as well as applying open-access and equivalence wholesale conditions.
- Prior to privatisation, Government should hold an independent inquiry to determine the optimal timing and structure of privatisation, potentially including structural separation of NBN Co. NBN Co should take appropriate interim steps to preserve the option of structural separation.
- Given that uncontested backhaul will remain a bottleneck asset that is difficult to regulate, it is unlikely that backhaul should be privatised.
- An ownership cap of no more than 15 percent of NBN Co equity should be imposed on carriers, CoSPs and CaSPs.

To secure long-term innovation and cost efficiencies, it is necessary to transition the industry to a self-sustaining pro-competitive market structure. As discussed in Chapter 9, the Implementation Study considers that notwithstanding the wholesale-only, open-access status of NBN Co, adverse competition scenarios may still unfold. This chapter proposes a suite of measures that collectively are aimed at mitigating the risks inherent in the industry transition and delivering the desired competition outcomes.

Chapter 10 is organised in 5 sections:

10.1 Ensuring NBN Co operates transparently

10.2 Creating a pro-competition environment

10.3 Setting a course to active-layer competition

10.4 Maintaining competitive outcomes through privatisation

10.5 Preserving a vibrant mobile market structure.

10.1 Ensuring NBN Co operates transparently

NBN Co will be an essential element in the value chain for the majority of telecommunications services. Other industry participants and, indeed, Australian consumers are all key stakeholders in its success and its ability to fulfil the industry's needs. NBN Co must ensure that its strategy, services and operations are aligned with the needs of these stakeholders. An open, transparent and consultative approach will reduce the risk of misalignment and assist more rapid adjustments. Mandating such an approach is consistent with international best practice (Exhibit 10–1).

Exhibit 10–1. International examples of transparency arrangements

International examples of transparency arrangements

United Kingdom. Separation of BT and creation of last-mile network operator Openreach was effected by a set of Undertakings by BT to Ofcom in response to the Telecommunications Strategic Review in 2003. Openreach must provide access to the last mile on an equivalence-of-inputs basis, including on the FTTP connections it is rolling out across the UK.

- The Undertakings require that if Openreach provides an FTTP product, the product development is in accordance with a roadmap developed through 'appropriate ongoing consultation' with Openreach's customers (communications providers).
- Openreach must publish its FTTP product consultation approach, including objectives, the questions it will ask, the decisions that the answers will inform, timeframes, etc.

New Zealand. The government is selecting partners to co-invest in local fibre companies (LFCs) which will roll out fibre to 75 percent of NZ's population via an open-access, wholesale-only structure providing Layer 1 services and, optionally, Layer 2 services. Government funding of up to NZ$1.5 billion is expected at least to be matched by the private sector partner(s). Proposals, including 2 nationwide proposals, are being evaluated. Requirements are:

- Proposals must specify pricing methodology and actual prices that will be charged;
- LFCs to provide regular reports on compliance with transparency requirements;
- Equivalence and non-discrimination will be implemented via behavioural undertakings (not yet prepared). Compliance will be monitored by the Commerce Commission;
- No specific operational transparency requirements are included for engagement with customers except for separation and transparency of the Layer 1- from the Layer 2-service business. The LFC can offer Layer 2 services but the equipment to do so must be funded by the partner only.

Singapore's next-generation broadband is expected to reach 95 percent of homes and offices by 2012. Government has required structural separation of the Next Gen NBN NetCo (passive layer), and operational separation of the Next Gen NBN OpCo (active layer). OpenNet was selected to design, build and operate the passive infrastructure.

- The tender required the winning bidder OpenNet to submit a Proposed Interconnection Offer (the terms under which OpenNet will offer services) which was put through public consultation before being approved by the Infocomm Development Authority (IDA).
- Pricing was not part of the consultation process but IDA will conduct scheduled reviews of prices, terms and conditions 3–5 years hence.

Source: Implementation Study

NBN Co has already commenced engaging with industry in an open and transparent way. Nevertheless, formal requirements are an important enabler of a successful wholesale business, particularly when a monopoly. Furthermore, subjecting NBN Co to full public transparency will apply valuable discipline to a company that will initially be shielded from the rigour of private ownership and the capital markets.

There will be some information which NBN Co is not able to provide due to commercial confidentiality. However, it is important that this legitimate qualification not prevent the publication of key data such as roll-out progress and service performance levels, which will enhance the accountability of the Board and management team.

Accordingly, it is appropriate that the Government impose a regime of transparency on NBN Co, requiring regular industry consultation and public reporting.

Recommendation 64. That NBN Co be required to conduct its strategy, planning and operations in a publicly transparent manner, subject to any requirements of commercial confidentiality.

Recommendation 65. That NBN Co be required to ensure its service offerings are developed in consultation with a wide variety of service providers through a transparent process including:

1. Holding regular industry forums to seek the views of current and prospective customers on the service offering;
2. Publishing a revised service development roadmap on at least an annual basis, and ensuring that demonstrable and reasonable market requirements are met.

Recommendation 66. That NBN Co be required to publish in its annual report comprehensive information on its performance, including:

1. Network roll-out performance and costs;
2. Achievement of service levels;
3. Faults;
4. Customer complaints;
5. Any matters, whether or not related to those above, that Government, represented by the shareholder Ministers, considers appropriate.

Highlight. Transparency will also be enhanced by the publicly-accessible Coverage Register discussed in Chapter 1.

10.2 Creating a pro-competition environment

A key objective of the NBN initiative is to foster competitive telecommunications markets in Australia. This requires the establishment of a regulatory environment that provides adequate constraints on NBN Co as the owner of bottleneck infrastructure. It must also facilitate vigorous retail competition while leaving scope for investment in innovation. In addition, given its mandate to deliver public policy outcomes by meeting ambitious coverage objectives and providing affordable services across all geographies, it is important to ensure that NBN Co is not disadvantaged by competitor ‘cherry picking’.

Three subsections address these challenges:

10.2.1 Creating an effective and limited wholesale operator

10.2.2 Meeting the needs of a diverse range of access seekers

10.2.3 Ensuring a level playing field for all superfast broadband networks.

10.2.1 CREATING AN EFFECTIVE AND LIMITED WHOLESALE OPERATOR

The Government has determined that NBN Co will be a wholesale-only, open-access telecommunications carrier applying the principle of equivalence to its provision of services to retailers. These policy conditions are driven by a desire to create a level playing field at the retail level.

Implementing this policy requires the concepts of wholesale services and equivalence to be thoroughly defined. It also requires measures to ensure that NBN Co remains an enabler of competition, rather than an inhibitor. The Implementation Study does not suggest that NBN Co Board or management have any intention other than implementing Government’s policy as intended. Nevertheless, a framework is required that creates certainty and contemplates the adverse conduct described in Section 9.4—particularly given NBN Co has been established to operate commercially with an intention to privatise.

Limiting the scope of NBN Co operations

Section 9.4 outlines forms of monopoly conduct in which NBN Co may have an incentive to engage. In particular, it highlights the danger that NBN Co may be tempted to enter markets for other network elements, or even devices and content. If it were to do so, leveraging the advantages of its monopoly network, or merely of its implicit Government backing, it could distort those markets and reduce competition. It is important that NBN Co be prevented from growing beyond its mandate.

> **Recommendation 67.** That NBN Co be prohibited from engaging in commercial or investment activities unrelated to the provision of wholesale telecommunications services in Australia. For the avoidance of doubt, provision of content services as defined by the *Telecommunications Act 1997* would constitute prohibited activities.

In addition, we note that the exposure draft of the *National Broadband Network Companies Bill 2010* includes a provision for the Minister to impose a licence condition mandating or prohibiting NBN Co from offering particular services. This mechanism provides a valuable failsafe which could be employed to enforce the general prohibition.

Imposing a wholesale-only requirement

The Government has stated a clear intention that NBN Co will be wholesale-only. Our understanding is that this is intended to maximise competition and prevent NBN Co from becoming vertically integrated and thus distorting competition in retail markets.

To ensure NBN Co operates on a wholesale-only basis, it will be necessary to prevent it from offering retail services. Although we recommend the exclusion of NBN Co from some markets, we do not recommend attempting to include an exhaustive definition of wholesale or retail services in the legislation. Given the dynamic nature of broadband technology, there is a real risk of the definition rapidly becoming outdated.

A better means by which legislative provisions might limit NBN Co to wholesale services is by specifying the classes of customer to whom NBN Co may offer services (Exhibit 10–2). The exposure draft of the *National Broadband Network Companies Bill 2010* adopts this approach, limiting NBN Co to offering services to carriers and service providers, as defined in the Telecommunications Act, with scope for the Minister to declare exceptions by regulation.

Under this proposed approach, there are two end-user groups at either extreme of the market that deserve special consideration: sophisticated end users; and uneconomic, or low priority, customers who may not be offered services by any retailer.

Exhibit 10–2. Definitions of permitted NBN Co customers

Definitions of permitted NBN Co customers

- **Carrier** means the holder of a carrier licence granted by ACMA. Carrier licences are required by owners of network units that are used to provide carriage services, which are services involving communications using guided or unguided electromagnetic energy.
- **Service provider** means the provider of either carriage services (as described above; e.g. iiNet is a carriage service provider) or content services. Content services include broadband services and online information and entertainment services (e.g. Foxtel is a content service provider).

Source: Implementation Study

Sophisticated end users, such as large banks or technology-services companies may demand services similar to those offered by NBN Co to retailers. It is possible that they could establish their own proprietary carrier or service provider entities, acting as shell retailers and thereby allowing NBN Co to offer services to companies that are essentially agents of end users.

Obtaining a carrier licence is not difficult in itself; there are more than 250 currently on issue in Australia. However, as NBN Co is limited to the provision of Layer 2 services, any shell retailer (i.e. one established for the primary purpose of providing services to a single end user, to which it is probably related) would require a significant level of sophistication to use these services to provision services at Layer 3 or higher. The sorts of services being provided by NBN Co will be of the character of wholesale rather than retail services.

Therefore, to the extent that a large and sophisticated end user business finds it more efficient to establish such a shell retailer, this would indicate a lack of efficiency or value-add on the part of the major retailers. On balance, there is a strong practical argument that such an outcome would represent enhanced competition at a retail level, rather than being interpreted as an implicit entry of NBN Co into the retail market. Accordingly, the Implementation Study believes there is no need at present to make a special provision in relation to this scenario. Similarly, the Minister should have the discretion to make exceptions to the strict definition of customers defined as wholesale.

This conclusion is dependent on the Government restricting NBN Co to offering Layer 2 services and, potentially, unbundled Layer 1 services. A number of stakeholders have suggested that NBN Co should offer Layer 3 services, to lower barriers to entry into the retail market. We believe this would be undesirable.

- If NBN Co were to provide only Layer 3 services, the scope for service innovation would be greatly reduced and NBN Co's customers would be relegated to the status of resellers of NBN services.
- If NBN Co were to provide both Layer 2 and Layer 3 services, its Layer 3 business unit would be in effective competition with its own Layer 2 customers. This would undermine the Government's policy objective of establishing a level playing field in the retail market, underpinned by NBN Co's disinterest in downstream competition.

However, in light of representations from some industry participants, the Government may wish to request that the ACCC's annual report on competitive safeguards in the telecommunications industry address the availability of Layer 3 wholesale services, to determine whether any further intervention is merited, and to retain the flexibility to relax this restriction should market or technological developments necessitate it.

These conclusions are consistent with the discussion of appropriate service offerings in Chapter 3.

The second class of end user that must be considered in defining the wholesale-only requirement is uneconomic customers. If the Universal Service Obligation were removed in the future, it is possible that uneconomic or low-priority customers may not be offered services by any retailer. Should this eventuate, Government could consider either a subsidy or a tender process to secure retail services for such customers. This option is preferable to allowing NBN Co to act as a retailer of last resort, which would compromise its wholesale-only nature and place it in competition with its customers.

Recommendation 68. That Government implement a wholesale-only restriction on NBN Co preventing it from offering or providing services to anyone other than a carrier or service provider as defined by the *Telecommunications Act 1997*; that Government retain the flexibility for the Minister to make exceptions to this rule.

Restricting NBN Co's ownership of retail operators

Given the policy objective of preventing the re-establishment of a vertically-integrated monopoly, we recommend restricting NBN Co from acquiring equity in telecommunication retailers. However, there is a need to include provisions for exceptions. For example, it may be desirable for NBN Co to acquire businesses with infrastructure or capabilities to develop its wholesale offerings. Such businesses may include service offerings which violate the set restrictions. We propose the following mechanisms to preserve the NBN objectives but allow acquisition flexibility:

- The acquisition by NBN Co of a business which offers services outside the regulated NBN services framework should only be considered if a compelling infrastructure asset is associated with the business and the acquisition of the infrastructure alone is either not practical or would result in an inferior commercial outcome for NBN Co.
- If the target business offers services inconsistent with NBN Co regulations, then the target should be allowed to apply to keep offering these services through a transitional period.
- If the target business offers services directly to end users then these services would need to be divested/transitioned within an appropriate timeframe.
- The regulatory scheme should include some discretion to relax restrictions on a case-by-case basis based on the magnitude of the problem (e.g. number of customers receiving non-compliant services), the threat to equivalence (for example, a grandfathered corporate Layer 1 service is less threatening than a differentiated video service to consumers) and the expected timeframe and complexity for remedying the breach.
- Additional transitional measures could be enabled to offset the risks of compromising Government's competition objectives during the transition period. These might include maintaining functional separation principles, giving powers to the ACCC to provide heightened regulatory oversight (potentially drawing on current powers under the TPA) and enforcing termination of services or divestment after a certain period.

Recommendation 69. That NBN Co be prohibited from investing in retail telecommunication companies and content service providers, subject to special provisions for transitional ownership where incidental to the acquisition of network assets relevant to its objectives.

Implementing open access and equivalence in a wholesale-only context

The Government's NBN policy recognises that open access and equivalence are an essential part of fair wholesale dealings. If the objective of creating a level playing field in the retail market is to be achieved, retailers must have confidence that no favouritism will be shown to particular retailers by the owner of the bottleneck infrastructure over which they will all compete.

Open access requires that NBN Co offer its services to any retailer which seeks them. This is a relatively simple principle, which should be made subject to exceptions based on technical feasibility, existing supplier commitments and creditworthiness in a similar manner to existing access obligations under Part XIC of the Trade Practices Act.

Equivalence is a more complex principle. The strictest interpretation of equivalence, known as equivalence of inputs, would require all customers to be provided with services at identical prices, on identical terms and using identical technical and business process interfaces with NBN Co. While this would achieve a theoretical equity between retailers, it would provide too little flexibility to recognise the different needs of the diverse range of potential customers of NBN Co. Interfaces that might suit a large retailer with substantial market share around the country are likely to be ill-suited to a boutique ISP operating in a single area.

The case for a more flexible interpretation of equivalence is strengthened by the wholesale-only nature of NBN Co. As NBN Co is not competing against its customers, it has less incentive to discriminate between them in a harmful way than does a vertically-integrated network owner.

We therefore believe that equivalence should be implemented principally by means of transparency and common availability.

- NBN Co should be obliged to publish its service offerings, its standard terms and conditions and any variations to those agreed with individual customers.
- NBN Co should be prohibited from discriminating between customers. Where a potential customer wishes to obtain like services, in like circumstances, and on like terms to those agreed in respect of another customer, NBN Co should be obliged to comply, subject to the usual qualifications to open access.

- While interpretation and enforcement of non-discrimination should be left to the discretion of the ACCC, it would be concerning if NBN Co were to offer terms and conditions of a nature that could not feasibly be accepted by at least three retailers (e.g. a volume discount requiring volumes so large that only one retailer could benefit).

Transparency ensures that customers are aware of opportunities and builds confidence in NBN Co's fair conduct. Availability ensures that customers are able to take advantage of these opportunities.

The Implementation Study does not believe a pre-approval process for access agreements should be introduced. As noted throughout this report, the telecommunications sector is highly dynamic. Cumbersome processes are to be avoided where possible. Commercial agreements should be able to be implemented rapidly. Publication of terms and hence independent vetting for consistency with the principle of equivalence should provide adequate safeguards in a wholesale-only environment.

An exception to these conclusions on equivalence is where NBN Co is offering services in competition with its customers. For example, this could occur if, subsequent to physical unbundling, NBN Co were to compete with its customers at Layer 2.

In relation to these services, NBN Co has a clear incentive to discriminate. Accordingly, a stricter interpretation of equivalence would be necessary, to ensure that the internal technical and business processes of NBN Co do not give its internal customer (e.g. the Layer 2 services unit) an unfair advantage. To avoid this, it would be necessary to implement strict equivalence of inputs in relation to such services.

Recommendation 70. That NBN Co be subject to an access regime similar to that set out in Part XIC of the *Trade Practices Act 1974*, but including an obligation to provide all services (other than those not available to any external parties) on an open-access, equivalent basis defined as follows:

1. Except in relation to services that NBN Co also provides to itself, equivalence should not require identical terms, conditions and processes so long as any variations (e.g. discounts) aid efficiency and are available to all access seekers in like circumstances, where 'like circumstances' are not taken to include scale unless at least three access seekers are of sufficient scale to qualify;
2. NBN Co is to publish any such variations;
3. In relation to services provided by NBN Co to itself and to other access seekers (such as any unbundled Layer 1 services), equivalence should be defined on an 'equivalence of inputs' basis, requiring identical terms, conditions and processes of supply;
4. The principle of open access should not require NBN Co to offer services to access seekers where NBN Co has good cause to believe the access seeker is not creditworthy or is otherwise unlikely to comply with the terms and conditions of supply.

10.2.2 MEETING THE NEEDS OF A DIVERSE RANGE OF ACCESS SEEKERS

Vibrant retail competition will only be created if NBN Co offers services that are suitable for, and accessible by, a diverse range of access seekers.

Points of Interconnect

Chapter 6 discusses the role of NBN Co in establishing a national backhaul network in areas where the backhaul market is uncompetitive. This is necessary to provide retailers with practical access to the fibre exchange.

If retailers are only permitted to access the fibre exchange on an unequal basis, the Government's objective of a level playing field for retailers will not be achieved. To resolve this problem, it is important that retailers only be allowed to connect to the NBN at points where they and their competitors will face similar backhaul costs.

In practice, this means that NBN Co should not allow access to its network except at points reached by competitive backhaul. Consistent with the recommendations of Chapter 6, NBN Co will provide transit backhaul from the fibre exchange to these locations, except where there is competitive backhaul at the fibre exchange itself.

While the fibre exchange and transit backhaul products offered by NBN Co should be separate, to enable access seekers to determine their own contention rates over backhaul, interconnection should not be offered at the fibre exchange if there is no competitive backhaul.

It is not a trivial matter to determine whether a particular backhaul link is genuinely competitive. We propose that NBN Co should build backhaul on links that are clearly not competitive, i.e. links where there is only one provider. While the presence of two backhaul providers does not guarantee competitive pricing, we believe that NBN Co should not extend its backhaul network to such links at this stage, in light of the following:

- The roll-out of the NBN access network may prompt further private investment in backhaul, increasing the competitiveness of some links;
- The ACCC has mechanisms to prevent anti-competitive conduct and has declared access to services of specific backhaul links;
- NBN Co can consult with potential providers of backhaul as it prepares its roll-out schedule and ensure that its POIs will be accessible over adequately competitive backhaul;
- To the extent that these mechanisms fail to address concerns on some links, the policy can be re-evaluated after roll-out of the access network is complete and the market has been given a chance to work.

Recommendation 50 (repeated). That NBN Co be required to offer a single POI in relation to a given premises:

1. At a fibre exchange where there are multiple alternative backhaul providers; or
2. At a fibre exchange linked to the Regional Backbone Blackspots Program; or
3. At a point accessible from the fibre exchange over an NBN Co transit backhaul link.

Practical access to a POI requires the co-location of customer equipment at the POI. This will create another potential bottleneck in the form of limited physical space at the POI. If NBN Co secures space for its POIs that is merely sufficient for its own equipment, the difficulty in obtaining space for retail service providers to locate equipment could impede competition, particularly at such point as physical unbundling is permitted.

This problem will be exacerbated if many NBN Co POIs are located in current Telstra exchanges. In this scenario, Telstra would enjoy a unique advantage over its competitors in gaining access to the NBN.

Accordingly, NBN Co should ensure that it secures ample space at its POIs to provide for interconnection by a range of retailers. To ensure a genuinely level playing field, reasonable space for retailer equipment should be provided free of charge, with costs covered with an interconnection fee at each POI that applies to each retailer choosing to connect there even if they do not have space requirements due to co-location of their own facilities.

Recommendation 71. That NBN Co be required to provision its physical infrastructure, including POIs and fibre exchanges, to accommodate reasonable expectations for customer equipment in anticipation of multiple retail competitors:

1. Seeking access to its Layer 2 services;
2. Seeking access to transit backhaul services;
3. Seeking access to unbundled physical fibre or wavelengths in the future.

Diversity and modularity of products

As discussed in Section 3.3, some retailers will wish to provide bundled services such as triple-play packages, while others may wish to become niche providers offering individual services. To enable vibrant competition between alternative business models at the retail level, it is important to ensure that NBN Co's service offering and pricing architecture are not prejudiced in favour of a particular model.

This will require NBN Co to offer services on a modular basis to avoid conferring a price advantage on large retailers who seek a discount on bundled services that would undermine the competitiveness of single-service retailers.

NBN Co should endeavour to offer a range of service and pricing options that maintains neutrality between competing business models.

Recommendation 72. That NBN Co be required to design its price architecture on the basis that services with distinct characteristics (e.g. level of aggregation or capacity) should be offered on a modular basis. For example, a multicast product suited to IPTV delivery should be sold independently of a standard bitstream service.

Enabling competition in premises

While the recommendations above will enable competition between multiple retailers, a truly innovative and dynamic retail market will be created only if competition is facilitated within the home. If the ONT is designed to allow a single retailer to effectively capture the premises, the ability for consumers to select innovative niche content, applications or devices will be subject to the intermediation of that retailer.

To open up competition within the home, it is important that the design of the ONT and method of installation allows other retailers to provide services by connecting to ports on the inside of premises. Ultimately, this will enable competing retailers to sell devices that the customer can self-install. Without adequate provision of ports internal to the premises, the scope for competition to drive service innovation within the home will be compromised.

This issue is discussed in Section 4.2.

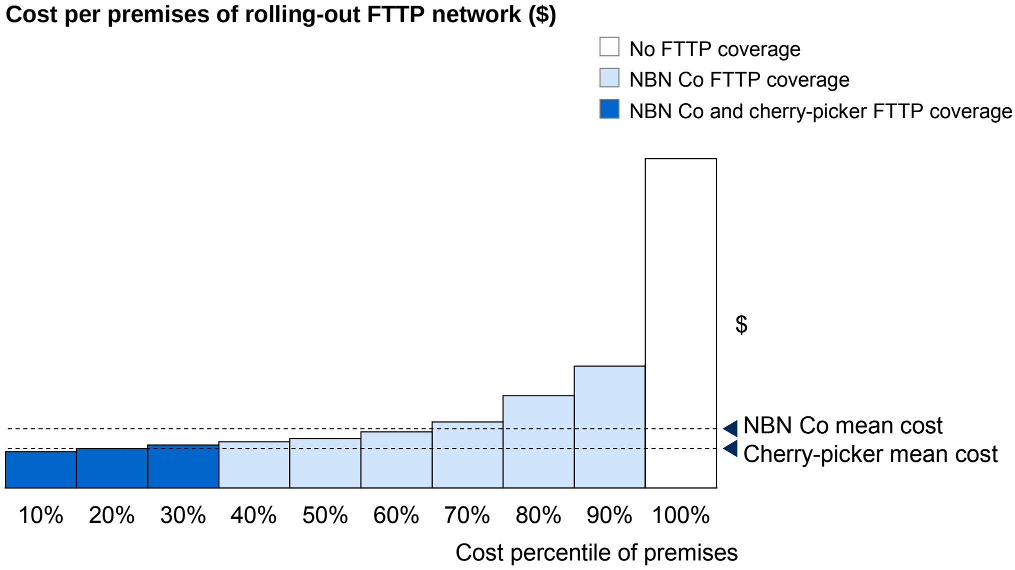
10.2.3 ENSURING A LEVEL PLAYING FIELD FOR ALL SUPERFAST BROADBAND NETWORKS

Consistent obligations for all new network builders

It is the stated intention of the Government to provide affordable broadband to all Australians. If, as proposed, NBN Co charges a uniform wholesale access price across its fibre footprint, this implies providing an implicit cross-subsidy to higher cost-to-serve areas from lower cost-to-serve areas. In effect, NBN Co will be charging an averaged price across the FTTP footprint, rather than the geographically-differentiated prices that would result from purely cost-based pricing.

This raises the risk that carriers other than NBN Co might construct fixed-line superfast access networks (such as FTTN, DOCSIS 3.0 or competing FTTP networks) only in high-income and low-cost, high-density areas and then undercut NBN Co's average price due to the lack of any need to subsidise operations in higher-cost areas. This cherry-picking approach could undermine Government's affordability policy by enabling the cherry picker to undercut NBN Co's pricing based on its lower costs (Exhibit 10–3), hence placing at risk NBN Co's ability to serve less attractive areas at affordable prices.

Exhibit 10–3. Effects of cherry-picking on average cost to serve premises (illustrative)



SOURCE: Implementation Study

In light of the policy of wholesale pricing uniformity, NBN Co would be caught between conflicting imperatives to:

- Match the competitor's pricing in high-value, low cost areas, thereby requiring it to reduce its pricing across the entire fibre footprint and thus fundamentally compromise its commerciality;
- Maintain pricing at a level designed ultimately to cover costs, in which case it would be unable to attract customers in the cherry-picked areas.

Any such limited, opportunistic network would not only pose a commercial threat to NBN; it would also advantage a vertically-integrated network operator over independent retail service providers using NBN services in those areas.

Another source of advantage for builders of such a third-party network would be the choice to ignore technical standards applied to NBN Co for policy reasons, such as implementing network topologies that facilitate unbundling.

The Implementation Study has considered multiple possible policy responses to this threat. Options considered included:

- Imposing technical standards on new FTTP networks, to ensure that they are compatible with NBN Co infrastructure and thus equally amenable to unbundling;
- Imposing open and equivalent access wholesale conditions on carriers building or upgrading to new, fixed-line superfast access networks in Australia, in relation to

services offered over those networks, so that vertically-integrated network owners are not able to gain unfair advantage at a retail level;

- Mandating that pricing of services on such fixed-line superfast access networks be set by the ACCC to match a rate of return based on NBN Co's actual, or anticipated, rate of return;
- Imposing a universal service levy on carriers building or upgrading to new fixed-line superfast access networks in Australia, calculated on a basis inversely related to their breadth of coverage in less attractive areas;
- Prohibiting the construction of competitor fixed-line superfast access networks.

On balance, we believe that the first two of these measures are appropriate.

Imposing open and equivalent access wholesale conditions in relation to these third-party networks is consistent with the Government's policy objective of achieving a level playing field at a retail level. Where the networks are compliant with the Government's policy objectives, the need for roll-out by NBN Co will be negated.

Consistent with the policy intent of the exposure draft of the *Telecommunications Legislation Amendment (Fibre Deployment) Bill 2009*, it is also appropriate to ensure that any FTTP network be compliant with technical standards promulgated by ACMA and based on the standards applied by NBN Co to the construction of its own network. This will ensure that areas of Australia are not left with sub-optimal FTTP networks.

Mechanisms such as a levy or capped return, which create a disincentive against building competing networks limited to the highest value areas, need to be considered carefully. They could create deterrents to desirable investment.

If cherry-picking were to emerge as a concrete threat during the NBN build, notwithstanding the measures proposed above, Government may wish to implement temporary protection for NBN Co against the commercial impact of cherry-picking beyond setting technical standards and ensuring open access and equivalence.

Rather than either outright prohibition of competing networks, which would reduce innovation and remove the discipline of competitive pressure from NBN Co, or linking rates of return explicitly to those of NBN Co, the simplest disincentive against cherry-picking would be to impose a levy on cherry-pickers, payable to the Government, with proceeds to be directed towards telecommunications subsidy programs (Exhibit 10–4).

Exhibit 10–4. Design of a possible Universal Service Levy

Example approaches to the design of a levy to prevent cherry-picking
■ The ACCC's classification of areas into different zones for the purposes of ULL pricing provides a useful precedent, and a levy could be based upon the ratio of premises served in different zones and proportional to the total number of premises served. ■ The levy could be hypothecated to specific telecommunications subsidy programs, such as the provision of affordable CPE upgrades for users of satellite broadband services.
Source: Implementation Study

Given the undesirability and potential controversy of punishing or prohibiting the deployment of FTTP technology by third parties, a universal service levy should be regarded as a last resort measure to be employed only if a significant threat of cherry-picking actually emerges.

Government should recognise that the rationale for such a levy would be that it was a necessary measure to enable NBN Co to deploy a superfast broadband access network, including FTTP to 90% of premises, over the next 8 years. There would be no justification for a levy in the absence of strong, ongoing Government commitment to the NBN initiative. The worst possible outcome would be a scenario in which the NBN was not being deployed, yet the levy continued to deter private sector investment in superfast broadband infrastructure. Under this scenario, the levy would become an obstacle to Australians accessing superfast broadband services. Indeed, if NBN Co's deployment was slowed substantially or the scope was narrowed, there would be a strong case to reconsider the other anti-cherry-picking measures.

In light of this risk, if a levy is implemented, it should be subject to a strict sunset clause of no more than ten years, recognising that it is a mechanism to prevent pre-emptive cherry-picking builds during the NBN roll-out. The possibility of private operators deploying competing FTTP infrastructure after the NBN roll-out is complete will, in the long term, be important to apply discipline to NBN Co and provide it with an incentive for innovation.

In practice, so long as NBN Co operates efficiently and responsively, it is doubtful that third parties will build significant networks when forced to offer open and equivalent access to wholesale services, even in the absence of a levy. In the case of pre-emptive builds they would still face the threat of NBN Co overbuild on top of the risks associated with entering a market which is undergoing such rapid regulatory change. Where the NBN is already deployed, they would face certain competition, while any benefits of vertical integration would be eliminated by the open and equivalent access conditions.

On balance the Implementation Study does not anticipate that a universal service levy is likely to be required as an additional deterrent, particularly preemptively.

Regardless of the measures which are adopted, they should not apply to small, proprietary networks that are not used to provide services to the public. This is consistent with the scope of the carrier licence regime in the Telecommunications Act.

Recommendation 73. That any future fixed-line superfast access network built in Australia must offer wholesale services on an open-access and equivalent basis and, if it is an FTTP network, must comply with the technical specifications mandated in relation to the construction of FTTP access networks in greenfields; that this recommendation be subject to the following qualifications:

1. This requirement should not apply to existing superfast access networks or to existing or future small proprietary networks that are not covered by the *Telecommunications Act 1997*;
2. For the purposes of this recommendation, a fixed-line superfast access network should be defined as a fixed-line access network delivering download data rates consistently exceeding 25 Mbps;
3. ACMA should be empowered to agree to variations to the technical specifications in specific cases where those variations do not interfere with the Government's NBN objectives and result in significant cost savings through the use of existing infrastructure.

Recommendation 74. That, if plans are announced for significant third-party deployments in high-value, low-cost areas of fixed-line superfast access networks (defined as a fixed-line access network delivering download speeds consistently exceeding 25 Mbps but excluding small proprietary networks) during the NBN roll-out, Government consider the introduction of a universal service levy on the owners of all such networks; this levy to be inversely related to a network's contribution to the Government's objective of providing affordable broadband coverage to all Australians. It would be hypothecated to fund telecommunications subsidy schemes; any such levy to be subject to a sunset clause causing its expiry after no more than ten years.

10.3 Setting a course to active-layer competition

If the NBN initiative is to deliver on its promise as a sound investment in Australia's broadband future, it must enable competition in active infrastructure in the decades ahead.

Healthy competition is the most effective driver of innovation in a telecommunications market. The NBN initiative represents a singular opportunity to establish a market structure that effectively harnesses this driver for decades to come.

While active-layer competition can reasonably be delayed to facilitate roll-out and industry transition, failure to set a path to achieve such competition would severely compromise the Government's long-term objectives. It would potentially necessitate further substantial and periodic Government subsidy of NBN Co to create an incentive for upgrades of active layer infrastructure to keep pace with technological developments. This issue is explored in four subsections:

10.3.1 Establishing active-layer competition once the platform is established

10.3.2 Ensuring a network topology that allows for physical unbundling

10.3.3 Determining the start of active-layer competition

10.3.4 Anticipating the equivalence of inputs obligation.

10.3.1 ESTABLISHING ACTIVE-LAYER COMPETITION ONCE THE PLATFORM IS ESTABLISHED

As we discuss in Chapter 9, Australia's endorsement of a single passive fibre network makes infrastructure-based competition from alternative networks unlikely. The Government must therefore plan for active-layer competition over the long term. A single passive network is efficient, but poses risks if it is permanently vertically integrated with the management of active electronics. Such a vertically integrated monopoly will lack the incentives to deliver dynamic improvements to active services. The need for such performance improvements is almost certain: Google recently announced its plan to deploy a 1 Gbps FTTP network to between 50,000 and 500,000 homes in the US, and Singapore's planned FTTP network is ultimately intended to enable peak download speeds of over 1 Gbps.

While a monopoly active layer service provider could be forced to introduce new products (through user forums, international benchmarking and regulation) and pursue cost reductions (through price regulation), these measures are substantially less effective than competition, as they cannot accurately align the incentives of the network service provider with the needs of a diverse market.

There is a sound precedent for such competition on existing copper infrastructure, and on long-distance fibre networks. The unbundling of Telstra's copper access network, and subsequent entry of competitors, spurred introduction of fast ADSL2+ services by the incumbent (Exhibit 10–5).

Exhibit 10–5. Unbundling of Telstra's copper access network

Copper access network unbundling drove roll-out of ADSL 2+ in Australia

As of today, Telstra's Customer Access Network (CAN) remains a bottleneck infrastructure in most areas, as it has not been commercially viable for a competitor of Telstra to duplicate it. However, some competitors were not content with merely reselling Telstra's telecommunications services as retailers. They sought access to unconditioned local loop (ULL) services from Telstra. Telstra resisted this strongly. This reflects the fact that, in the absence of ULL access, Telstra was able to leverage its bottleneck asset, the CAN, to restrict competition in downstream active layer services.

The ACCC declared ULL services. This decision reflected the fact that there was a potentially competitive market in active layer services, downstream from the passive copper network: specifically, competitors installed their own DSLAMs in selected Telstra exchanges. Competitor equipment is now located in 557 exchanges, with 1.3 million out of 10 million services based on competitor access to ULL or line sharing services (LSS).

Active-layer competition provided discipline even on parts of the network which were not subject to competition at a given time, eventually driving upgrades. Prior to 2008 Telstra upgraded its exchanges to ADSL 2+ only as competitors installed DSLAMs in each exchange and began to provide that service. Competition on the active layer eventually created the incentive for Telstra to roll-out ADSL 2+ more broadly on its network. In 2008, Telstra began providing ADSL 2+ even in areas which competitor DSLAMs had not reached.

Competitive markets also place downward pressure on costs. Advertisements for retail broadband plans focus primarily on price. While comparisons are complex due to the number of variables involved, we note that the price of an incremental gigabyte of data over an ADSL or ADSL 2+ service varies substantially between incumbent providers ($1.19 for Telstra) and attackers ($0.54 for iiNet).

Source: Implementation Study

Enabling both physical unbundling and wavelength unbundling

There are three forms of unbundling that can be used to enable competition between retailers on a wholesale network:

- **Bitstream unbundling**: the provision of generic Layer 2 services to competing retailers. This will be the default method of unbundling on the NBN.
- **Wavelength unbundling**: the allocation of specific bands of the optical spectrum to individual retailers, so that they can define the Layer 2 services they desire. NBN Co would then use its active layer infrastructure to provide these.

- **Physical unbundling**: the provision of unique fibres to individual retailers. This enables the retailers to place their own active layer electronics at the ends of the fibre, allowing them to upgrade at will.

Some stakeholders have questioned the need to enable physical unbundling in light of the possibility of wavelength unbundling–the assignment of different segments of the optical spectrum to different retailers, enabling them to deliver services over the same fibre, and hence over the same splitter in a GPON network.

While wavelength unbundling may well play a role in enabling future competition on the NBN, the Implementation Study believes it would be risky and short-sighted to rely on this as the sole solution to the threat posed by NBN Co's future active layer monopoly, since:

- Wavelength unbundling does not remove NBN Co's monopoly on the active layer infrastructure. While retailers could request the delivery of particular forms of Layer 2 service over their segment of the spectrum, the active layer electronics would remain in NBN Co's control and upgrades would occur only at NBN Co's discretion.
- Wavelength unbundling technology has been applied on backhaul links but, due to its expense, has not been used for any wide-scale deployment over an access network. Relying on the future development of this technology to provide an alternative to physical unbundling presumes that wavelength unbundling technologies will develop with sufficient speed to meet future bandwidth requirement. Such reliance carries risk, given the inherent uncertainty involved in predicting future technological developments.
- Incumbents will no doubt resist unbundling internationally. Consequently, major global vendors may have little incentive to develop technologies that their largest customers do not want. This may constrain the development of an effective ecosystem, in which there will be enough scale and economic viability to deploy wavelength unbundling as a mass-market access technology.

For these reasons, the Implementation Study believes it is important to preserve the option of physical unbundling.

> *The risk of trying to pick WDM-PON technology developments now would be analogous to installing a leading edge ADSL 1 technology that foreclosed a later installation of VDSL 2*
>
> Telecom New Zealand Limited (2009)

The need to provide for physical unbundling to future-proof networks and drive active-layer competition and innovation has been recognised by other nations building superfast broadband networks (Exhibit 10–6).

Exhibit 10–6. Other countries have concluded that physical unbundling is needed

Country	Situation
Singapore	The Singaporean Government's FTTP network will be structurally separated between passive, active and retail layers, to enable future active-layer competition. Ultimately, the duct infrastructure that houses the fibre will also be divested into an independent entity.
Japan	The regulator has declared access to NTT's Layer 1 services, albeit at prices that enable full cost recovery including depreciation. Despite high prices, several competitors utilise these services.
New Zealand	The planned national broadband network will be controlled by public/private partnerships offering Layer 1 services, with active equipment to be built independently by the private sector wherever possible.

Source: Implementation Study

10.3.2 ENSURING A NETWORK TOPOLOGY THAT ALLOWS FOR PHYSICAL UNBUNDLING

Physical unbundling is only possible where enabled by an appropriate network topology. Chapter 4 discusses the possible network topologies and concludes that:

- A home-run topology is best-suited for physical unbundling;
- Where a shared topology is used, the economic feasibility of physical unbundling increases with the number of premises served by each splitter cabinet.

Incumbent telecommunications carriers have preferred to deploy shared network topologies. The effect of this is to make future physical unbundling difficult if not impossible.

Government's competition objective suggests that NBN Co should prefer topologies that are more easily unbundled. To the extent that shared topologies are employed, larger splitter cabinets serving greater numbers of premises should be preferred, increasing the economic feasibility of physical unbundling in the future. See Section 4.2 for further explanation of the topology choices.

Ideally, a home-run topology would be implemented across the fibre footprint. However, as there are varying cost implications in different geographies, we recognise that this may not be feasible. Nonetheless, it is important to recognise that ubiquitous deployment of a topology that can be unbundled is not necessary to derive significant competition benefits.

For example, if home-run technology is deployed over a substantial proportion of the fibre footprint, thus enabling physical unbundling, the conduct of active-layer competitors in those areas will provide a useful benchmark for the appropriate service offerings and standards that NBN Co should be expected to offer in other regions. This effect was demonstrated by the unbundling of ULL services, which ultimately led to the roll-out of ADSL2+ by Telstra even in exchanges which did not contain competitor DSLAMs (Exhibit 10–5).

> **Highlight**. Unbundling over a substantial proportion of the network leading to competition, once established, provides sufficient pressure to drive improved services over the entire network.

As indicated in Chapter 4, we believe construction of the NBN with 50 percent of premises in the fibre footprint being covered by home-run topology would incur approximately an 8 percent cost premium over that half of the network, or approximately 4 percent as a portion of the spend on the fibre access network. The entire NBN would still be constructed within Government's $43 billion expenditure estimate. The appropriate mix of network topologies for NBN Co to deploy across the country can be estimated today based on pre roll-out and limited field trials, but it is prudent to retain some flexibility until actual roll-out cost data are available. The Implementation Study is also cognisant of NBN Co's tight schedule and of the undesirability of delaying network roll-out.

As it may not be in NBN Co's long-term commercial interests to construct a network that is easily unbundled, there is a need for external policy oversight on the appropriate topology. While detailed network design is best left to NBN Co, the Government and the competition regulator have a legitimate interest in ensuring that the topology meets competition objectives. For example, in the United Kingdom, Ofcom has intervened in the issue of cabinet size in BT's FTTN network on the basis that the proposed small size would frustrate sub-loop unbundling.

Having regard to these considerations, the Implementation Study suggests that the exact extent of deployment of different network topologies be determined once adequate roll-out experience has been gained.

> **Recommendation 75.** That, to determine NBN Co's fibre network topology:
>
> 1. Once NBN Co has gained adequate network roll-out experience and has had the opportunity to conduct demonstrations of alternative topologies NBN Co determine the appropriate network topology to enable both physical and wavelength unbundling;
> 2. NBN Co, in consultation with the ACCC, develop a plan setting out the appropriate extent of deployment of this topology having regard to construction cost and competition outcomes;
> 3. Government determine interim deadlines to complete this process in consultation with the ACCC and NBN Co;
> 4. NBN Co be required to secure Government approval of its topology plan, by the earlier of: coverage of 15 percent of premises within the proposed fibre footprint; and 31 December 2013.

Advice. That the NBN Co Board arrange for trials of alternative network technologies across different geographic types; these trials should include home-run topology and shared topologies involving varying levels of aggregation at the splitter cabinet; the trials should be conducted as early as possible so that they can inform network design at an early stage in the roll-out.

10.3.3 DETERMINING THE START OF ACTIVE-LAYER COMPETITION

Chapter 9 discussed the benefits of vertical integration of NBN Co's active layer and passive-layer activities during the roll-out period. This consideration sets a bound on how early physical unbundling should occur.

Chapter 8 discussed the importance of establishing a stable NBN Co business model and track record prior to privatisation. This effectively sets a bound on how late physical unbundling should occur, as its impact on NBN Co's commercial performance could be interpreted by the capital markets as a risk necessitating a significant discount on the Government's likely proceeds.

In the ordinary course of events, physical unbundling will occur at such time as Layer 1 services are declared by the ACCC, as NBN Co is unlikely to decide to reduce the market share of its active layer services unit by offering such services of its own accord. The ACCC would make this decision based on the usual statutory considerations, having regards to the long term interests of end users.

However, given the Government's interest in the privatisation of NBN Co, it is possible that the Government will wish to pre-empt the declaration process by mandating the provision of Layer 1 services to accelerate the process of moving towards an appropriate privatisation structure. Provision for such an action has been made in the draft legislation prepared by the Department.

Regardless of the catalyst, the ACCC will have to consider a number of issues at the time of unbundling.

- How should NBN Co determine which retailers can receive Layer 1 services where network topology limits the number of competitors (e.g. limited space for OLTs in the fibre exchange, or a limited number of fibres feeding a cabinet)?
- How should the pricing of unbundled Layer 1 services be determined, especially if some of the network construction cost is effectively written off?
- How should Layer 1 service pricing vary between different network topologies?
- Should integrated service providers be permitted to access Layer 1 services or should it be restricted to wholesale-only active-layer operators (Layer 2 and 3)?

Given the uncertainties surrounding network topology, business performance and technological and market developments, these issues will be best resolved by the regulator at the time of unbundling.

Recommendation 76. That Government not require NBN Co to unbundle Layer 1 services before network roll-out is almost complete; that Government endorse unbundling of Layer 1 services to occur at the earliest of:

1. Voluntary unbundling of Layer 1 services by NBN Co;

2. Declaration of Layer 1 services by the ACCC;

3. A requirement to provide Layer 1 services being imposed by the Minister.

Highlight. It is unlikely that NBN Co will voluntarily offer Layer 1 services. While declaration of Layer 1 services would remain at the discretion of the ACCC, it is difficult to envisage it being in the long term interests of end users to disrupt NBN Co's operations by requiring physical unbundling to occur before the roll-out period has concluded.

10.3.4 ANTICIPATING THE EQUIVALENCE OF INPUTS OBLIGATION

Section 10.2 above discusses the definition of equivalence and recommends that strict equivalence of inputs be imposed on NBN Co only in circumstances where it is competing with its own customers.

The unbundling of Layer 1 services will lead to such a situation. To ensure that NBN Co does not favour its own active operations above active-layer competitors, it will be appropriate to mandate strict equivalence of inputs in relation to those services.

There are a number of steps NBN Co could take to facilitate its compliance with this obligation. While it is a commercial matter for NBN Co to determine which of these steps should be taken initially and which should be left until the time of unbundling, it is important that the Government provide NBN Co with sufficient guidance to ensure that these issues are given proper consideration.

To enable regulated pricing of Layer 1 services on the basis of actual costs, it will be important for NBN Co to have accounting systems in place that enable costs associated with passive and active infrastructure to be differentiated.

This should be considered for the upfront design of product definitions, business processes and OSS/BSS systems. On the basis of discussions with vendors, failure to prepare for physical unbundling in the design of systems and processes may lead to the preparations for unbundling stretching for a period of up to three years due to the need for a wholesale replacement of OSS/BSS systems, as opposed to around one year if adequate preparation is made upfront. By comparison, the additional time required to make such preparations would be limited to the design phase and less significant in the context of the overall initiative. These factors notwithstanding, ultimately such decisions should be based on the NBN Co Board’s commercial judgement, subject to Government oversight as shareholder.

Recommendation 77. That NBN Co be asked to demonstrate that in the design of its products, systems and processes it has anticipated the likely unbundling of Layer 1 services on an equivalence-of-inputs basis and future ACCC price regulation of Layer 1 services based on actual costs; that in doing so NBN Co have regard to the commercial impact and technical feasibility of upfront preparation compared with steps taken at the time of unbundling.

Advice. That the NBN Co Board consider measures to prepare for the future unbundling of Layer 1 services on an equivalence of inputs basis; that the NBN Co Board determine on a commercial and pragmatic basis which steps to take in advance and which to leave to the time of unbundling; that the NBN Co Board consider in particular:

1. Maintaining accounting structures that will enable future regulated pricing of NBN Co’s Layer 1 services on the basis of cost by differentiating active and passive units;
2. Defining products and designing its business processes and OSS/BSS to maintain a distinction between passive and active products and divisions, so that NBN Co is capable of offering passive products to its active layer business and to third parties on an ‘equivalence of inputs’ basis.

10.4 Maintaining competitive outcomes through privatisation

Government has stated its intention to privatise NBN Co subsequent to the roll-out of the network. While privatisation will impose market disciplines on NBN Co, the company's exclusive focus on commercial performance following privatisation could compromise the Government's competition objectives.

At the time of privatisation, Government will naturally be focussed on the proceeds it will receive. There is a risk that a future government with this focus might undertake a privatisation at a time, or in a form, that would undermine the achievements of the NBN initiative. This risk can be mitigated, although not eliminated, by setting in place statutory mechanisms to ensure that competition objectives are not forgotten.

Privatisation should only occur when it can be implemented in a manner that establishes an appropriate market structure to preserve competition and when adequate regulatory safeguards are in place. These issues are addressed in five subsections:

10.4.1 Addressing the key risks of private ownership

10.4.2 Privatising only when the right competition settings in place

10.4.3 Keeping backhaul in public ownership

10.4.4 Enacting the trigger for separation and maintaining ease of separability

10.4.5 Setting ownership caps to support continued wholesale independence.

10.4.1 ADDRESSING THE KEY RISKS OF PRIVATE OWNERSHIP

The privatisation of NBN Co will significantly reduce the Government's subsequent capacity to influence its operations and market conduct. At the same time, pressure from private shareholders and the appointment of a new board representing them will create an incentive for NBN Co to focus on commercial returns to the exclusion of other objectives. This will enhance the need for competition safeguards.

The wholesale-only, open-access and equivalence principles will continue to apply and will help to ensure that NBN Co continues to provide a level playing field for retail competition. Ownership caps, discussed below in Section 10.4.5, will buttress this regime.

However, the risks of monopoly behaviour outlined in Chapter 9 will remain, and Government will be less able to address them. In the absence of appropriate regulatory measures, there could be a strong incentive for NBN Co to:

- Under-invest in upgrading and maintaining its network infrastructure, leading to degraded service standards and a failure to adjust to ongoing technological innovation;
- Seek monopoly rents by increasing prices, without commensurate improvement in value delivered;
- Even if basic service prices are regulated, use market segmentation to improve returns by extracting monopoly rents from premium products, reducing the take-up of premium services.

The enhanced risk of such conduct will need to be addressed through regulation at the time of privatisation.

- To ensure adequate investment in maintenance, detailed service standards will need to be imposed on NBN Co, as they are today on the existing CAN. The exact nature of these standards will best be determined and refined as the regulator is informed by experience during the roll-out and pre-privatisation process.
- Upgrades to keep pace with changing technology will be difficult to enforce. It is for this reason that we believe the privatisation of a monopoly Layer 2 service provider is undesirable, as outlined in 10.3 above. Passive infrastructure is unlikely to require an upgrade once unbundling has occurred and a competitive Layer 2 market exists.
- Pricing will continue to be monitored by the ACCC under the competition regulatory regime. It is obviously too early to assess the impact of the changes to Part XIC contained in the *Telecommunications Legislation Amendment (Competition and Consumer Safeguards) Bill 2009* which is before the Parliament. We merely note that upon privatisation, Government will lose its ability to influence pricing through other means and will be reliant upon the regulatory regime to prevent NBN Co from extracting monopoly rents.

10.4.2 PRIVATISING ONLY WHEN THE RIGHT COMPETITION SETTINGS IN PLACE

The construction of a publicly-owned NBN will restore to Government a degree of influence over the market structure and competitive dynamics of the telecommunications industry that it has not enjoyed since before the privatisation of Telstra.

The flawed nature of the current market structure has led Government to intervene in a substantial and unprecedented way to reform it. The privatisation of NBN Co will see Government relinquish its principal lever of intervention. If the structure is not right when Government withdraws from the industry as an owner, competition issues will become much more difficult to address.

In Chapter 9, we discuss a number of possible development paths for the telecommunications industry. As noted there, it is not possible to foresee with any certainty which of these will prevail. While we may speculate on future developments, it would be unrealistic to attempt to set in stone today the market structure that Government should establish at the time of privatisation over a decade hence.

The Implementation Study believes the most appropriate approach is to retain maximum flexibility in relation to future market structure. This does not mean doing nothing today. On the contrary, it requires that Government take three steps to prepare for privatisation by:

- Establishing tools that the government of the day can use to optimise the market structure;
- Ensuring that the lasting elements of the network infrastructure do not foreclose possible market structure solutions;
- Putting in place mechanisms to ensure a thorough review of competition issues immediately prior to privatisation.

First, Government should retain the ability to require structural separation of NBN Co and divestment of specified assets to optimise market structure at the time of privatisation. This is discussed and recommended in Section 10.3 in the context of establishing active-layer competition.

The flexibility of this tool should not be constrained—providing the Minister with a power to define structural separation will enable a decision to be taken in the context of the market structure that has been established at the time. By establishing this power in legislation today, a key hurdle is removed from the path of a future government seeking to preserve competitive outcomes.

Second, Government's power to determine the optimal post-privatisation market structure must not be compromised by passive infrastructure that forecloses likely solutions. This issue is discussed in Section 10.3. In particular, the construction of a passive network that cannot feasibly be unbundled at Layer 1 would preclude the possibility of full active-layer competition.

Third, it is critical that Government maintain competition objectives as a primary consideration when determining the timing and nature of privatisation. It is possible that a future government, keen to maximise privatisation proceeds, might neglect some of the market structure issues that Government today is committed to resolving. While this risk cannot be eliminated, it could be mitigated by the creation of a statutory requirement to hold an independent review by a body such as the Productivity Commission prior to privatisation to advise on issues of desirable market structure and implications for the nature and timing of privatisation. Such an inquiry would be consistent with the recommendations of the Hilmer Report into National Competition Policy.

Recommendation 78. That for the purposes of safeguarding competition outcomes in the event of privatisation of NBN Co:

1. Government commission an independent review into the telecommunications market structure and competition safeguards subsequent to the completion of roll-out and prior to privatisation;
2. The review assess the achievement of the competition objectives of the NBN initiative, and recommend any adjustments to regulatory and other arrangements required to maintain an effective wholesale model under private ownership (including, if appropriate, structural separation and/or divestment of interests in real property associated with the network);
3. Government determine its privatisation plans and schedule on the basis of that review.

10.4.3 KEEPING BACKHAUL IN PUBLIC OWNERSHIP

There are unique issues surrounding backhaul infrastructure that make privatisation challenging.

Uncontested backhaul will remain a bottleneck asset that will be very difficult to regulate. Data volumes will be constantly increasing, requiring upgrades in equipment to keep service quality high, with backhaul providers unlikely to be able to raise prices to levels required to generate economic returns. Stand-alone commerciality will always be challenging while ensuring affordability, so a commercial owner will rationally under-invest. These issues are discussed in Section 6.1.

Recommendation 79. That the independent review of competition prior to privatisation start with a rebuttable presumption that backhaul not be privatised.

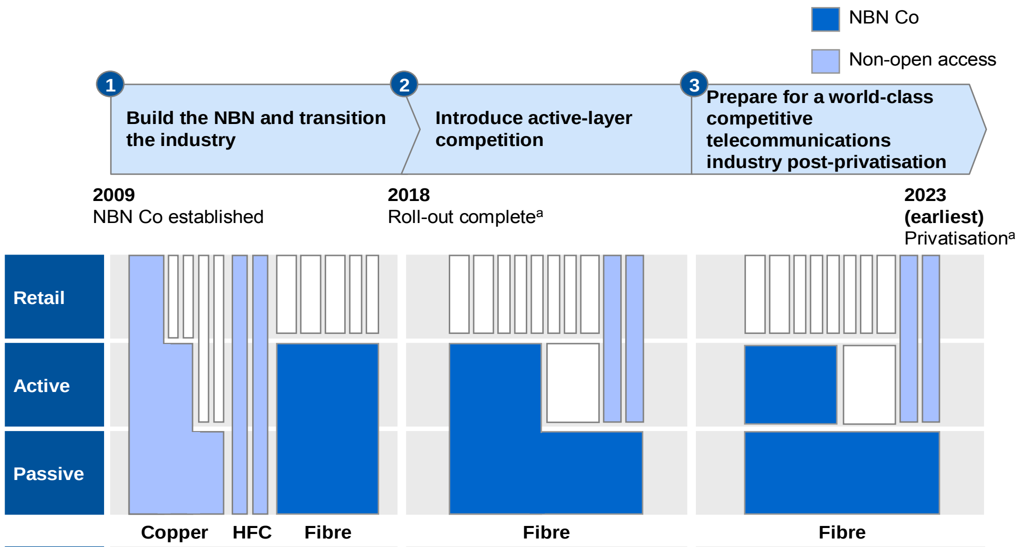
Advice. That NBN Co Board ensure that NBN Co anticipate structural separation of its transit backhaul assets, including:

1. Maintaining accounting structures and asset registers designed to enable structural separation of NBN Co's transit backhaul assets;
2. Maintaining modularity of transit backhaul services;
3. Maintaining its interests in physical infrastructure directly associated with the transit backhaul network in a separate corporate entity.

10.4.4 ENACTING THE TRIGGER FOR SEPARATION AND MAINTAINING EASE OF SEPARABILITY

It is reasonably likely that the independent inquiry into the timing and nature of privatisation would recommend a market structure in which NBN Co's passive-layer business is privatised as a structurally separate entity from its active-layer operations (Exhibit 10–7). As discussed in Chapter 8, this may well align with the optimal way to structure the privatisation to maximise appeal to different investors and therefore privatisation proceeds. NBN Co is also likely to be required to divest its transit backhaul assets to Government consistent with the view that these should remain publicly-owned. It is also possible that the inquiry might recommend the divestment of NBN Co's duct, pit, pole and exchange infrastructure. This last option may be a valuable fallback to enable infrastructure competition if NBN Co's network topology is not conducive to active-layer competition.

Exhibit 10–7. Potential evolution of fixed-line access network industry structure



Compe-tition	▪ Copper migration ▪ New FTTP subject to open access wholesale obligation and industry levy ▪ HFC consolidation/acquisition/ migration	▪ Emergence of active layer wholesalers or vertically integrated retailers ▪ Equivalence between 'NBN Co active' and passive access seekers	▪ Potential separation of Passive Co (enduring monopoly) and Active Co (competitive market)
Services	▪ Layer 2 bitstream only for access network ▪ Transit backhaul	▪ Layer 2 bitstream (or similar) ▪ Physical/ wavelength unbundling ▪ Transit backhaul	▪ Layer 2 bitstream (or similar) ▪ Physical/ wavelength unbundling ▪ Transit backhaul
Pricing	▪ Pricing for affordability and take-up ▪ Uniformity within access technologies ▪ No restrictions on migration incentives ▪ Cross subsidies OK between active, passive and backhaul	▪ Uniformity within access technologies ▪ No cross-subsidies between active, passive and backhaul ▪ Regulated real price increases	▪ Uniformity possibly only required for passive access ▪ Separation or regulation ensures no cross subsidies between lines of business
Regula-tion	▪ Wide ministerial and ACCC discretion to implement policy goals ▪ Approval of NBN Co topology for unbundling at earliest of 2013 or 15% premises covered	▪ Narrower ministerial and ACCC discretion ▪ Definition of active layer industry structure	▪ Stable, predictable and comprehensive regulatory regime
Funding	▪ Government funded for all equity ▪ Commercial investment-grade debt as appropriate	▪ Increased levels of debt once cashflows are established	▪ Passive assets likely to be privatised separate to active layer business ▪ Backhaul likely to remain under Government ownership

a. Copper and HFC networks still likely to be in service
Note: Layer 2 and layer 3 have been simplified here into 'Active' and 'Retail' layers
SOURCE: Implementation Study

We believe it is appropriate that the power to implement such steps be included in legislation at an early stage:

- Any uncertainty over future measures to mandate or otherwise effect structural separation would undermine confidence in that outcome amongst telecommunications stakeholders, including NBN Co itself;
- Legislative provision of powers to implement the recommendations of the independent review will make it harder for a future government to engage in premature and/or inappropriately structured privatisation;
- Stakeholder concerns over the creation of a 'new Telstra' will be alleviated by the existence of concrete measures to give effect to the market structure recommended by the independent review.

We envisage that there would be provisions in NBN Co legislation empowering the Minister to trigger structural separation of NBN Co, as defined by a legislative instrument at the time, and to require NBN Co to divest assets or classes of assets specified in the instrument. A non-disallowable instrument would be preferable to provide certainty.

Should this recommendation be accepted by Government, the Implementation Study believes it would be desirable for the Minister to inform NBN Co and other telecommunications stakeholders as soon as possible of the intention to establish a mechanism for future separation. This would ensure that decisions NBN Co makes in the period prior to the introduction of the relevant licence condition and legislative triggers are consistent with future separation.

Recommendation 80. That the Minister be empowered to issue an instrument ordering structural separation of NBN Co at one or more levels (such as between active and passive layers), with the nature of separation defined by the instrument.

Recommendation 81. That the Minister be empowered to issue an instrument ordering NBN Co, or a company formed from structural separation of NBN Co, to divest its interests in defined assets or classes of asset (for example: access-network ducts, pits and exchanges; transit backhaul assets).

Recommendation 82. That NBN Co be required to maintain its interests in real property directly associated with the access network, including ducts, pits, poles and exchanges, in a separate corporate entity to facilitate divestment in the event that it is required in the future.

Advice. That NBN Co Board prepare for future structural separation to the extent that commercial and practical considerations favour the implementation of measures now rather than at the time of separation. In particular, NBN Co should maintain asset registers to enable easy separation of active, passive and backhaul business units.

10.4.5 SETTING OWNERSHIP CAPS TO SUPPORT CONTINUED WHOLESALE INDEPENDENCE

NBN Co will have substantial power in the wholesale access market. It is critical that this market power does not result in anti-competitive outcomes downstream. In particular, other Carriers, Carriage Service Providers (CaSP) and Content Service Providers (CoSP) must not be able to exert undue influence on NBN Co to stifle competition or innovation at the expense of their competitors or end users. The benefits of a wholesale-only network would be undermined if a customer of the network was able to exercise effective control, or exert undue influence, on NBN Co.

Ownership of equity is the most direct means of obtaining control or influence. Therefore, ownership caps which restrict ownership of NBN Co by other Carriers, CoSPs and CaSPs are necessary to protect the Government's objectives of a wholesale-only, open-access network providing equivalent access.

In Chapter 8, we recommended that Government maintain full ownership of NBN Co until NBN Co has established a stable and proven outlook following completion of network roll-out. If this recommendation is accepted, it would be sufficient to establish any ownership caps in the constitution of NBN Co at any point in the intervening period. To eliminate the risk of such restrictions in NBN Co's constitution being overturned in the future or becoming the subject of litigation however, the Implementation Study believes ownership caps should be legislated prior to the acceptance of private equity investment, whether or not that investment occurs in line with our earlier recommendation.

The level of control afforded by a particular percentage equity stake varies based on a host of additional factors including industry structure, the financial health of the target company, the availability of alternative sources of capital, additional levers of influence and even the personalities of key directors and executives in the target company and the owner.

If one company becomes the largest customer of NBN Co by a substantial margin (which is a distinct possibility if Telstra does become a customer) then this customer will already have a degree of influence through its buying power. Once Government privatises NBN Co, there may be no majority shareholder. In that case, a shareholding of, for example, 15 percent might be the largest shareholding, which would give that shareholder much greater influence than if there was a majority shareholder with a stake of 51 percent or more, or two other shareholders with 20 percent each. Mechanisms to prevent customers exercising undue influence need to be considered against this backdrop.

The risk of undue influence being exercised by NBN customers and thus compromising the objectives of maintaining a wholesale-only, open-access network providing equivalent access to NBN customers must be weighed against the commercial implications of setting a lower ownership cap and the ability to use non-ownership restrictions on control to mitigate the prima facie risk of a higher cap. It also needs to be seen in the context of other competition safeguards that will be in place—most obviously, equivalence and open access. We see two specific commercial considerations: the first regarding the cost of capital; the second around preserving flexibility for negotiations.

Once the market seeks to attribute value to NBN Co through the privatisation process, the removal of any opportunity for a Carrier, CaSP or CoSP to gain equity (and other) control will be a value impediment, even though the caps would be specific to a certain class of investors.

Examples where blanket caps have increased a company's cost of capital are Santos in the 1980s where a 15 percent cap translated into status as a market laggard and Air Canada where removal of the company's 15 percent cap on individual domestic ownership was required to expand opportunities for investment and thereby lower its cost of capital. One could imagine a scenario in which financial markets are frozen and a privatised NBN Co needs capital to upgrade its network. Its customers would have strong incentives to invest in NBN Co to ensure the health of their own business, without being motivated to gain control of NBN Co.

Ownership caps on NBN Co equity

Ownership caps on NBN Co will play an important role, in conjunction with other measures, in achieving the Government's policy objectives of the NBN operating as a wholesale-only, open-access business. While Section 50 of the *Trade Practices Act 1974* can be used to prevent acquisitions having the effect of substantially lessening competition, this places a substantial evidentiary burden on the ACCC. In light of the threat posed by vertical integration to the Government's central objective of fostering a competitive telecommunications market through structural separation, explicit ownership caps are appropriate.

We recommend the setting of caps on individual ownership by Carriers, CaSPs and CoSPs of NBN Co prior to the first consideration of private equity in NBN, shares to mitigate the risk of undue influence being exerted on NBN Co by one of its customers. These ownership caps should extend to an entity which is a customer of NBN Co but falls outside the definition of a Carrier, CoSP or CaSP. The caps should relate to individual customers, rather than the aggregate shareholding of competing customers, as the principal danger is that NBN Co may show preference to a particular customer. By contrast, a significant shareholding by a diverse range of customers may actually be beneficial, leading to greater responsiveness to emerging industry trends.

We believe that the Government's policy objectives can be achieved by setting individual ownership caps for carriers, CaSPs and CoSPs of no more than 15 percent, in conjunction with other measures.

Setting ownership caps is an inexact science, and needs to be considered in conjunction with other forms of influence such as monopsony power and the relative size of other shareholdings. Most relevant precedents are in the range of 5 percent to 15 percent, with 20 percent being the relevant threshold for takeover provisions under the *Corporations Act 2001*, suggesting that this is a point at which the risk of ownership conferring control is qualitatively increased.

The methodology we have used involves researching national and international ownership cap precedents, considering industry feedback and the requirements of the Government's objectives. On the basis of our research, most precedents are in the range of 5 percent (the minimum that should be considered) to 15 percent. We note that caps of 5 percent typically apply to holdings further down the value chain (i.e. holdings by suppliers in their customers). This is because an interest in a customer's company immediately creates a direct financial interest in the performance of that customer, and an incentive to discriminate in favour of that customer. There is a deliberate asymmetry in some example legislation, which allows a higher cap in shareholdings by customers in their suppliers (Exhibit 10–8).

Exhibit 10–8. Domestic and international examples of ownership caps

Equity cap	Domestic and international illustrations
5 percent	■ *Airports Act 1996* restricts airlines from owning more than 5 percent of airport operator companies. Substantial shareholder notification rules of the Corporations Act apply. ■ *Victorian electricity sector:* under the *Electricity Industry Act 2000 (Vic)* an owner of a licensed Victorian generation, transmission or distribution licensee can have a greater than 5 percent stake in no more than one other generation, transmission or distribution licensee.[a]
10 percent	■ *Domestic takeover rules*: under these rules, 10 percent constitutes a blocking stake since compulsory acquisition of 10 percent of equity can be mandated where a bidder has achieved 90 percent bid approvals from voting equity holders. ■ *Norwegian financial sector*: An acquisition of more than 10 percent (and thereafter 20 percent, 25 percent, 33 percent and 50 percent) in a Norwegian financial institution is subject to licence from the Norwegian government. ■ *Cyprus banking sector*: Cypriot Central Bank's prior approval is necessary before any individual person or entity, (Cypriot or foreign) can acquire over 9.99 percent of a bank incorporated in Cyprus.
15 percent	■ *Airports Act 1996* restricts cross-ownership between paired operator companies to no more than 15 percent. ■ *Broadcasting Services Act* 1992 restricts cross-ownership to no more than 15 percent of more than one commercial television broadcasting licence in the same licence area. ■ *Medibank Private Sale Act 2006* proposed a maximum limit of a 15 percent stake that any entity can hold in Medibank Private companies during the 5 year period following the designated sale day.

Equity cap	Domestic and international illustrations
	■ *Foreign Acquisitions and Takeovers Act 1975* contains a Foreign Investment Review Board (FIRB) compulsory notification / approval threshold. A substantial foreign interest occurs when a single foreigner (and any associates) has 15 percent or more of the ownership or several foreigners (and any associates) have 40 percent or more in aggregate ownership of any corporation, business or trust. ■ *Financial Sector (Shareholdings) Act 1998* restricts a person's ownership in a particular financial sector company to no more than 15 percent. The treasurer has the discretion to approve a higher percentage on national interest grounds. ■ *Santos*: Until 2007, under South Australian legislation there was a 15 percent ownership restriction on the oil and gas company Santos to aid share price and company growth.[b] ■ *Air Canada*: Government removed the 15 percent restriction on individual domestic ownership of shares in Air Canada, to offer the private sector opportunities to invest.
20 percent	■ *Corporations Act* takeover rules apply above 20 percent. ■ *Canadian financial sector*: one shareholder (either an individual or an entity) may own up to 20 percent of a large chartered bank's shares with a limit for non-voting shares of 30 percent. The Bank Act restricts any one shareholder from having control over any of the large banks.[c] ■ *Petro-Canada Public Participation Act (1991)*: restricts a single shareholder from holding more than 20 percent of stock in Petro-Canada, a Canadian state owned oil and gas company. ■ *Electricity Industry Act 2000 (Vic:)* the owner of a licensed Victorian generation, transmission or distribution licensee cannot have >20 percent interest in another generation, transmission or distribution licensee. ■ *2009 Victorian tram and rail re-franchising*: the Victorian Government is currently re-franchising the rail and tram public transport services. Under new franchise contracts the owner of the train franchise cannot own more than 20 percent of the tram franchisee and vice versa.[d]
30 percent	■ *Singapore broadband*: 30 percent ownership restriction applies to equity interest in NetCo if the holding entity is involved in any other part of the telecommunications sector value chain.[e]

a. Furthermore under s.68 of the *Electricity Industry Act 2000 (Vic)*, a person (not a licensee) can hold a 20% or more interest in no more than one generation, transmission or distribution licensee and a 5% or more interest in no more than two licenses. In addition to the above limits, distribution licensees are precluded from controlling more than 200 MW of generation capacity

b. The cap was imposed in 1979 to protect the Company from a potential takeover from Alan Bond, which threatened to divert SA gas supplies away from state.

c. Previously, no one shareholder could have more than 10% of a bank's shares

d. Whilst public transport fares are set by the State, the Government has sought to prohibit higher levels of cross-ownership to foster non-price competition such as quality and reliability of services. It is noted that due to the franchise nature of the transaction these caps are contained in the franchise contracts rather than legislation

e. The Singapore model splits the network into NetCo (which owns the infrastructure) and OpCo (the operating company), which is being introduced to competition from a second OpCo. It is also noted that the Singapore Government may have more influence, due to the degree of ongoing informal supervision, to mitigate the potential risk of the higher cap interfering with policy objectives than the Australian Government would post-privatisation when the Government's shareholding is sold

Source: Implementation Study

The Implementation Study also considered submissions received by the Department from key industry participants regarding ownership restrictions (Exhibit 10–9). Industry feedback has been in favour of the imposition of ownership restrictions on NBN Co with a focus on equity ownership caps with proposals at 5 percent, 15 percent or 20 percent. Telstra did not address ownership caps in its submission.

The Implementation Study believes that while setting the cap at the lowest practical level of 5 percent would represent the most conservative path relative to limiting undue influence by market participants, based on our review of precedents the cap in practice could be set at up to 15 percent and still achieve the Government's policy objectives. Cap levels above 15 percent would be inconsistent with precedents, which would be a concern given the policy goals, the history of the industry and the monopsony power that Telstra

Exhibit 10–9. Submissions on equity ownership caps

Stakeholder	Submission on equity ownership cap
Telstra	■ Not addressed in its submission, except for need to operate as any other commercial entity and ensure separation between Government role as shareholder and regulator.
Optus	■ 20 percent cap on voting equity owned by any retail telecommunications provider. ■ Cap should continue for lifetime of NBN Co even after Commonwealth has sold down and including any expansions of capital.
Macquarie Telecom	■ Propose as a principle, retail service providers and other carriers should not be allowed to have a shareholding in NBN Co. However, if assets are vended in, up to 5 percent shareholding in NBN Co would be permissible. ■ If above cap is not sufficient to cover asset value, preferred alternatives are, in order of preference: (1) Cash only; (2) Non-voting shares up to 20 percent and (3) unlimited non-voting shares. ■ In-principle support for direct issue of shares to Telstra shareholders in exchange for vend in of Telstra assets.
Seven Network	■ Private interests should be prevented from having control of NBN Co. ■ Ownership interests in NBN Co should be limited to 5 percent in relation to companies active in any related industry sector, and 15 percent in the case of public or private equity investors that do not exercise control of a business active in any related industry sector.
Unwired	■ No private sector investor should be able to own (or control) more than 5 percent of the shares, or no more than 15 percent for an investor who does not exercise control of a business active in a related sector (in line with Seven Network).
ISOC AU	■ Propose no one organisation that is a carrier, a carriage service provider or a content service provider be allowed to hold more than a 5 percent shareholding in NBN Co.

Source: Implementation Study; various submissions to the Department. It is also noted that a number of stakeholders not identified in this table addressed ownership caps in their submissions, including the CCC, ATUG, DEIWG, VHA and ACTU will enjoy. Setting a much lower cap, for example 5 percent, may restrict funding options and therefore NBN Co's value at privatisation.

The ownership caps must be supported by appropriate tracing provisions and adequate penalties and powers:

- **Tracing provisions:** tracing provisions are necessary to ensure that the policy intention of a cap is not breached by individuals, groups or their associates. Relevant precedents for this exist in, for example, the *Foreign Acquisitions and Takeovers Act 1975*, the *Airports Act 1996*, *Telstra Corporation Act 1991* and the *Medibank Private Sale Act 2006*. The scope of application of tracing provisions may be quite broad, for example, to include any agreement, arrangement, understanding, promise or undertaking, whether express or implied and whether or not enforceable as is contained under the *Medibank Private Sale Act 2006*. We believe this is an appropriate precedent to adapt to the ownership caps applying to NBN Co.
- **Penalties and powers:** the Implementation Study recommends following existing precedents and practices contained in legislation for penalties and powers. For example, the *Airports Act 1996* stipulates that, should an unacceptable ownership situation arise (i.e. breaching ownership cap), the Federal Court of Australia can make orders as it considers appropriate, such as ordering the disposal of shares, restraining exercise of any rights attached to shares or prohibiting/deferring payment of any money due in respect to shareholdings etc, for the purpose of ensuring that the situation ceases to exist. Where fines are appropriate the level of such fines will need to be calibrated such that they are proportionate to the severity of contraventions under the legislation to mitigate any reluctance by a court to penalise. In practice, it is probable that only a small number of customers will ever be in danger of breaching the cap. Accordingly, to avoid the practical complexity of NBN Co attempting to maintain a register of shareholdings traceable to customers, we suggest that the ACCC be given a power to compel a declaration from any person as to the shareholding in NBN Co attributable to them under the tracing provisions, on both a periodic and ad-hoc basis, with appropriate penalties for false disclosure. The ACCC would be authorised to apply to the Federal Court for appropriate orders in circumstances where it believed a breach had occurred. Given that the ACCC is responsible for monitoring competition in the telecommunications market, it is the agency most likely to become aware of behaviour that might signal a potential breach.

The ownership caps should be legislated prior to any private investment in NBN Co.

Recommendation 83. That an individual ownership cap (including associated interests) be set of no more than 15 percent each on Carriers, CoSPs and CaSPs in relation to shareholdings in NBN Co, subsidiaries of NBN Co, or any company resulting from structural separation of NBN Co; that practical control tests be imposed in relation to such investors; that a public inquiry be required before altering these caps.

Other ownership caps

Further to the analysis of individual ownership caps discussed above, the Implementation Study examined other types of ownership caps that may be applied:

- The Implementation Study considered whether an aggregate cap should apply to Carrier/CoSP/CaSP entities. Aggregate caps are used in relation to foreign ownership under a number of the precedents that examined (e.g. Qantas Sale Act). However, given the competitive dynamics of the telecommunications industry, we consider it unlikely that a coordinated coalition of Carrier/CoSP/CaSPs promoting anti-competitive interests would emerge, and that individual caps will provide sufficient safeguarding.
- As discussed in Chapter 8, private equity investment should not occur until at least after completion of network roll-out, including vending in assets in return for equity.
- The Implementation Study believes ownership-cap restrictions on entities that are not Carriers, CoSPs, CaSPs are not necessary. It will be important to enable private sector investment to meet NBN Co's significant post-privatisation funding requirements. Furthermore, investment by any such entity will not result in direct vertical integration and therefore would be unlikely to compromise the Government's objective of equivalence. Such restrictions should be left to existing takeover rules.

Non-ownership control restrictions

In addition to the ownership restrictions discussed above, the Implementation Study considered additional permanent control restrictions to mitigate risks of improper influence.

On balance, the Implementation Study considers that restrictions on the voting rights of shares owned by Carriers/CaSPs/CoSPs should not be constrained; nor should they be prohibited from Board representation. Ownership caps make such protections redundant, and these investors have a legitimate interest in the conduct of NBN Co. Their inclination to invest would likely be reduced if such protections were implemented, making more difficult NBN Co’s capital raising task at privatisation.

However, we believe that practical control tests (i.e. de facto control as distinct from direct control tests) should also be included in legislation. Such provisions would examine whether other entities are in a position to exercise indirect control over NBN Co through either formal or informal means. Practical control provisions are part of the *Airports Act 1996* and the *Financial Sector (Shareholdings) Act 1998*. For example, in addition to direct control, the *Airports Act 1996* contains a provision where the Minister may declare a person to have practical control of an airport-operator company if:

- The directors of an airport-operator company are accustomed or under an obligation, whether formal or informal, to act in accordance with the directions, instructions or wishes of a person; or a person is in a position to exercise control over an airport-operator company; and
- The person does not have any type of stake in the company; or if the person has one or more types of stake in the company—each of those stakes is not more than 15 percent.

Provisions to control senior executives and Board members moving to Carriers, CaSPs and/or CoSPs within a reasonable period have been suggested (these provisions would be based on overseas best practice in this regard and would be informed by consultation with Commonwealth agencies such as the ACCC). However, on balance we would advise against such restrictions. They would significantly restrict NBN Co's ability to attract talented personnel, which will be critical to its success. The Implementation Study believes the intent of these restrictions—to prevent confidential information about NBN Co's operations and those of its customers passing to a customer and providing that customer with a competitive advantage—should be addressed instead through ongoing confidentiality obligations.

Foreign ownership restrictions

The Implementation Study sees no reason to constrain foreign ownership beyond existing legislation. Consistent with Government's intention for NBN Co to be privatised, access to foreign investors will be important. NBN will represent critical infrastructure, however ensuring the company is subject to the existing foreign ownership review mechanisms under the *Foreign Acquisitions and Takeovers Act 1975* (FATA) should provide sufficient protection.

FATA applies to a corporation in which a natural person not ordinarily resident in Australia or a foreign corporation holds a substantial interest, which is defined as 15 percent or more of the ownership, or several foreigners and any associates with 40 percent or more in aggregate of the ownership. Under the FATA, a foreign investment application may be blocked where it is contrary to the national interest.

A relevant precedent in relation to critical telecommunications infrastructure is the acquisition of Cable & Wireless Optus Ltd (Optus) by Singapore Telecommunications Ltd (SingTel) which was subject to review by FIRB. The existing frameworks proved adequate to allow this investment despite Optus' ownership of potentially sensitive assets such as satellites and terrestrial telecommunications links used for military applications.

There are precedents, however, where Government has exercised its discretion to impose foreign ownership restrictions separate to the FATA framework including:

- The *Telstra Corporation Act* 1991, which contains foreign ownership restrictions including:
  - A limitation on total foreign ownership of more than 35 percent
  - A limitation on foreign ownership by an individual including that individual's associated interests to no more than 5 percent
- The *Airports Act 1996* contains a 49 percent limit on foreign ownership of airport-operator companies. This effectively defines a first-in, best-dressed regime whereby if the foreign ownership level is close to the cap, any additional foreign parties seeking to invest will be prohibited from doing so.
- The *Qantas Sale Act 1992* imposes certain foreign ownership restrictions on the ownership (including joint ownership) and issue of Qantas shares, including (but not limited to) restrictions on:
  - Foreign persons having no more than 49 percent of the total value of the issued share capital
  - Foreign airlines having no more than 35 percent of the total value of the issued share capital
  - Any one foreign person having no more than 25 percent of the total value of the issued share capital.

Consideration of imposing such restrictions should be subject to appropriate legal advice as the Commonwealth needs to comply with its international obligations with respect to any restriction it may wish to put in place. The precedents outlined above imposed such restrictions prior to the implementation of the Australia–United States Free Trade Agreement (AUSFTA). The AUSFTA deems acquisitions by US investors of interests in Australian businesses, valued below specified monetary thresholds, exempt from the need to obtain FIRB approval. A threshold regime has also been enacted for non-US investors.

The Commonwealth may also consider different limits for offshore sovereign wealth funds, which are a potentially important source of infrastructure funding. We note that under recent reforms, sovereign wealth funds that wish to invest in Australia face additional requirements to those of other investors in relation to FIRB approval, including: the need to demonstrate independence; adherence to the law and common standards of business behaviour; the impact on competition; the impact on Australian Government revenue and other policies; national security compliance; and the impact on Australian business, the economy and the broader community. These considerations will need to be balanced by the need to secure sufficient sources of funding and the Government may wish to streamline processes to deal with these issues.

Should the Commonwealth wish to impose further restrictions on foreign control of NBN Co, non-ownership restrictions which it may consider include:

- Board composition;
- Head office location;
- Place of incorporation;
- Trading exchange locations (primary and secondary).

As an example of the use of non-ownership restrictions, the *Medibank Private Sale Act 2006* required that for five years from the designated sale day, the Medibank Private companies remain under Australian management, maintain an Australian base of operations and remain incorporated in Australia. It also required that a majority of the directors of a Medibank Private company during that period be Australian citizens.

However, as noted at the beginning of this section, we do not see any reason to recommend additional restrictions on foreign ownership and control beyond those included in the FATA.

10.5 Preserving a vibrant mobile market structure

The announcement of the NBN initiative has given rise to significant public commentary on the role of wireless broadband services in Australia's broadband future. It is true that wireless technologies continue to advance, leading to expectations of ongoing growth in services. However, the technical capabilities of fibre are superior and hence the market is likely to see a bifurcation of fixed (fibre) and wireless usage in the future, making them largely complementary technologies.

In the interim, wireless services are likely to have a dampening effect on NBN take-up rates. Nevertheless, given the likelihood of the NBN becoming the predominant fixed-line network, a vibrant and competitive wireless industry is a healthy counterweight. Independent of such near-term commercial considerations, infrastructure-based competition will serve the long-term interests of end users.

For these reasons, it is important that NBN Co not make decisions that constrain the development of the wireless broadband industry, such as refusing to supply wireless operators with services within the fibre footprint where those services could be provided using NBN Co's network infrastructure.

Recommendation 84. That Government instruct NBN Co to provide fit-for-purpose access services to wireless base stations within the FTTP footprint on a commercial basis where requested by mobile operators; these access services to include transit backhaul where required to reach an NBN Co POI.

As discussed in Section 6.3.4, unless granted temporary relief by the Minister, NBN Co should provide transit backhaul as a separate service to other network operators, including mobile operators. Given NBN Co already would be providing the transit backhaul where mobile operators interconnect at relevant POIs, the only impact of this requirement is to ensure that the NBN access service is priced relative to access alternatives, and not based on leveraging NBN Co's control over the transit backhaul bottleneck.

Similarly, as discussed in Section 5.4, where requested by the NBN fixed-wireless provider(s) resulting from the public tender process, NBN Co should extend fibre transit backhaul links to existing towers and new tower sites needed to provide coverage to the designated footprint. This will remove one of the largest barriers to expanding wireless coverage areas beyond the fibre footprint: lack of access to competitively priced backhaul at adequate capacity. This transit backhaul should be priced at the same rates as transit backhaul in the fibre footprint and, consistent with NBN Co's open-access requirements, would be offered to other operators in addition to the fixed-wireless NBN network provider(s).

D Maintaining momentum

Government has set an objective to construct the NBN within 8 years. This rate of build—in terms of the number of premises covered per year—has been achieved in other international FTTP builds; however, it represents a sustained and rapid pace of implementation that has not been attempted elsewhere on a geographic scale comparable to the NBN. Achieving this goal will require careful coordination and effective execution by multiple stakeholders over the 8 year period. Unexpected hurdles will undoubtedly emerge, so the implementation process will need to incorporate sufficient flexibility to respond and adjust as required.

NBN Co is already working on a planned schedule for the network roll-out. At present, NBN Co must proceed on the basis of the default policy settings implicit in the current regulatory regime, the draft legislation before parliament and Government policy statements. As NBN Co's preparations for deployment become more advanced, it will become more difficult, expensive or, in some cases, impossible to shift away from these default settings.

The Implementation Study's recommendations to Government set out a number of proposed changes to current policy settings, many of which will require regulatory or other action by Government. It is critical that Government rapidly determines the policy settings it wishes to add or modify and establishes a framework of regulation and guidance to implement those changes. Providing this clarity will be a key element of enabling NBN Co and other providers involved in delivering the NBN to meet the rapid implementation schedule set out by Government.

Government's role in facilitating the timely delivery of the NBN will not be limited to one-off policy decisions at the beginning of the project. Compared with an established government-owned utility, the start-up nature of NBN Co will lead to a much greater number of decisions with policy implications on a month-to-month basis over the course of the roll-out. This will necessitate streamlined mechanisms to provide policy guidance on a rapid and sometimes informal basis.

Ultimately, responsibility for roll-out actions across the fibre footprint will lie with NBN Co. The company's corporate plan will require regular review and revision. While recognising that it is impossible to foresee the challenges that the coming years will bring, NBN Co should establish an initial roadmap of actions and a mechanism for revision and government approval.

Part D consists of one chapter:

- Chapter 11 discusses how Government can provide appropriate support and guidance to NBN Co in a timely manner and how NBN Co can establish a corporate plan that provides an initial framework for the journey ahead.

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11 Facilitating implementation of the NBN

SUMMARY

- The development and approval of NBN Co's corporate plan provides an effective mechanism to achieve formal alignment between Government objectives and the design and operation of the NBN, as the company translates these objectives into practical measures and manages implementation risks.
- Government will need to provide timely guidance to NBN Co on the Implementation Study recommendations. This guidance will inform decisions that need to be taken over the next few months around network design, product and service specifications and regulatory undertakings.
- Government should explore a governance approach which balances the legal and administrative responsibilities of multiple Government departments with the need for unique levels of co-ordination, flexibility, expertise and timeliness in decisions.
- Government will need to employ a variety of mechanisms to implement the recommendations of the Implementation Study. While a number of these recommendations require new legislation, momentum can be maintained through alternative mechanisms such as licence conditions, funding agreements and GBE oversight before this legislation is in place. Careful consideration of the appropriate sequencing of actions will be required to facilitate implementation of the project.

NBN Co's corporate plan should be used as the primary vehicle for communicating and gaining alignment around NBN Co's intended actions. In the initial plan, NBN Co should develop a detailed roadmap of implementation actions over the next 12–18 months. Experience with FTTP roll-outs overseas highlights a number of challenges that present particular risks to timing. Addressing these should be a high priority for NBN Co.

Government will also need to provide continuing policy guidance and other support to NBN Co as new issues arise. An appropriate governance framework for managing interaction between NBN Co and Government should be developed.

Finally, the recommendations in this report set out the ways in which Government should facilitate the NBN project and safeguard the achievement of its policy objectives. This requires addressing practical issues around available mechanisms and timing.

This chapter discusses these implementation issues in three sections:

11.1 Overseeing the development of the NBN Co corporate plan

11.2 Establishing a governance model

11.3 Implementing the recommendations.

11.1 Overseeing the development of the NBN Co corporate plan

The complexity and rapid pace of the planned roll-out of the NBN makes it critical that NBN Co develops a comprehensive corporate plan. A number of activities require long lead-times, such that their failure would jeopardise the entire project schedule. Focussing on, and developing mitigation strategies for, the areas of greatest risk to timing will reduce the likelihood of delaying deployment of the NBN.

NBN Co's corporate plan will serve two important purposes:

- It will assist NBN Co in ensuring that it has a clear roadmap of actions to address implementation challenges and give effect to its objectives;
- It will provide a mechanism for Government to verify that plans are consistent with Government's objectives and to identify issues that warrant Government intervention.

NBN Co must be the principal architect of the corporate plan. However, Government will wish to ensure that the plan is consistent with its expectations, requiring additions to the plan where necessary.

An exhaustive list of the elements that should be included in the corporate plan is beyond the scope of the Implementation Study, and new issues will no doubt emerge over time as planning and trials continue. At a minimum the plan should outline the core elements of the corporate model, the coverage approach, operations, services and pricing, and financial aspects of standing up the company, as outlined in Exhibit 11–1.

In developing the plan, the company should take account of lessons learned from international fibre deployments around potential implementation pitfalls. These include:

- **Gaining approvals for physical network deployment:** in Chapter 7 the Implementation Study recommends changes to the legislation defining Low Impact Facilities to facilitate the roll-out of the NBN. Experience with other roll-outs has shown that in addition to any legislative action, active outreach to local communities, councils and state governments is essential to success—for example to establish rights to deploy cables aerially or gain access to homeowners' private property. Similarly, as outlined in Chapter 2, access to common areas in MDUs will be essential to deploy fibre to individual units, and has proven very time-consuming in some European roll-outs such as those in France and Portugal. NBN Co should therefore engage with MDU corporate bodies well before entering a given area to explain options for installation and gain permission to access relevant infrastructure.

- **Managing availability of skilled labour and equipment:** experience with major fibre builds overseas has highlighted the potential bottlenecks in key skill categories, such as fibre splicing. While these skill gaps can be addressed in part through the choice of technology (e.g. deploying pre-connectorised cables), NBN Co will inevitably face capability gaps in the available workforce, and should develop a plan early in the process for accessing sufficient labour pools. This will include developing strong internal capabilities for project management, contractor management and procurement, and deciding which capabilities to develop in-house and which should be provided by contractors.
- **Managing the supply chain:** the construction of the NBN represents a substantial logistical challenge. Detailed planning will be needed for: the procurement, delivery and management of materials and equipment; implementation of contractual frameworks with suppliers; rigorous contract management; and the development of flexible and responsive delivery mechanisms. Detailed contingency planning will also be needed to minimise impact on NBN Co's schedule from disruptions to the supply chain, such as delays in delivery, supply shortages and force majeure events. Deployments in Japan, France and Portugal successfully used short pilots and 1–2 year pre-deployment phases to refine processes before engaging in wide-scale roll-out. NBN Co should start by building a strong internal procurement function, and working with the vendor community to ensure a robust supply chain is established.
- **Establishing the OSS/BSS:** for both incumbent and greenfield network builds, choosing the right OSS/BSS design and implementing it efficiently is a critical enabler of success. In the Netherlands for example, implementation of the OSS/BSS for an FTTP network fell behind by 18 months. Investing sufficient time in defining the OSS/BSS functionality upfront is critical as subsequent changes are typically substantially more expensive and time-consuming. The service offering is the main driver of OSS/BSS complexity, so it is preferable that the initial design should account for both initial and future service offerings. In particular, as we discuss in Section 10.3.4, NBN Co should consider designing the OSS/BSS at the outset to provide for future unbundling of dark fibre and potential structural separation of NBN Co into active and passive service companies. In addition, NBN Co should therefore engage early with existing carriers and carriage service providers to understand the likely challenges around interfacing with their systems to provide service.

Exhibit 11–1. Example elements that should be included in an initial corporate plan

Category	Example elements
Corporate and regulatory	■ Company Charter, including commitments to transparency, approach to industry interaction, and core management principles; ■ Statement of lines of business and scope of operations; ■ Corporate structure, including key roles; ■ Human resource and industrial relations strategies; ■ Calendar of formal reporting to Government; ■ Regulatory management update and plan, including any undertakings submitted (Special Access Undertaking if applicable); ■ Plan for engagement with the ACCC on unbundling regime, including assessment of network suitability for future unbundling; ■ Approach and progress on stakeholder and industry reporting and consultation; ■ Corporate social responsibility update and plan.
Coverage planning	■ Definition of premises, illustrated with example cases and benchmarked against current service availability; ■ Details of Coverage Register, including categories and description of online portal; ■ Three-year coverage and activation forecasts by service line, including assessment of market and competitive environment (for example, greenfields competition); ■ Proposed levels of provisioning for growth, business demand, including mix of shared and home-run fibre, space in ducts and exchanges; ■ Initial fibre coverage plan, detailing areas to be covered over next 18 months, planning for 93 percent of selected areas with fibre; ■ Coverage plan for greenfields, including market assessment, engagement model for developers, and estimates for premises to be served by NBN Co in first 18 months; ■ Coverage plan for transit backhaul; ■ Projected coverage for non-fibre solutions, including interim measures, if any.
Operations and progress reporting	■ Fibre deployment reporting, including review of methods and processes; ■ Cost analysis for fibre deployment, with comparisons between geographical types and topologies as appropriate; ■ Satellite deployment reporting, including review of methods and processes; ■ Description of end user premises installation; ■ Supply chain establishment and procurement processes, including availability of key inputs and engagement with major contracting partners and vendors; ■ OSS/BSS planning and key linkages to services development

Category	Example elements
	roadmap ■ Labour management plan, including ensuring availability of skilled workforce, approach to industrial relations, and management of risks; ■ Network maintenance plan; ■ Customer service operations plan; ■ Operational targets and SLAs for service activation and maintenance ■ Quality control procedures and reporting, including faults and customer complaint reporting; ■ Policy and program for engaging with householders, building managers, and bodies corporate to gain necessary access; ■ Local community engagement, including potential for various forms of community collaboration, including property access, funding of coverage extensions, etc.
Services and pricing	■ Process for defining FTTP standards (if not already completed); ■ Wholesale service plan of record, including launch dates, specifications, pricing, ancillary charges / incentives; ■ Technical review of proposed offers to confirm suitability for next-generation services (particularly those requiring QoS); ■ Voice services plan, including product definition, pricing, bundling; ■ Review of services with respect to market needs, including identification of new customer requirements; ■ Description of entry-level service specifications; ■ Upgrade policy, including proposed benchmarking on service specifications; ■ Solution for providing end user location and complying with security agency requirements; ■ Revenue and service take-up, including product mix.
Financial	■ Description of asset base, forecast for three years; ■ Statement of financial position and forecast, including funding requirements; ■ Details of any significant contractual commitments, including for plant, materials, or services.

Source: Implementation Study

11.2 Establishing a governance model

NBN Co will be almost unique among large, publicly-financed enterprises in that it is a start-up company. In contrast to Government-owned utilities, which have legacy infrastructure and long-standing business models that evolve only slowly, NBN Co is establishing an entirely new business model and infrastructure.

On a day-to-day basis, NBN Co will be making many decisions with policy implications for Government, far more than a mature GBE. Government will need to react quickly to new developments if it is to retain practical control of policy; otherwise, the pace of events will dictate that the default position on every issue becomes the final position. NBN Co will seek rapid policy guidance and, if it is not forthcoming, will respond either with indecision, leading to delay, or by pressing ahead using its best judgement.

To respond to unfolding events and provide guidance on emerging policy issues, Government will need to ensure that it maintains at all times a detailed knowledge of progress on the NBN initiative and potential issues. If issues are addressed only on an ad hoc basis by officials who turn their attention to NBN Co only when guidance is requested, the ability of Government to engage in relevant and timely intervention will be compromised, especially given the technical complexity of many of the issues, requiring a strong foundation of understanding and context. Only dedicated departmental officials who remain deeply involved in the NBN project can hope to fulfil this function in a meaningful way.

Government will need not only to provide rapid policy guidance, but also the right guidance. There will be situations where NBN Co's commercial interests diverge from Government's coverage and competition policy objectives, which may lead to healthy tension and debate, if constructively managed. The temptation will be for officials maintaining a 'watching brief' over NBN Co to accept the Company's proposals and assurances uncritically, rather than subject them to genuinely independent review. It is critical therefore that there be departmental officials assigned to the NBN project with sufficient depth of expertise that they can identify key issues and have sufficient confidence in the detail that they can challenge NBN Co's positions.

The complexity of the project and its implications across multiple departmental portfolios means that substantial interdepartmental coordination will be required. It will be important to implement a governance model that keeps stakeholder agencies updated on the project's progress, so that decisions with policy implications can be syndicated and resolved. Each agency will have its own legal and administrative responsibilities and processes, which must be respected, but coordinated in a way that is practical and efficient for NBN Co management.

Similarly, the cross-portfolio implications of the project will mean that multiple Government stakeholders will be inclined to make requests of, or present views to, NBN Co. In the absence of a governance model that manages this process, uncoordinated communications from different Government stakeholders are likely to act as an unnecessary distraction to NBN Co management and leave NBN Co in the awkward position of having to resolve potentially conflicting messages from different parts of Government.

While policy objectives will be communicated to the company by a Statement of Expectations from the Minister, and through other formal exchanges between the company and the Government, these standard mechanisms for interaction are likely to be too formal and unwieldy to provide in themselves the frequent and rapid policy guidance that NBN Co will require.

While it is beyond the scope of this report to address issues internal to Government regarding how it might provide ongoing oversight and guidance to NBN Co, the Implementation Study highlights that these challenges need be considered by Government in designing its internal governance model for the NBN Co initiative. This model would need to balance the legal and administrative responsibilities of each interested Government agency with the need for unique levels of coordination, flexibility, expertise and timeliness required to implement the NBN successfully

11.3 Implementing the recommendations

This section discusses the practical mechanisms that may be employed to implement the recommendations, in two subsections:

11.3.1 Identifying the relevant mechanisms

11.3.2 Implementing the individual recommendations.

11.3.1 IDENTIFYING THE RELEVANT MECHANISMS

Government has at its disposal a range of mechanisms to give effect to the recommendations in this report, including:

- Legislating to mandate the desired outcome of a recommendation;
- Using subordinate instruments such as licence conditions or Ministerial Pricing Determinations to mandate the desired outcome;
- Using legislation or a subordinate instrument to empower a regulator, such as ACMA or the ACCC, to monitor an issue and enforce the desired outcome;
- Imposing an obligation to implement the recommendation under a Funding Agreement between Government and NBN Co;
- Including provisions in NBN Co's constitution to stipulate the desired outcome;
- Requiring the desired outcome to be reflected in NBN Co's corporate plan as submitted annually to the Minister, and issuing a Ministerial direction to modify the plans if necessary (Section 11.2);
- Expressing the desired outcome in a statement of expectations of NBN Co and/or other formal correspondence from the shareholder ministers;
- Communicating the desired outcome informally through interactions between NBN Co and departmental officials (Section 11.3).

Exhibit 11–2 summarises the advantages and limitations of each of these mechanisms.

Exhibit 11–2. Mechanisms Government may use to effect recommendations

Mechanism	Advantages	Disadvantages
Legislation	■ Provides highest level of policy certainty to NBN Co and investors ■ Can be legally binding on NBN Co	■ Potential uncertainty and delay of parliamentary process ■ Inflexibility: may require subsequent legislation to amend
Subordinate instruments	■ Flexibility: can be adjusted rapidly at Ministerial discretion ■ Legally binding on NBN Co	■ Must be within power under the enabling legislation and made for a ‘proper purpose’ ■ Most subordinate instruments are disallowable
Monitoring and enforcement by regulator	■ Allows for dynamic monitoring of compliance at a detailed level	■ Monitoring regime imposes compliance costs on NBN Co and the regulator
Funding Agreement	■ Clarifies Government’s expectations for NBN Co within a binding commercial framework	■ Will require reconsideration in the context of privatisation
Company constitution	■ Easily set and modified while Government is the sole shareholder in NBN Co	■ Cannot override legislation (such as the *Corporations Act 2001*) ■ Following privatisation, other shareholders may wish to amend it
Requiring inclusion in NBN Co’s plans	■ Provides a formal mechanism to align NBN Co’s plans with policy objectives	■ Ensures alignment annually at a high level but not self-enforcing
Statement of expectations	■ Provides a clear communication of Government’s policy objectives for NBN Co	■ Not legally binding on NBN Co without an appropriate legislative framework ■ Will have less influence once non-government investors are introduced
Communication with departmental officials	■ Allows for dynamic policy guidance to be provided in an informal manner	■ Not legally binding on NBN Co ■ Will have less influence once non-government investors are introduced

Source: Implementation Study

The Implementation Study acknowledges that a number of relevant legislative measures have already been developed. Nonetheless, the uncertainty of the legislative process and the likelihood of additional legislative measures mean that NBN Co is planning its network design, roll-out and operations in the context of significant uncertainty over the legislative framework that will apply to it and to the telecommunications industry generally.

- The *Telecommunications Regulation (Competition and Consumer Protection) Bill 2009*, currently before the Parliament, would have significant effects on the competitive dynamics of the Australian telecommunications industry;
- Exposure drafts of the *National Broadband Network Companies Bill 2010* and the *Telecommunications Legislation Amendment (National Broadband Network Measures—Access Arrangements) Bill 2010* have been released. These Bills establish regulatory settings for NBN Co itself;
- There remain other relevant regulatory issues not addressed in any of the Bills above which Government may wish to address through legislation.

Resolution of these uncertainties will be needed to ensure that NBN Co's planning is consistent with Government policy objectives as expressed through the ultimate regulatory settings.

The Implementation Study has reviewed the exposure drafts of the *National Broadband Network Companies Bill 2010* and the *Telecommunications Legislation Amendment (National Broadband Network Measures—Access Arrangements) Bill 2010*. Under this draft legislation:

- NBN Co would be governed by Part XIC of the *Trade Practices Act 1974*, but a number of NBN Co-specific measures would apply;
- NBN Co would be obliged to operate as a wholesale-only, open-access telecommunications carrier;
- A process for privatisation would be put in place.

Two issues that are not addressed in the draft legislation should be considered for inclusion:

- **Uniformity of pricing**. Government has announced a policy of uniform pricing on the NBN. This is not provided for in the current draft legislation. However, it is possible to address this issue through a Ministerial Pricing Determination.
- **Future changes to market structure**. Chapter 10 discusses the importance of making provision now for potential future changes to market structure, such as the divestment of ducts and exchanges or the separation of NBN Co into passive and active businesses. Under our recommendations, an independent review prior to privatisation would consider what changes are appropriate.

In general terms, it is desirable to put in place at an early stage the overarching legislative framework that will govern NBN Co. We recognise that this may not be possible in relation to some recommendations, at least in the short-term.

Where this is the case, it is generally feasible to construct an interim solution through a funding agreement, licence conditions or, where that is not appropriate, through a statement of expectations. For most recommendations, such interim solutions are likely to be sufficient, if not ideal, during the period of sole government ownership of NBN Co. However, it is important that a full legislative framework be put in place well before privatisation, to secure policy outcomes and provide regulatory certainty for private investors.

11.3.2 IMPLEMENTING THE INDIVIDUAL RECOMMENDATIONS

While it will ultimately fall to Government to determine how to take forward our recommendations, in this section we consider the implementation issues Government will face in doing so. Exhibit 11–3 sets out an exhaustive list of the recommendations to Government contained in this report and discusses the implementation issues and timing considerations related to each. Bold numbered headings in the list refer to the chapter in which the recommendation appears.

Exhibit 11–3. Recommendations and implementation considerations

Recommendation	Implementation considerations
Chapter 2. Establishing a mandate for NBN Co	
Recommendation 1. That NBN Co only enter markets where there is insufficient infrastructure to support superfast broadband or where retail service providers are unable to access bottleneck assets on reasonable terms.	NBN Co's mission should be set out in the statement of expectations, but where there are well-defined markets from which it should be excluded, a binding prohibition through legislation or licence conditions may be appropriate.
Recommendation 2. That Government's objective of providing superfast broadband to premises be measured in terms of coverage, with premises considered covered by the NBN where: 1. NBN Co is able to provide a wholesale service to those premises at the request of a retail service provider within a maximum number of days, specified by Government. For premises to be defined as 'covered', NBN Co should not be required to install CPE, or for fibre to perform the 'drop' and install the ONT. NBN Co should not perform the 'drop' and install the ONT until services are ordered via a retail service provider; 2. The ACCC or appropriate agency has declared the premises to be 'adequately served' by other providers where premises already have access to last-mile services of the required speed, with infrastructure-based competition and/or open-access wholesale arrangements in place, and with pricing comparable with NBN services; that to the extent that premises are deemed to be 'adequately served' by FTTP infrastructure, these should be counted towards the FTTP coverage objective.	In relation to premises that NBN Co lists in its coverage register as 'covered', it is appropriate to compel NBN Co to meet minimum standards for service activation times. This should be legally binding and should be monitored, to ensure that NBN Co's roll-out does not distract it from ensuring adequate service levels in covered areas. The maximum time for activation of 'covered' premises could be included in NBN Co's licence conditions, together with an obligation to provide ACMA with data on activation time performance. Maximum activation times impact on the activation / maintenance resources NBN Co needs to provision for areas where roll-out has occurred. The maximum activation time permitted may need to be modified if experience shows it not to be feasible.

Recommendation	Implementation considerations
Recommendation 3. For the purposes of NBN Co's coverage requirement, that premises be defined, to mean any building (or part of a building) that meets one of the following criteria: 1. Currently has a standard telephone service activated as defined under the USO; 2. Currently has a fixed-line residential or business broadband product activated; 3. Is used on an ongoing basis for residential, business, health or educational purposes; or, 4. Is defined as a school by the Department of Education, Employment and Workplace Relations.	Initially, it is sufficient for Government to inform NBN Co of the definition of premises it is using in the coverage objectives, so that NBN Co can plan and implement its roll-out accordingly. This could be achieved through a statement of expectations. Once roll-out is complete, Government should impose an ongoing coverage obligation through a binding instrument such as NBN Co's licence conditions. As well as defining the desired end-point, Government will need to monitor progress of the roll-out and communicate to NBN Co any desired changes of pace or focus. The proposed requirement for NBN Co to submit a Corporate Plan including both strategic and operational commitments for Ministerial approval on an annual basis, combined with informal communications between NBN Co and departmental officials, provides a mechanism for Government to do this.
Recommendation 4. That Government permit NBN Co to provide connections to non-premises on a commercial basis; that Government retain the option to require NBN Co to cover specified classes of non-premises on terms approved by Government.	No regulatory action is necessary to retain this flexibility; Government should merely ensure regulation does not preclude such activities. Should Government choose to specify non-premises for coverage, this could be achieved through the statement of expectations and reinforced with licence conditions prior to privatisation to give regulatory certainty to investors and ensure continued coverage.

Recommendation	Implementation considerations
Recommendation 5. That Government set NBN Co the objective that, once NBN roll-out is complete, all premises in Australia have access to superfast broadband services, specifically that: 1. 93 percent of premises be covered by a fibre-to-the-premises (FTTP) network that can deliver speeds of up to 100 Mbps; 2. All other premises be covered by NBN Co via satellite technologies that deliver peak speeds of at least 12 Mbps; 3. A fixed-wireless network be provided beyond where fibre is deployed to 4 percent of total premises, but that this not be the responsibility of NBN Co unless there are no acceptable tenders by commercial operators; 4. These coverage objectives be reviewed over time based on actual costs of deployment and technology developments.	While the network is incomplete, it is not feasible to codify NBN Co's coverage objectives as a universally enforceable obligation. Instead they could be included in the statement of expectations, leaving NBN Co with flexibility around roll-out scheduling. Coverage objectives could also be included in the Funding Agreement between the Government and NBN Co, to provide directors with certainty around these obligations, but again it is important to maintain flexibility for NBN Co to determine the details of the roll-out schedule. Government expectations of premises to be covered should be clarified as soon as possible to facilitate network planning. Service standards such as download speed of the basic service offering should be made binding, for example through inclusion in licence conditions. The licence conditions might also specify that once premises are registered as 'covered' in the Coverage Register, an ongoing coverage obligation exists.
Recommendation 6. That NBN Co select a number of priority areas for roll-out that together comprise a representative mix of the country; that, once NBN Co has completed its roll-out to these priority areas Government review whether NBN Co is on track to achieving the objective of 93 percent FTTP coverage and use performance management mechanisms as required; that the Minister request NBN Co include details of its progress in achieving the 93 percent FTTP coverage objective in each corporate plan.	It is sufficient for this to be set out in the statement of expectations, as coverage will be complete well before the entry of private equity. These expectations regarding coverage should be set as soon as possible to enable NBN to plan its initial roll-out schedule.

Recommendation	Implementation considerations
Recommendation 7. That NBN Co be permitted to establish a mechanism by which a community can fully or partially fund the extension of the FTTP network to cover its location, provided that these premises will not be counted towards the FTTP coverage objective. This could include financial contributions towards the network extension from businesses, not-for-profit organisations, state and local governments or from Government, independent of its equity investment in NBN Co.	While NBN Co is in the early stages of deployment, such a scheme would be an unnecessary distraction and would be based upon inadequate roll-out cost data. Any formal appeal process would be impractical, and NBN Co's commercial incentive is likely to cause it to establish a pragmatic approach. Transparency of its decision-making and its treatment of applications will exert sufficient pressure to compel NBN Co to comply with the substance of this recommendation.
Recommendation 8. That until the FTTP roll-out is complete in a given area, only premises that cannot access a metro-equivalent service as defined under the Australian Broadband Guarantee program be eligible for an NBN satellite service.	While the network is incomplete, it is not feasible to codify NBN Co's coverage objectives as a universally enforceable obligation. Instead they should be included in the statement of expectations, leaving NBN Co with flexibility around roll-out scheduling. Coverage objectives could also be included in the Funding Agreement between the Government and NBN Co, to provide directors with certainty around these obligations, but again it is important to maintain flexibility for NBN Co to determine the details of the roll-out schedule. Government expectations of premises to be covered should be clarified as soon as possible to facilitate network planning.
Recommendation 9. That NBN Co be granted a right of access to shared property in multi-dwelling units to undertake the inspection, installation and maintenance of FTTP infrastructure and that an obligation be imposed on building managers and bodies corporate to facilitate NBN Co exercising that right of access.	This requires legislative action, such as insertion of a new provision into the Telecommunications Act. This should be implemented as soon as the legislative process allows to avoid unnecessary cost and delay in the NBN roll-out.

Recommendation	Implementation considerations
Recommendation 10. That NBN Co follow a defined process in the event that it cannot install FTTP infrastructure in a multi-dwelling unit (MDU) because it has been denied access to the building; that this process include: 1. NBN Co conducting a notice process to ensure the building entity understands the implications of its decision; 2. If the building entity does not grant NBN Co access to the building after the notice process, then NBN Co can list the MDU on the NBN Coverage Register as 'frustrated'; 3. If the building entity later invites NBN Co to enter the building and install FTTP infrastructure, NBN Co is to undertake the installation but to have flexibility over when it will do so.	As it relates to the integrity of the key performance metrics of NBN Co's roll-out and service levels, the process NBN Co must undertake before it may enter premises as 'frustrated' in the Coverage Register should be made binding, for example by stipulation in licence conditions.
Recommendation 11. That NBN Co be required to install FTTP in MDUs as opposed to alternative technologies such as VDSL; that Government review this policy if widespread building access problems or cost overruns emerge as NBN Co seeks to cover MDUs in the early phase of the roll-out.	This could be specified in the statement of expectations and potentially in the Funding Agreement.
Recommendation 12. That NBN Co's coverage objective include new premises that are constructed during the period of the roll-out; however, that NBN Co not be expected to cover these new premises prior to the NBN access network being deployed to that geographic area.	As per Recommendation 8
Recommendation 13. That NBN Co be required to act as the network provider of last resort for premises constructed within, or adjacent to, NBN Co's fibre access network; that developers be required to cover the costs of trenching and providing the duct, pit and pipe network; that NBN Co cover the costs of installing all other FTTP network infrastructure up to the premises.	The obligation to act as a provider of last resort may best be imposed by legislation, although Government should initially communicate this as part of the coverage objectives as per Recommendation 8, so that NBN Co can account for this obligation in its planning. Government must also ensure that proposed greenfields legislation is consistent with this recommendation.

Recommendation	Implementation considerations
Recommendation 14. That ACMA be tasked with issuing national FTTP design standards that all parties should adhere to when deploying an FTTP network for the purposes of providing telecommunications services to the public; that these standards should align with the network architecture deployed by NBN Co in its roll-out; that Government and NBN Co work with state governments to reference the design standards in state planning and building controls.	This would require legislative action. ACMA should be the regulator setting the standards, but it should be required to do so in the context of the Government's broadband policy objectives. In practice this would mean adopting the NBN standards. The effective commencement should be determined by the speed with which NBN Co can advise on appropriate standards. Advice should be sought on any implications under Australia's international trade obligations of setting these standards.
Recommendation 15. That the national FTTP standards require that the topology deployed in new developments be home-run and not shared; that this requirement be reviewed in conjunction with the broader review of topologies to be completed by the earlier of: 1. Coverage of 15 percent of premises within the proposed fibre footprint; 2. 31 December 2013.	As per Recommendation 14
Recommendation 16. That NBN Co overbuild third party FTTP networks that do not comply with the FTTP design standards; that, where a deployment does comply with the FTTP design standards established by Government, NBN Co may: 1. Apply to ACMA to have the premises declared 'adequately served'; 2. Attempt to secure access from the network owner that would allow NBN Co to offer wholesale services over the network; 3. Overbuild the network where NBN Co is unable to secure necessary access and the premises are not declared 'adequately served'.	This policy should be communicated to NBN Co through the statement of expectations, potentially reinforced through the Funding Agreement between the Government and NBN Co. As it relates to the integrity of the key performance metrics of NBN Co's roll-out and service levels, the process NBN Co must undertake before it may enter premises as 'adequately served' in the Coverage Register should be made binding, for example by stipulation in licence conditions.

Recommendation	Implementation considerations
Recommendation 17. That all new developments where fixed telecommunications infrastructure is deployed be required to provide a duct, pit and pipe network with sufficient additional capacity to allow for an FTTP deployment by NBN Co; that this infrastructure be provided at the developer's expense—an exemption being made for new premises where no fixed-line telecommunications infrastructure is installed.	This could be required by regulation under Government's proposed greenfields legislation. The standards imposed should be developed in consultation with NBN Co to ensure suitability. The current Bill does not require that the developer fund such infrastructure, but the mandatory nature of the requirement makes this the probable outcome. Government should ensure that developments where infrastructure roll-out is already planned by the time the standards are issued are not affected, and that sufficient additional notice period is granted so as not to delay developments.
Recommendation 18. That the national FTTP design standards include a requirement, to come into effect after a sufficient notice period, that internal wiring installed in all new premises be of a standard that allows high-speed data transfer, e.g. CAT 5 or CAT 6.	This is likely to require legislative action. A notice period of at least six months would be appropriate.
Recommendation 19. That a register (the NBN Coverage Register) be maintained of all premises in Australia; that the register meet the following requirements: 1. Be publicly available through mechanisms approved by Government; 2. List premises in specific categories that detail the coverage status of each premises; 3. Be updated at regular intervals; 4. Identify premises with specific geographical location data.	As it relates to the integrity of the key performance metrics of NBN Co's roll-out and service levels, the requirement to keep a Coverage Register should be made binding, for example by stipulation in licence conditions. The requirement to maintain a Coverage Register should come into effect by 1 July 2011, to give NBN Co time to identify relevant premises and establish necessary systems.
Recommendation 20. That a register be maintained of all monopoly transit backhaul routes between NBN Co's proposed fibre exchanges and POIs, on which NBN Co intends to build or purchase capacity; that NBN Co be required to update this register as it secures access to and offers services over each backhaul route; that the backhaul register be made accessible to wholesale customers of NBN Co.	As it relates to the integrity of the key performance metrics of NBN Co's backhaul roll-out, the requirement to keep a backhaul register should be made binding, for example by stipulation in licence conditions. The ACCC should be tasked with determining which routes are uncompetitive. The requirement to maintain a backhaul register should come into effect by 1 October 2010, to give NBN Co time to identify relevant backhaul and establish necessary systems.

Recommendation	Implementation considerations
Recommendation 21. That NBN Co be required to deliver in its annual report detail of its progress towards meeting its coverage objective, expenditure incurred in doing so and provide such interim progress reports as Government requires and are reasonable.	Reporting requirements will be included in the establishing legislation; informal requests may be made for interim updates
Recommendation 22. That NBN Co be permitted to use HFC networks as an interim technology, provided that these networks are capable of providing wholesale open-access services; that NBN Co be required to plan and establish a construction schedule to achieve its FTTP coverage objective by the end of its roll-out, regardless of coverage of HFC networks.	As per Recommendation 8
Recommendation 23. That NBN Co be directed to set wholesale prices and offer migration incentives with the objective of achieving broadband take-up targets that Government sets at regular intervals and in accordance with the applicable regulatory pricing regime.	The pursuit of a take-up objective can be included in the statement of expectations. However, pricing and migration incentives remain subject to the regulatory regime.
Recommendation 24. That NBN Co be permitted to apply differentiated wholesale pricing for each technology platform used in its customer access network; that, within each technology platform, uniform wholesale pricing be required for all access products.	As initial pricing of at least some services will be set in a Special Access Undertaking, the Government should clarify its pricing requirements as soon as possible through the statement of expectations, which could then be reflected in the special access undertaking that would bind NBN Co before and after privatisation. A Ministerial Pricing Determination is another potential mechanism, which would bind the ACCC in decisions relating to the period subsequent to the expiry of the special access undertaking
Recommendation 25. That the entry-level services offered over each technology platform in NBN Co's customer access network be available to end users at a comparable but not necessarily identical price; that the same performance specifications of entry level services on different technology platforms not be required.	As per Recommendation 24

Recommendation	Implementation considerations
Recommendation 26. That NBN Co be required to provide industry standard PSTN emulation at the ONT on all connections to its FTTP access network and bear the associated network costs.	This should be set out in the statement of expectations. As it relates to service standards, it should also be stipulated in licence conditions.
Recommendation 27. That NBN Co be required to provide an ONT power supply unit to all FTTP customers with the potential for a back-up battery to be installed; that Government establish a program for subsidising the provision of back-up batteries for end users that Government identifies as requiring lifeline services at the time that those customers migrate from the copper network to the NBN—with the distribution and maintenance of batteries to be undertaken by retail service providers; that beyond these identified end users, provision of a battery be the choice of the end user and supply and maintenance be the responsibility of the end user.	As per Recommendation 24. Government will also need to establish a mechanism to require retail service providers to distribute and maintain batteries. This could be done by creating an appropriate regulation that allows ACMA to make a service provider determination containing a new service provider rule under s.99 of the *Telecommunications Act 1997*.
Recommendation 28. That NBN Co be required to support retail service providers' ability to provide end-user location information including the enablement of emergency call operators to automatically locate a caller.	This should be set out in the statement of expectations. As it relates to service standards, it should also be stipulated in licence conditions. It may also necessitate changes to the *Telecommunications (Emergency Call Services) Determination 2002*
Recommendation 29. That a minimum public notice period be required for deactivating any copper exchange; in this context 'deactivating' would mean the withdrawal of a significant proportion of copper services.	As this requirement will in practice only affect Telstra's network, it could be included in licence conditions of the network owner.
Recommendation 30. That a review be undertaken to determine how the universal service regime and other carrier and service provider obligations may apply to NBN Co and other carriers and service providers; that this review be completed by the end of 2011.	A review of the USO has previously been foreshadowed by Government and should be conducted once implementation details of the NBN are more settled. The review should be carried out only when greater clarity around the implementation challenges of the NBN have emerged from initial roll-outs.

Recommendation	Implementation considerations
Recommendation 31. That NBN Co be directed to develop a Charter that outlines how it will conduct its affairs to best meet the needs of stakeholder groups—for example, the Charter should state a commitment to consultation with the industry and end-user groups	It is sufficient to set out this requirement in the statement of expectations. This should be implemented immediately as NBN Co is already involved in stakeholder consultations.
Chapter 3. Enabling a new generation of services for end users	
Recommendation 32. That NBN Co only be permitted to operate at the lowest layer of the network stack that enables sufficient retail competition and diversity of services for end users. Initially, this will translate into Layer 2 bitstream services in the FTTP network, and Layer 3 IP services in the satellite access footprint; that Government request that the ACCC periodically monitor competition, and recommend necessary modifications of the service portfolio to best serve the long term interests of end users; that this include considering the offering of passive services.	The principle expressed in this recommendation could be included in the statement of expectations. It is also appropriate that NBN Co be restrained through its licence conditions from offering services above the stipulated layers; these conditions could be altered upon ACCC recommendation.
Recommendation 33. That NBN Co be required to offer services with comparable levels of performance in all geographies within a technology footprint, specifically: 1. While it is the sole provider of active layer NBN services, NBN Co should upgrade services over time and demonstrate that the functionality and performance of its services are in line with international benchmarks; NBN Co's upgrade plans should be submitted for ACMA's approval that they are sufficient to maintain Australia's broadband position internationally; 2. As network elements are upgraded over time, NBN Co should ensure all equipment within an access technology platform is on a similar upgrade path. If active-layer competition is in place, NBN Co's offers in competitive areas should be consistent with NBN services in all areas; 3. In the satellite footprint, NBN Co should ensure that CPE upgrades continue to be offered via service providers.	Government's requirements should initially be communicated to NBN Co through the statement of expectations. As roll-out continues, and prior to privatisation, they should be rendered enforceable, for example by inclusion in licence conditions. Administration of the detailed requirement for technological upgrades could be conducted by ACMA.

Recommendation	Implementation considerations
Recommendation 34. That Government permit NBN Co to offer an RF overlay service on its FTTP network provided it meets these conditions: 1. Except where necessary to compete for greenfield FTTP contracts, RF overlay supports multiple providers and the RF port on the household ONT is not exclusive to a single provider; 2. The deployment of RF overlay capability is commercially viable for the Company as a standalone service.	This should be set out in the statement of expectations. As it relates to service standards, it should also be stipulated in licence conditions.
Recommendation 35. That NBN Co be required to provide a wholesale Layer 2 bitstream service which enables multi-operator delivery of next-generation video services (e.g. high definition, video-on-demand) that meets industry standards.	This should be set out in the statement of expectations. As it relates to service standards, it should also be stipulated in licence conditions, although inclusion in NBN Co's special access undertaking would delay the need for a binding licence condition to be added.
Chapter 4. Building a fibre access network to 90 percent of premises	
Recommendation 36. That NBN Co be required to deploy fibre topologies that support the ongoing needs of multiple stakeholders, including: 1. Service providers who may seek access to Layer 1 services, anticipating the likelihood of future unbundling requirements; 2. High bandwidth, dedicated class-of-service requirements for enterprise and government users, and for mobile base-stations and other users.	Government's policy principles should be communicated through the statement of expectations. Recommendation 75 deals with the issue of determining the network topology, which will then need to be made binding in a licence condition.

Recommendation	Implementation considerations
Recommendation 37. That NBN Co be required to ensure that the assets used to physically deploy the network support an enduring open-access network; specifically for: 1. New trenches and ducts: to be over-provisioned to ensure sufficient space for future expansion or alternative use; detailed records of the location of ducts to be maintained; 2. Existing ducts: perpetual or long-term (with firm options to renew) indefeasible rights of use to be sought to ensure renegotiation of leases cannot put the future network, or commerciality of NBN Co, at risk; short-term leases to be avoided; 3. Existing overhead poles: long-term rights of use, ease of access and longevity of assets to be ensured; rights and obligations for future repairs and maintenance to be set out; political and community risks to network security and longevity to be considered.	These requirements will remain a matter of subjective judgement and are best implemented as guiding principles through the statement of expectations. The obligations to comply with duct over provisioning standards and to maintain detailed records of duct locations are less subjective and should be made binding, for example through licence conditions. Actual duct standards could be set to match those which apply to greenfields developers.
Recommendation 38. That the network access point at end-user premises (i.e. the ONT) be required to provide a sufficient number of physical ports to enable multiple providers to offer services to each premises; that NBN Co ensure physical access to this point within the premises, at a location reasonably requested by the user (e.g. within close proximity to existing copper lead-in); this requirement includes: 1. If the ONT is installed externally, an internal patch panel providing open access to service providers on an equivalent basis; or 2. If the ONT is installed internally, that NBN Co be permitted to contract with retail service providers to implement these network access point requirements.	This should be set out in the statement of expectations. As it relates to service standards, it should also be stipulated in licence conditions. Three ports on the ONT would be an appropriate minimum

Recommendation	Implementation considerations
Recommendation 39. That an entry-level wholesale bitstream service for NBN Co's fibre network be defined that would be the minimum acceptable service for residential broadband use, specifically: 1. That this bitstream service enable a significant improvement over typical experiences on other fixed networks, and offer at least a 20 Mbps peak download speed within the fibre access network; 2. That this entry-level speed be reviewed over time to ensure it continues to deliver sufficient performance relative to other fixed broadband networks; 3. That exceptions for a lower-speed entry-level service be considered for commercial reasons where most end-users will take retail services using at least a 20 Mbps wholesale bitstream service.	This should be set out in the statement of expectations and communicated to NBN Co as quickly as possible to assist in development of its service offering. As it relates to service standards, it should also be stipulated in licence conditions, although inclusion in NBN Co's special access undertaking would delay the need for a binding licence condition to be added.
Recommendation 40. That NBN Co be required to offer wholesale services that support the implementation of carrier-grade QoS functionality, allowing retail service providers to deliver premium services from within their network to end users: 1. Initially, this means ensuring that the appropriate specifications are adopted through consultation with industry and potential customers; 2. Over time, this may require offering services that are higher in the network stack, as has already been considered for IPTV, where IGMP functionality is being considered, and/or extending the geographic extent of the Layer 2 network (i.e. further upstream); such decisions to expand the scope of NBN Co operations should not be taken lightly, and should be based on demonstrated inability of NBN wholesale services to enable services that are feasible within other networks internationally and for which there is demand.	This should be set out in the statement of expectations. As it relates to service standards, it should also be stipulated in licence conditions.

Recommendation	Implementation considerations
Recommendation 41. That NBN Co be permitted to provide one-off incentives to service providers to encourage migration of their customers onto the network; that these incentives be transparent and offered on a broadly equivalent basis within geographic areas at a point in time; that uniformity of incentives across geographic areas or time not be required.	Government should set out this policy in the statement of expectations, recognising that it is subject to the regulatory regime. If Government proposes to introduce a Ministerial Pricing Determination, it should ensure that the determination is consistent with this recommendation. Government should ensure that the implementation of 'equivalence' requirements in legislation is consistent with this policy.
Recommendation 42. That Government not constrain the commercial flexibility of NBN Co to design and update a price architecture, within the requirements of regulation and its obligations for affordability and take-up of services; that Government support NBN Co's adoption of price mechanisms such as price differentiation (except where it is based on geographic location) and differentiated commercial terms and charges that are consistent with equivalence	No additional regulatory action required.
Chapter 5. Ensuring national availability of high-speed broadband	
Recommendation 43. That NBN Co be required to provide a next-generation satellite service ensuring access to at least 12 Mbps peak data rates to all premises beyond the fibre footprint. Satellite system capacity should be dimensioned to offer an average data rate per premises that reflects potential growth in usage patterns over the lifetime of the satellite system.	While the network is incomplete, it is not feasible to codify NBN Co's coverage objectives as a universally enforceable obligation. Instead they should be included in the statement of expectations, leaving NBN Co with flexibility around roll-out scheduling. Coverage objectives could also be included in the Funding Agreement between the Government and NBN Co, to provide directors with certainty around these obligations, but again it is important to maintain flexibility for NBN Co to determine the detail of the roll-out schedule. Satellite solutions involve significant deployment risks. Moreover, it takes 3 to 4 years from the starting design date to launch a satellite. For this reason, funding and policy issues should be resolved as quickly as possible.

Recommendation	Implementation considerations
Recommendation 44. That Government ensure affordability of next-generation satellite broadband services for premises underserved by other technologies through a program that funds satellite CPE costs incurred by retailers and guarantees a high quality of service.	This could be modelled on the Australian Broadband Guarantee. It will be necessary to provision adequate satellite capacity to manage the expected demand, so the timing issues referred to in relation to Recommendation 43 apply.
Recommendation 45. That an Expression of Interest (EoI) and tender process be conducted for a commercial provider to build and operate a fixed-wireless network, specifically: 1. That the network offer services on both a wholesale and retail basis beyond the fibre footprint to cover 4 percent of total premises; 2. That the services include an offer with at least 12 Mbps peak data rates and high average data rates, with service characteristics subject to periodic review; that the services include an entry-level offer providing a high-quality broadband experience at a specified price comparable to entry-level pricing on the fibre and satellite footprints; that Government specify as part of the tender a mechanism for adjusting prices of the entry-level and 12 Mbps offerings over time, for example via a cap on annual price rises or another regulatory mechanism; 3. That the tenderer(s) describe an expected upgrade path for the implemented technology; 4. That spectrum renewal rights for the fixed-wireless network operator be guaranteed; 5. That, in the absence of an acceptable bid, NBN Co be required to build the network and offer services on a wholesale-only basis.	Government should set NBN Co's coverage obligations in the statement of expectations consistent with this recommendation, noting the proposed contingency role of NBN Co. Government should immediately start preparations for the EoI and tender process, as the possibility of an unsuccessful process would put pressure on the Government's timeline. In the event that NBN Co is allocated the task, Government should revise NBN Co's coverage objectives to require the fixed-wireless network build and ensure that NBN Co's corporate plan is altered to prioritise wireless deployment. This may require a specific licence condition, or could be incorporated in a new funding agreement. Government may wish to engage in an iterative tender design process in consultation with likely bidders and other industry experts.

Recommendation	Implementation considerations
Recommendation 46. That carrier licence conditions associated with the 700 MHz spectrum be added to require network operators to implement future technology upgrades in rural/regional areas in parallel with metropolitan areas; that Government review prior to the 700 MHz auction the value of requiring one or more successful bidders to expand their coverage footprint.	These licence conditions would have to be clarified prior to the auction for 700 MHz spectrum, with enough time allowed for bidders to estimate the impact on value. Government should seek submissions from network operators and other stakeholders in relation to the possibility of a coverage requirement.
Recommendation 47. That Government instruct NBN Co to extend transit fibre backhaul to existing towers and new tower sites needed by the fixed-wireless network operator to provide coverage in the designated areas (e.g. between the 94th and 97th percentiles); this transit backhaul to be offered to all operators and priced at the same rates as transit backhaul within the fibre footprint.	This should be set out in the statement of expectations and potentially codified in a binding licence condition. If Government chooses to privatise backhaul assets, codification in a licence condition would be appropriate.
Chapter 6. Ensuring ubiquitous backhaul availability	
Recommendation 48. That NBN Co be required to construct a transit backhaul network to connect all fibre exchanges to the nearest practical point where backhaul services are available from Government (e.g., Regional Backbone Blackspots Program) or multiple providers, not including NBN Co; for fibre exchanges that are already located at a point with multiple backhaul providers or Government backhaul services, NBN Co not to construct transit backhaul links.	As per Recommendation 47
Recommendation 49. That NBN Co be directed to construct the transit backhaul network including passive fibre elements and active electronics, except where NBN Co is able to secure long-term indefeasible rights of use (with options to renew) to other parties’ fibre assets at the physical layer (‘dark fibre’) more economically.	This should be set out in the statement of expectations but not made binding, as there may be a need for flexibility in some cases.

Recommendation	Implementation considerations
Recommendation 50. That NBN Co be required to offer a single POI in relation to a given premises: 1. At a fibre exchange where there are multiple alternative backhaul providers; or 2. At a fibre exchange linked to the Regional Backbone Blackspots Program; or 3. At a point accessible from the fibre exchange over an NBN Co transit backhaul link.	This may be included in a licence condition. Post-privatisation, implementation may require negotiation between the privatised NBN Co and the public backhaul company. This policy should be clarified as soon as possible, as NBN Co is already developing its product offering.
Recommendation 51. That the location of NBN Co's POIs be reviewed on a regular basis to permit new investment below the POIs and to ensure the objectives of affordability and a level playing field are met above the POIs.	This can be left to the Company's discretion prior to privatisation, as the ACCC will retain the power to declare a service and access to facilities is provided for in Schedule 1 of the *Telecommunications Act 1997* (to which the Implementation Study has proposed amendments). In practice, it is expected that NBN Co would consult with the ACCC to ensure alignment.
Recommendation 52. That for defining NBN Co's backhaul services: 1. NBN Co be required to offer backhaul services as single Ethernet links from the POI to the fibre exchange, with some level of protection (alternative secondary links in the case of outages on the primary link) available on all links; 2. The transit backhaul bitstream product to be specified as a separate product from the access bitstream product, allowing service providers to select their preferred combination of backhaul capacity and access services; 3. NBN Co not to offer or be required to offer connection below the POI to an NBN Co access network.	This should be set out in the statement of expectations. As it relates to service standards, it should also be stipulated in licence conditions. Post-privatisation, NBN Co will need to reach an agreement with the Government-owned backhaul unit on the continued provision of transit backhaul to the POI.

Recommendation	Implementation considerations
Recommendation 53. That NBN Co be required to specify transit products to meet an affordability test; specifically: 1. That the price of transit backhaul services attributable to a single premises' access service be not more than a certain percentage of the retail price of a typical entry-level NBN wholesale broadband product; 2. That Government define the percentage, preferably not more than 10 percent; the transit backhaul service be defined from the POI to the fibre exchange, on a per-user basis, given a defined contention ratio; 3. That NBN Co be required to set a minimum contention ratio based on international benchmarks, and to review it annually based on ongoing monitoring of customer experience and observed network performance; 4. That the NBN Co transit backhaul prices scale linearly with bandwidth for contention ratios higher than the one used in the affordability test.	As it is not appropriate to refer directly to the variable retail price in a licence condition, this policy is best effected by certification in a Ministerial Pricing Determination, so that it can be administered by the ACCC.

Recommendation	Implementation considerations
Recommendation 54. That NBN Co be required to provide transit backhaul services to alternative network operators, specifically: 1. That such transit backhaul services be offered on equivalent terms to those offered to customers of its own access network; 2. That NBN Co provide a point of interconnect for the transit backhaul service in the fibre exchange environment (but not the access service if not at a POI) and access seekers be responsible for all costs of reaching and entering the fibre exchange environment to meet this point of interconnect; 3. That the Minister consider granting temporary relief from this requirement, but not in relation to backhaul services necessary to enable the provision of wireless broadband services beyond the fibre footprint, once it is defined.	This should be set out in the statement of expectations. Assuming that Government accepts the recommendation to maintain backhaul in public hands, there may not be a need to codify this expectation into a binding licence condition, although it would be beneficial for creating certainty. Instead, ongoing backhaul decisions can be taken in line with the statement of expectations as modified from time to time. However, it may be desirable to set licence conditions in relation to associated standards of service.
Chapter 7. Delivering a sustainable business case	
Recommendation 55. That Government, in consultation with NBN Co, expand the definition of Low Impact Facility in the *Telecommunications (Low-impact Facilities) Determination 1997* to include facilities likely to be included in NBN Co's roll-out; that Government consult NBN Co to determine the appropriate items for inclusion in the revised definition.	Regulatory instrument required; legislative amendment may be required if, for example, Government chooses to extend to cables over 13 mm in diameter.

Recommendation	Implementation considerations
Recommendation 56. That Government reform the process of seeking access to infrastructure of telecommunications carriers under Part 5 of Schedule 1 of the *Telecommunications Act 1997* such that: 1. The 'negotiate-arbitrate' model is replaced with a model consistent with the changes to the access regime in Part XIC of the *Trade Practices Act 1974* proposed in the *Telecommunications Legislation Amendment (Competition and Consumer Safeguards) Bill 2009*; 2. This reformed right of access is extended to grant NBN Co access to infrastructure potentially relevant to its network deployment, including ducts, poles and pipes belonging to non-telecommunications utilities and other parties, such as owners of ducts in greenfields.	This requires legislative action; revision of Schedule 1 Part 5 of the *Telecommunications Act 1997* is the likely mechanism.
Recommendation 57. That Government require telecommunications carriers, non-telecommunications utilities and other owners of relevant infrastructure, such as owners of ducts in greenfields estates, to provide to Government such information on their networks, infrastructure and operations as Government requests from time to time for purposes directly related to the deployment of the NBN; that Government provide such information to NBN Co on a confidential basis for purposes directly related to the deployment of the NBN, subject to appropriate safeguards around commercially confidential information.	Legislation on this topic is currently before the Parliament.
Chapter 8. Funding the NBN	

Recommendation	Implementation considerations
Recommendation 58. That Government retain full ownership of NBN Co until roll-out is complete; that this include not issuing equity in return for vended-in assets.	This recommendation should be implemented through NBN Co's constitution to prevent it from issuing equity to non-government investors. Legislative limitations could also be implemented, but this appears unnecessary given that Government will be the sole shareholder for the period that this recommendation is relevant. It is unlikely that NBN Co will seek equity finance from private investors in the near future. Nonetheless, to provide clarity to NBN Co, a prohibition on issuing equity to private investors should be included in the NBN Co constitution.
Recommendation 59. That NBN Co be funded with Government equity until NBN Co can support private sector debt without explicit Government support and achieve an investment grade credit rating; that private sector debt be permitted to be accessed to repay Government capital while maintaining an investment grade credit rating.	As NBN Co will ultimately be responsible for raising its own financing, Government endorsement of the maximal use of private sector debt as it becomes available at investment grade should be communicated to NBN Co. The statement of expectations would be an appropriate mechanism.
Recommendation 60. That flexibility be maintained in the timing and structure of privatisation of NBN Co: prime determinants of timing should be favourability of market conditions and readiness of the company for private ownership.	The exposure draft of the *National Broadband Network Companies Bill 2010* is consistent with this recommendation.
Recommendation 61. That NBN Co be directed to evaluate alternatives for a corporate structure that preserves flexibility and considers transaction costs at privatisation.	This could be communicated through the statement of expectations
Recommendation 62. That Government and NBN Co enter into formal agreements for security of funding.	This would take the form of a long-term funding agreement under which the Government agrees to provide funding to NBN Co in return for pursuing and ultimately achieving the Government's coverage objective. The initial agreement should be set in place as early as possible to signal commitment to the project and give the NBN Co board confidence to enter long-term contracts. It could be supplemented as roll-out progresses.

Recommendation	Implementation considerations
Chapter 9. Understanding adverse competition scenarios	
Recommendation 63. That the Government request the ACCC to monitor and report annually on the market for Layer 3 telecommunications services.	The Minister could request that the ACCC include this in its annual review of competitive safeguards in the telecommunications industry.
Chapter 10. Securing competition outcomes	
Recommendation 64. That NBN Co be required to conduct its strategy, planning and operations in a publicly transparent manner, subject to any requirements of commercial confidentiality.	These requirements could be included in the statement of expectations. Prior to privatisation, a binding mechanism should be put in place, such as a licence condition. This could require compliance with transparency rules established from time to time and approved the regulator.
Recommendation 65. That NBN Co be required to ensure its service offerings are developed in consultation with a wide variety of service providers through a transparent process including: 1. Holding regular industry forums to seek the views of current and prospective customers on the service offering; 2. Publishing a revised service development roadmap on at least an annual basis, and ensuring that demonstrable and reasonable market requirements are met.	As per Recommendation 64.
Recommendation 66. That NBN Co be required to publish in its annual report comprehensive information on its performance, including: 1. Network roll-out performance and costs; 2. Achievement of service levels; 3. Faults; 4. Customer complaints; 5. Any matters, whether or not related to those above, that Government, represented by the shareholder Ministers, considers appropriate.	This could be made binding on NBN Co through a licence condition, in addition to being highlighted in the statement of expectations.

Recommendation	Implementation considerations
Recommendation 67. That NBN Co be prohibited from engaging in commercial or investment activities unrelated to the provision of wholesale telecommunications services in Australia. For the avoidance of doubt, provision of content services as defined by the *Telecommunications Act 1997* would constitute prohibited activities.	This limitation is so critical that it would be appropriate to include it in the establishing legislation. As a substitute, it might be set through licence conditions.
Recommendation 68. That Government implement a wholesale-only restriction on NBN Co preventing it from offering or providing services to anyone other than a carrier or service provider as defined by the *Telecommunications Act 1997*; that Government retain the flexibility for the Minister to make exceptions to this rule.	This limitation is so critical that it would be appropriate to include it in the establishing legislation. We note that such a provision is included in the exposure draft of the *National Broadband Network Companies Bill 2010.*
Recommendation 69. That NBN Co be prohibited from investing in retail telecommunication companies and content service providers, subject to special provisions for transitional ownership where incidental to the acquisition of network assets relevant to its objectives.	This limitation is so critical that it would be appropriate to include it in the establishing legislation. We note that such a provision is included in the exposure draft of the *National Broadband Network Companies Bill 2010.*

Recommendation	Implementation considerations
Recommendation 70. That NBN Co be subject to an access regime similar to that set out in Part XIC of *the Trade Practices Act 1974*, but including an obligation to provide all services (other than those not available to any external parties) on an open-access, equivalent basis defined as follows: 1. Except in relation to services that NBN Co also provides to itself, equivalence should not require identical terms, conditions and processes so long as any variations (e.g. discounts) aid efficiency and are available to all access seekers in like circumstances, where 'like circumstances' are not taken to include scale unless at least three access seekers are of sufficient scale to qualify; 2. NBN Co is to publish any such variations; 3. In relation to services provided by NBN Co to itself and to other access seekers (such as any unbundled Layer 1 services), equivalence should be defined on an 'equivalence of inputs' basis, requiring identical terms, conditions and processes of supply; 4. The principle of open access should not require NBN Co to offer services to access seekers where NBN Co has good cause to believe the access seeker is not creditworthy or is otherwise unlikely to comply with the terms and conditions of supply.	This requirement is so critical that it would be appropriate to include it in the establishing legislation, with the case by case assessment of variations managed by the ACCC. This is consistent with the exposure drafts of the *National Broadband Network Companies Bill 2010* and the *Telecommunications Legislation (National Broadband Network Measures – Access Arrangements) Bill 2010*.
Recommendation 71. That NBN Co be required to provision its physical infrastructure, including POIs and fibre exchanges, to accommodate reasonable expectations for customer equipment in anticipation of multiple retail competitors: 1. Seeking access to its Layer 2 services; 2. Seeking access to transit backhaul services; 3. Seeking access to unbundled physical fibre or wavelengths in the future.	While this requirement can be left as a principle in the statement of expectations, the potential conflict with NBN Co's commercial interests makes it important that the ACCC be asked to report broadly on compliance as part of its annual review of competitive safeguards in telecommunications. This policy should be communicated to NBN Co immediately to inform network design.

Recommendation	Implementation considerations
Recommendation 72. That NBN Co be required to design its price architecture on the basis that services with distinct characteristics (e.g. level of aggregation or capacity) should be offered on a modular basis. For example, a multicast product suited to IPTV delivery should be sold independently of a standard bitstream service.	As initial pricing of at least some services will be set in a Special Access Undertaking, the Government should clarify its pricing requirements as soon as possible through the statement of expectations. Such pricing principles should be made binding prior to allowing private equity in NBN Co. A Ministerial Pricing Determination is one potential mechanism.
Recommendation 73. That any future fixed-line superfast access network built in Australia must offer wholesale services on an open-access and equivalent basis and, if it is an FTTP network, must comply with the technical specifications mandated in relation to the construction of FTTP access networks in greenfields; that this recommendation be subject to the following qualifications: 1. This requirement should not apply to existing superfast access networks or to existing or future small proprietary networks that are not covered by the *Telecommunications Act 1997*; 2. For the purposes of this recommendation, a fixed-line superfast access network should be defined as a fixed-line access network delivering download data rates consistently exceeding 25 Mbps; 3. ACMA should be empowered to agree to variations to the technical specifications in specific cases where those variations do not interfere with the Government's NBN objectives and result in significant cost savings through the use of existing infrastructure.	It is possible that this could be introduced by licence conditions on existing carriers. However, given the magnitude of the change, Government may consider legislative action, such as extending the access regime referred to in Recommendation 70 to such networks. Ideally, this would be implemented by subjecting operators of such networks to the same set of revised standard access obligations that Government intends to apply to NBN Co's services. This has the merit of emphasising that the rule merely ensures a level playing field.

Recommendation	Implementation considerations
Recommendation 74. That, if plans are announced for significant third-party deployments in high-value, low-cost areas of fixed-line superfast access networks (defined as a fixed-line access network delivering download speeds consistently exceeding 25 Mbps but excluding small proprietary networks) during the NBN roll-out, Government consider the introduction of a universal service levy on the owners of all such networks; this levy to be inversely related to a network's contribution to the Government's objective of providing affordable broadband coverage to all Australians. It would be hypothecated to fund telecommunications subsidy schemes; any such levy to be subject to a sunset clause causing its expiry after no more than ten years.	Note that this recommendation proposes a levy only as a 'last resort' if cherry-picking becomes an endemic problem. This would require legislative action following more detailed design of an appropriate scheme. The proceeds could be hypothecated towards telecommunications subsidy schemes.
Recommendation 75. That, to determine NBN Co's fibre network topology: 1. Once NBN Co has gained adequate network roll-out experience and has had the opportunity to conduct demonstrations of alternative topologies NBN Co determine the appropriate network topology to enable both physical and wavelength unbundling; 2. NBN Co, in consultation with the ACCC, develop a plan setting out the appropriate extent of deployment of this topology having regard to construction cost and competition outcomes; 3. Government determine interim deadlines to complete this process in consultation with the ACCC and NBN Co; 4. NBN Co be required to secure Government approval of its topology plan, by the earlier of: coverage of 15 percent of premises within the proposed fibre footprint; and 31 December 2013.	This policy should both be communicated to NBN Co through the statement of expectations and, as it may not be consistent with NBN Co's commercial interests, should be made binding through a licence condition. In particular, the agreed network topology should be made binding through a licence condition. Initial interim deadlines should be discussed with NBN Co and ACCC and settled by 1 October 2010 to ensure feasibility of complying with the timeline.

Recommendation	Implementation considerations
Recommendation 76. That Government not require NBN Co to unbundle Layer 1 services before network roll-out is almost complete; that Government endorse unbundling of Layer 1 services to occur at the earliest of: 1. Voluntary unbundling of Layer 1 services by NBN Co; 2. Declaration of Layer 1 services by the ACCC; 3. A requirement to provide Layer 1 services being imposed by the Minister.	This would be the position under the exposure drafts of the *National Broadband Network Companies Bill 2010* and the *Telecommunications Legislation (National Broadband Network Measures – Access Arrangements) Bill 2010*.
Recommendation 77. That NBN Co be asked to demonstrate that in the design of its products, systems and processes it has anticipated the likely unbundling of Layer 1 services on an equivalence-of-inputs basis and future ACCC price regulation of Layer 1 services based on actual costs; that in doing so NBN Co have regard to the commercial impact and technical feasibility of upfront preparation compared with steps taken at the time of unbundling.	This policy should be included in the statement of expectations. Due to its subjectivity, it should not be codified in a licence condition. However, the ACCC should report on compliance as part of its annual review of competitive safeguards in telecommunications under Section 151CL of the *Trade Practices Act 1974.* This policy should be communicated to NBN Co immediately in the statement of expectations.
Recommendation 78. That for the purposes of safeguarding competition outcomes in the event of privatisation of NBN Co: 1. Government commission an independent review into the telecommunications market structure and competition safeguards subsequent to the completion of roll-out and prior to privatisation; 2. The review assess the achievement of the competition objectives of the NBN initiative, and recommend any adjustments to regulatory and other arrangements required to maintain an effective wholesale model under private ownership (including, if appropriate, structural separation and/or divestment of interests in real property associated with the network); 3. Government determine its privatisation plans and schedule on the basis of that review.	This requirement would ideally be included in the establishing legislation to ensure it is binding on future governments. Alternatively, we understand that the approach of expressly foreshadowing an inquiry in the Explanatory Memorandum has been adopted previously. While we understand that this provides some level of assurance, we advise that a future Government pressing ahead with privatisation of a unified NBN Co without an independent inquiry into market structure could jeopardise the Government's competition objectives.

Recommendation	Implementation considerations
Recommendation 79. That the independent review of competition prior to privatisation start with a rebuttable presumption that backhaul not be privatised.	This rebuttable presumption should be included in the terms of reference of the review. Legislative triggers for structural separation and divestment of assets are proposed in Recommendations 80 and 81; these would also facilitate implementation of the foreshadowed outcome. This outcome should also be foreshadowed in the statement of expectations, to ensure appropriate design of systems.
Recommendation 80. That the Minister be empowered to issue an instrument ordering structural separation of NBN Co at one or more levels (such as between active and passive layers), with the nature of separation defined by the instrument.	This should be included in the establishing legislation, as it is a critical safeguard of future competition, and the exercise of this option at the time of privatisation should not be made subject to the uncertainty of future legislative processes. If this is not possible, the obligation of NBN Co to comply with such an order from the Minister could be included in the Funding Agreement.
Recommendation 81. That the Minister be empowered to issue an instrument ordering NBN Co, or a company formed from structural separation of NBN Co, to divest its interests in defined assets or classes of asset (for example: access-network ducts, pits and exchanges; transit backhaul assets).	As per Recommendation 80
Recommendation 82. That NBN Co be required to maintain its interests in real property directly associated with the access network, including ducts, pits, poles and exchanges, in a separate corporate entity to facilitate divestment in the event that it is required in the future.	It is sufficient to include this requirement in the statement of expectations, as its relevance will expire prior to privatisation. NBN Co should be informed of this policy immediately to ensure compliance as it acquires assets and interests.
Recommendation 83. That an individual ownership cap (including associated interests) be set of no more than 15 percent each on Carriers, CoSPs and CaSPs in relation to shareholdings in NBN Co, subsidiaries of NBN Co, or any company resulting from structural separation of NBN Co; that practical control tests be imposed in relation to such investors; that a public inquiry be required before altering these caps.	These caps must be given legislative force if they are to bind NBN Co subsequent to privatisation. Assuming that the quantum of the caps is set by regulation, the legislation should require a public inquiry to be held prior to any modification of the cap. As an interim measure, it is sufficient to set the caps in the NBN constitution; however, this will not be a sufficient solution at the time of privatisation.

Recommendation	Implementation considerations
Recommendation 84. That Government instruct NBN Co to provide fit-for-purpose access services to wireless base stations within the FTTP footprint on a commercial basis where requested by mobile operators; these access services to include transit backhaul where required to reach an NBN Co POI.	These obligations could be supported by licence conditions. The Part XIC access regime provides a fallback if NBN Co's compliance is deemed by mobile operators to be insufficient. This policy should be communicated to NBN Co as soon as possible to inform network design.