Before the
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Washington, D.C. 20554

In the Matter of:	)	
	)	
A National Broadband Plan for Our Future	)	GN Docket No. 09-51

REPLY COMMENTS OF INFORMATION TECHNOLOGY AND INNOVATION FOUNDATION

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[1] ITIF is a nonprofit, non-partisan public policy think tank committed to articulating and advancing a pro-productivity, pro-innovation and pro-technology public policy agenda internationally, in Washington and in the states. Through its research, policy proposals, and commentary, ITIF is working to advance and support public policies that boost innovation, e-transformation and productivity.

The Information Technology and Innovation Foundation (ITIF) is pleased to offer the following reply comments on the FCC's Notice of Inquiry, "In the Matter Of A National Broadband Plan for Our Future," MB Docket No. 09-51. ITIF has long been an advocate of a National Broadband Plan because we recognize the societal value of universal adoption and use of broadband networks. In that connection, we have produced a number of reports that have direct relevance to this NOI. These include *Framing a National Broadband Policy*[2], in which we made the case for a national broadband strategy by carefully examining the societal benefits of ubiquitous broadband coverage and wide adoption. We found significant network externalities that justify public investment in next-generation networks. *Explaining International Broadband Leadership*[3] carefully analyzed both policy and non-policy factors in nine OECD countries in order to better understand their relative importance and effectiveness. *Managing Broadband Networks: A Policymaker's Guide*[4] explained the statistical nature of the Internet and gave reasons why the public interest requires active management of Internet traffic. We attach all three reports.

In this reply, we summarize the consensus, highlight open issues, and offer our recommendations on key focus areas for the Plan.

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[2]Robert D. Atkinson, "Framing a National Broadband Policy," *Commlaw Conspectus,* Fall 2007. Web: http://www.itif.org/index.php?id=118
[3]Robert D. Atkinson, Daniel K. Correa and Julie A. Hedlund, *Explaining International Broadband Leadership*, ITIF, May 1, 2008. Web: http://www.itif.org/index.php?id=142
[4]George Ou, *A Policymaker's Guide to Network Management,* ITIF, Dec. 11, 2008. Web: http://www.itif.org/index.php?id=205

Summary

1) The ultimate long-term goal of the Plan is universal adoption of state-of-the-art broadband by 100% of the U.S. population. This goal recommends itself because of the significant positive externalities of universal broadband adoption for interpersonal communication, civic participation, distance learning, e-healthcare, tele-work, entertainment, the Smart Grid, and economic growth in general. While the goal is not fully achievable in the short term, incremental policies need to advance toward it.

2) There is a significant broadband adoption gap in the United States. While high-latency broadband is available to virtually 100% of Americans by satellite-based systems and over 90% have access to a cable-based option (with a significant share also having access to DSL or fiber-based options), the latest survey from the Pew Internet and American Life Project[5] indicates an adoption rate in the range of 60-65%. Consequently, understanding the reasons for this gap and increasing adoption must be an immediate, short-term goal.

3) The United States ranks roughly in the middle of OECD countries in terms of wireline broadband adoption, price, and speed. This is widely viewed as an unacceptable state of affairs which needs to be overcome to the extent practical by proactive policies, including incentives for high service tier adoption and increased investment in network infrastructure.

4) Upgrading America's wireline broadband networks from their current state to Next-Generation Networks capable of delivering 100-1000 Mb/s to each residence will cost considerably more money than was required to accomplish a similar feat in Japan, Korea, and certain European capitols, mainly because of housing density differences. A much less expensive upgrade to the 20-100 Mb/s range is already underway in some areas.

5) Data on broadband deployment and adoption is lacking in several significant areas, which has the effect of hampering research, impairing policy development, limiting the ability of local economic development officials, and reducing the value of the discourse on broadband adoption. In addition, many aspects of regulatory housekeeping, such as a thorough spectrum inventory and reliable surveys of Internet traffic growth, have been neglected for too long. The Plan can only be successful to the extent that it's data-driven. Hence, improving the data on spectrum utilization, Internet traffic, and broadband deployment is an immediate goal.

6) Public discourse on broadband policy has come to be dominated by poorly-defined terms overloaded with emotional significance such as "net neutrality" and "discrimination." When such terms are unpacked into constituent parts, there is

[5]John Horrigan, *Home Broadband Adoption 2009*, Pew Internet & American Life Project, 2009. Web: http://www.pewinternet.org/~/media//Files/Reports/2009/Home-Broadband-Adoption-2009.pdf

broad agreement on many elements, but as long as these terms represent constellations of concerns, they can only be as widely accepted as their least acceptable elements. Unbundling such terms into specific elements and concerns and revising the Internet Policy Statement toward balanced, comprehensible, and positive consequences is an immediate goal.

7) The Plan will be an ongoing process for many years to come. Consequently, the responsible agencies should prepare themselves to conduct ongoing data collection, assessment, and policy revision as policies are enacted and their effects are felt, and as new broadband technologies and applications emerge. There is already a tension between state-of-the-art wireline technologies such as FTTH with extremely high capacity and low latency and 4G wireless technologies which exhibit the benefits of mobility.

8) Access to the Internet is the immediate rationale for a National Broadband Plan, and an Internet focus should be apparent in efforts to map broadband infrastructure and to find choke-points. Hence, broadband mapping should begin at Commercial Internet Exchanges (CIX) and work outward toward the Last Mile, with special emphasis on the desire to ensure that fiber optic cable advances from the core further toward the network edge (the typical urban or suburban American home is located within one mile of a fiber terminal today.)

9) The Internet as we know it today is not the last word in networking. Because of such shortcomings as designed-in limits to scalability, security flaws, architectural flaws in naming and addressing, and service model deficiencies, the Internet will eventually be replaced by a different and better system. Financial support for network research can help accelerate this process and ensure a smooth transition that does not sacrifice fundamental values. Hence, the Plan's long-term focus must be broader than current generation "Internet only."

10) Wireless broadband, both fixed and mobile, is growing faster than wireline broadband in the United States. The continued growth of wireless depends on the availability of new spectrum, both licensed and unlicensed, and the adoption of better, more efficient models for spectrum regulation.

Issues

There is a broad consensus in the comments already filed on this NOI around many, if not most elements of a National Broadband Plan. Most people and organizations that filed agree on the benefits of improving broadband coverage and performance, and most agree that the government has a role to play in bringing about these goals. There is broad agreement that competition plays a role in increasing broadband speed and reducing cost, although there is substantial disagreement on where and how that competition should occur and the state of competition today. There is a broad consensus that broadband networks have to be built according to multiple design goals (such as reliability and efficiency as well as openness,) and that application utility drives broadband adoption. There is consensus about the need to reform the Universal Service Fund, and to use community anchor institutions as a pathway for introducing broadband into unserved and underserved communities. Similarly, there is no disagreement on the evident advantages in installing conduit as a part of roadway repair and installation, or on the advantages of close cooperation between the FCC and the states which have already adopted broadband plans.

The following highlights some of the issues yet to be resolved and offers commentary and guidance.

1) **Learning from Other Countries:** The modest position of the United States in the ranking of OECD countries in broadband provides us with the opportunity to learn a great deal about the policy factors and non-policy factors which have enabled other countries to leapfrog ahead of us. The ITIF's May, 2008 report, *Explaining International Broadband Leadership,* examines these factors in detail in nine OECD countries.

   Some excuse our relatively poor ranking by claiming that it is largely determined by demographic, geographic and other factors that policy cannot easily influence. Others argue that public policies are the key, and with little evidence other than correlation, point to other nations' telecommunications policies, especially in the area of unbundling and competition, as the determining factor in their higher rank. What is missing in this often heated and polarized debate is a careful, objective and in-depth analysis of nations' broadband environments and policies to determine what role, if any, public policies have played in spurring broadband deployment and adoption. This is important because nations with more and better broadband are better positioned to reap significant economic and social benefits. If we can identify policy factors that have spurred broadband performance in other nations' higher ranks, U.S. policymakers will have better information on which to base their decisions.

   In our report, we identify both non-policy and policy factors that influence broadband performance: adoption, speed, and price. First, we examine anecdotally how non-policy factors may influence broadband performance. Next, we review statistical analyses of how non-policy factors affect broadband ranks. Finally, we report on in-

depth case studies of broadband policies in nine nations with a diversity of ranks: Canada, France, Germany, Japan, the Netherlands, South Korea, Sweden, the United Kingdom, and the United States.

In reviewing other nations' broadband performance, it is tempting to be critical of U.S. broadband companies, broadband policies, or both. For after all, if the United States is lagging behind it must be because either our policies or our companies, or both, are deficient. In fact, the reality is much more complicated and less black and white.

First, non-policy factors such as urban population density, per capita income, median age, and the number of Internet users play key roles in determining broadband performance. The fact, for example, that over 50 percent of Koreans live in large, multi-tenant apartment buildings makes it significantly cheaper on a per-subscriber basis to roll out fast broadband there compared to the United States where many people live in single-family suburban homes. In fact, these and other factors explain about three-quarters of the difference between nations in broadband performance. Another major reason for the U.S. position in broadband adoption is the fact that U.S. household computer ownership is significantly lower than many other nations, particularly nations leading in broadband.

This is not to say that institutional factors and public policies are not important. But some of these factors appear to be unique to individual nations and therefore hard to easily transfer to other nations. For example, a major reason why Japan leads the world in high speed fiber-optic deployment is that their companies, in particular the partially government-owned incumbent telecom provider NTT, face significantly less pressure from capital markets for short-term profits and received tax incentives for broadband deployment. Observers can legitimately differ over whether the U.S. capital market and business environment are better or worse, but the bottom line is that this is the market in which U.S. broadband providers operate.

Likewise, many broadband advocates look to European broadband success, especially in France, and argue that unbundling regulations (rules to allow competitors use the facilities of incumbent telecommunications companies) are the key to their success and claim that if only the United States adopted such policies we would rocket ahead. Yet, this overlooks the fact that there are a number of European Union (EU) nations with the same unbundling regime as France that rank below the United States. Moreover, the principal reason France and most EU nations went this route is because they had almost no inter-modal competition, in part because their cable regulations significantly limited investment in cable modem service. Moreover, while proactive unbundling regimes in these nations spurred broadband adoption, they run the risk of limiting investment by both incumbents and competitors in next generation networks, with the result being a modest-speed "DSL cul-de-sac" on their relatively short copper loops. This is perhaps a major reason why the United States leads Europe in terms of fiber broadband deployment.

But the fact that non-policy factors are important, or that some policy environments are different than the United States', should not serve, as it does for some, as cause for complacency or worse, smug satisfaction. Clearly the United States can do better and doing so would generate significant economic and social benefits. It is in this regard that public policy matters. For based on our review of studies and documents, discussions with experts in the various nations, and other analysis, it is clear that the right broadband policies can and do have a significant positive influence on broadband performance. Moreover, even though nations differ in institutional and economic environments, there are many policy lessons the United States can productively learn from other nations and many policies that if adopted here, would effectively spur broadband performance.

Overall, at the broadest level nations with robust national broadband strategies – that is those that make broadband a priority, coordinate across agencies, put real resources behind them, and promote both supply and demand – fare better than those without. In particular, Korea, Japan and Sweden established robust national strategies that not only shaped their broadband policies but also helped gain widespread political support for them. And in the case of Korea and Japan, these strategies had support at the highest level of government and business. In Japan, for example, Prime Minister Yoshiro Mori appointed the Information Technology Strategy Council, headed by Sony Chairman Nobuyuki Idei, which crafted a strategy to make Japan the "world's leading IT nation" by 2005.

But while not all nine nations developed robust national broadband policies, every nation, including the United States, has put in place at least some effective policies to spur broadband performance. To promote broadband deployment, some nations have explicit or implicit government mandates; tax incentives, grants, and low cost loans to telecommunications providers; subsidies for rural broadband deployment; and policies to spur inter-model or intra-modal competition in the broadband market. To encourage take-up of broadband among residents, nations have adopted policies to encourage the development of broadband demand including promoting broadband in education; subsidizing computer adoption, establishing digital literacy programs; and migrating government services and content to the Internet (e-government). Overall, nations with more effective and well-funded policies appear to have been able to boost their broadband performance more than nations with less effective or less well-funded policies.

So what should the United States do to improve its broadband performance? There are a number of specific policy recommendations that we propose. But perhaps the most important step we can take as a nation is to move beyond the divisive and unproductive debate over broadband policy that we are now caught up in. The current debate over broadband revolves around arguments about whether we are behind or ahead; whether our relative position is due to policy or other factors; whether unbundling is a magic bullet or an investment killer; and of course, whether net neutrality is the solution to the greatest threat to the Internet since its inception or merely an anachronistic concept. Indeed, the U.S. broadband policy environment is

characterized on the one hand by market fundamentalists who see little or no role for government, and indeed see government as the problem; and on the other by digital populists who favor a vastly expanded role for government (including government ownership of networks and strict and comprehensive regulation, including mandatory unbundling of incumbent networks and strict net neutrality regulations) and who see big corporations providing broadband as a problem.

It's time to move beyond free market fundamentalism on the right and digital populism on the left and begin to craft pragmatic, realistic policies that focus on the primary goal: getting as many American households using high-speed broadband networks to engage in all sorts of online activities, including education, health care, work, commerce, and interacting with their government.

2) **The Role of Competition:** There is perhaps no issue more central to the debate about broadband policy than the state of and role of competition. Indeed, the issue of competition drives many of the debates over broadband, including net neutrality, wireless spectrum auctions, municipal broadband, and unbundling proposals. Although some advocates claim that the current state of broadband competition is more than adequate, others decry market conditions and seek proactive public policies to spur more competition. Yet almost everyone involved in broadband policy in the United States agrees that regardless of the current state of competition, more competition is better. The reason stated by advocates is that more competition leads to lower prices, higher speeds, broader deployment, more innovation, and better customer service.

   Yet, the Washington consensus in favor of more broadband competition ignores the fact that broadband displays natural monopoly or duopoly characteristics. Because of the nature of the broadband industry, there are significant tradeoffs between more competition and goals of efficiency, innovation, low prices, and higher speeds and broader deployment. Thus, it's a mistake for policymakers to assume that if they simply "push the competition lever," all the problems with broadband policy will be solved. Some problems will recede, but others are likely to emerge, such as the increased overall cost of providing broadband over too many infrastructures. The bottom line is that if policymakers want to maximize not only societal welfare but also consumer welfare, they must balance the push for more competition with the need to maintain and create an efficient broadband industry structure. It remains to be determined how competition policies should be best applied across infrastructure, broadband transit services, and applications.

3) **Meta-Infrastructure**: By its nature, a plan is an abstract exercise even if the immediate effect is to increase the deployment and use of the current generation of network technology. This plan can become an effective exercise only if it focuses less on wires, switches, and routers and more on the meta-infrastructure within which they're deployed. The meta-infrastructure – internetwork exchange centers, conduits, trenches, poles for overhead wiring and towers for wireless networking – will outlive the current generation of technologies such as RG69/U coaxial cable, single-mode

and multi-mode fiber, and 3G packet wireless. Therefore, meta-infrastructure should be a major part of the Plan's focus on the supply side.

4) **Internet Core**: The Plan should address the problem of increasing high-speed Internet access from the inside of the network outward, not from the edge toward the core. There has been a pronounced tendency in the public discourse on Internet access to emphasize first/last mile capacity. While this is an certainly an important part of the discussion, performance at the edge for many subscribers - real, sustained performance, not just marketing hype - is often constrained by conditions closer to the network core. The Internet itself is not simply a network of edges, it's a hierarchical mesh of links of varying capacities woven together by private and public switches, many located at exchange centers. Consequently, the Plan has to focus on capacity and performance in the core, the middle, and the edge.

5) **Middle Mile**: For the first time in the history of broadband policy discussion, the middle mile is becoming important. This is as it should be, as the middle mile is the most crucial portion of the network for expansion into unserved and underserved areas. The problem that has to be overcome in these scenarios is the relatively high cost of connecting a rural community to a distant Commercial Internet Exchange (CIX) point. The Internet literally lives in the CIXs, yet there are only 300 of them in the entire world. The number of these centers of interconnection needs to be expanded, with more of them moving deeper into underserved territories. Rural CIXs won't be as densely populated as major exchanges such as those operated by CRG West, Equinix, or Switch and Data, but they would substantially decrease the cost of interconnection and increase capacity. Direct subsidy to develop remote CIXs would not require ongoing government support, but would overcome a substantial barrier to broadband in unserved and underserved areas.

6) **Technology Neutrality**: The Plan should refrain from making too many assumptions about the proper means of managing broadband networks, focusing instead on promoting pro-competitive practices, levels of service, service plan transparency, and service plan honesty. Most of all, the Commission should recognize that its role is not simply to design a network of a particular speed and description but to create the conditions for networks to be built, maintained, and upgraded continually by agents in both the private and public sectors. Next generation networks have been built around the world out of combinations of copper, glass fiber, and wireless, and these technologies will necessarily continue to evolve.

7) **Collaborative Projects:** Competitive last-mile networks will often be helped by collaboration among competitors on shared middle-mile projects to facilitate high-bandwidth interconnection to CIXs and satellite CIXs by such means as sharing the cost of installing fiber. Cooperative arrangements of this sort should be encouraged.

8) **A Different Kind of Utility**: Broadband networks have certain characteristics that distinguish them from utility networks for services such as water and sewage: we expect broadband to get faster and cheaper year after year, but we don't have similar

expectations for our water, sewer, and garbage collection systems. We believe it's reasonable to ask consumers to moderate their use of utilities in light their societal costs by conserving water and electricity and recycling, but we have no such expectation where broadband is concerned. In fact, we have quite the opposite attitude, considering ever-higher consumption of broadband capacity indicative of virtue: people who consume lots of broadband bandwidth are deemed "innovators," not profligate wasters. This is as it should be, of course, because innovative new network applications often do consume more bandwidth than old, established ones (but not always, Twitter is a narrowband innovative service.) So if broadband networks are utilities, they're utilities of an entirely different kind than water and sewer systems, ones in which we don't ask consumers to conserve and which we expect will constantly increase in capacity and decrease in cost to the user. So the "utility" formulation is not helpful and doesn't serve to drive the debate in a constructive direction, with a few exceptions.

9) **More than Internet**: The Plan should focus on the general theme of "broadband networking" instead of the more narrow theme of "the Internet." There are four reasons for this:

- The Internet as we know it – a collection of systems bound together by their common use of a particular set of protocols – is nearing the end of its useful life and will be placed by an "Internet 2.0" in a few years. This will take place because of design limits embedded in Internet protocols with respect to addressing and routing, and its evident flaws with respect to security and mobility.

- Internet service by itself has a troubled adoption history at the consumer level. Experiments in advanced last-mile networks have repeatedly shown that consumers are much more interested in triple- and quadruple-play service packages that combine Internet access with TV and telephone services, whether conducted by private companies or by local governments, than by Internet service alone. All of the municipal fiber projects that are anywhere close to success have had to offer triple-play in order to attract a reasonable subscriber base: this includes Lafayette, LA, Morristown, TN, Burlington, VT, and UTOPIA in Utah.

- While the Internet's growth and penetration has astounded many of us, it pales in comparison with the uptake of wireless networking. Thirty five years after its birth, some 1.5 billion people use the Internet, but the cell phone network has grown to some 4 billion people in half the time. Networks of the future will include the critical elements that have pushed the cell network into its commanding position - mobility and voice support - and will support Internet connectivity modes as a secondary function. This is, after all, what the networks of the present do.

- The choice of networks and networking technologies should be made by the people who use them, not by government agencies. It's reasonably clear that consumers want networks that can do the things that the telephone and TV networks are good at – real-time communication and broadcasting – as well as those that the Internet is good at, such as file transfer, e-mail, and web publishing.

10) **Neutral, Technical Language**: The Plan should avoid the use of emotionally-charged language in the ongoing dialog about business plans, networking technology, and the public interest. The notion of "discrimination," for example, has little utility in this debate because it carries so much baggage as a term in common speech as well as a term of art in the law and in engineering.

    As we have previously pointed out[6], networks discriminate by design:

    - Physically, they deliver signal and filter noise;
    - Logically, packet switched networks filter and forward based on addresses;
    - Financially, networks allocate prices in relation to costs, and facilitate transactions which reflect the differential value of information.

    The use of such terms as "discrimination" requires the development of new meanings in the broadband context, an exercise that would be more productive on a base of neutral language with less prior significance. There is no doubt that packet discrimination is an essential and productive activity in packet networks, and there are no serious concerns about it among engineers. Network regulators need to address issues that may arise as perverse side-effects of packet discrimination, such as anti-competitive practices, pricing, disclosure, and exclusivity, but these ongoing regulatory concerns are not central to a far-reaching National Broadband Plan.

11) **The Paradox of Triple-Play:** The concern that gives rise to the calls for a ban on "discrimination" is a paradox of Triple-Play Services. We know that broadband adoption is highest when Internet access is offered in combination with cable TV and telephone service. This is the case not only in commercial markets, but on municipal systems such as those cited. These service packages give rise to fears that multisystem operators (MSOs) will unfairly discriminate against television and telephone services provided over the Internet access service in order to favor their own competing services. In some sense, this sort of "disfavoring" is inevitable under a strict anti-discrimination rule for reasons that anti-discrimination advocates may fail to appreciate. Let us explain.

    There are two technical means by which triple-play services are offered:

[6] See George Ou, *A Policymaker's Guide to Network Management*, ITIF, Dec. 2008. web: http://www.itif.org/index.php?id=205

- Voice and TV may be provided in separate frequency bands on "broadband" systems as classically defined[7]. In this case, the services don't compete with Internet access for bandwidth. This is the mode used by Verizon FiOS and the cable MSOs.

- Voice and TV may be provided on the same frequency band as Internet access using time-division multiplexing with a pre-assigned or preferential bandwidth allocation. This mode is used by AT&T U-verse and other services which are consistent with the IETF's Integrated Services (Intserv) and Differentiated Services (Diffserv) protocols.

It certainly is the case that VoIP and live video streaming provided over the Internet access service is disadvantaged over similar services provisioned over dedicated circuits, but it may not be obvious to the consumer. The Internet is a pooled-bandwidth system in which overall performance is a function of the number of active users and the load they offer to the system. During periods of time in which load is light, there may be no perceptible difference between over-the-top VoIP and dedicated voice, but during periods when the system carries a large video file load, a difference may be detected. Peer-to-peer networking, for example, can easily degrade the performance of Vonage and Skype on shared-cable systems and on dedicated-cable systems when multiple applications are active at the same time. The Internet achieves low cost by pooling bandwidth, but suffers statistical latency variations as a consequence. Avoiding variations in latency is the primary reason for separating live TV (even IPTV) and telephony from general-purpose Internet access.

But the performance of dedicated-resource voice and video streaming comes at a cost to the MSO, one that customers are apparently quite willing to pay as evidenced by the high take-up rates for broadband systems that offer this option. It's therefore not obvious that MSOs must be required to offer dedicated-circuit performance to over-the-top services, or that doing so would pass muster with an anti-discrimination rule, or that they even could if they wanted. The reason for this is that the only technical means to ensure dedicated-circuit performance to over-the-top VoIP is to boost its priority during periods of high load in an exercise of "positive discrimination" which would also require the use of deep-packet inspection in most instances, and this only works within a single routing domain, not across the public Internet as a whole. The alternative is to bar MSOs from offering dedicated-circuit services, which burns down the barn.

In Korea an exclusive right to provide telephone service was granted to carriers as part of the incentive package for Next-Generation Broadband systems. These carriers are permitted by law to block Vonage[8] and Skype, on the understanding that the high-speed, low-latency networks they provide have greater public utility than a free market in VoIP. This is a policy choice that Asian policy makers have chosen to

[7] In network engineering, "broadband" refers to systems in which frequency-division multiplexing is used to support multiple concurrent communication streams. In policy circles, the term has come to mean simply "high-capacity networks."

[8] See: "Korea Blocking Service July 1st,"Vonage web site, http://www.vonage-forum.com/ftopic15004.html

enact, but not one that we consider appropriate.

Experimental systems are under development that might allow users to signal desired priorities for particular packet streams to their ISPs, and for the ISPs to cause them to be routed across the Internet according to user requirements. If such systems prove workable, there should be no barrier in regulation to the sale of priority-based services. Such a system could sensibly be augmented by an agreement for the ISP to classify streams using some form of DPI for legacy applications that lack the ability to signal priority preferences[9].

The purpose of such a system is not to make some web sites load faster than others, as many advocates fear; rather, it's to enable real-time communication across the public Internet at a lower cost than standard telephony and with a higher Quality of Service than is typically required by *any* web site. This is a middle ground between triple-play and the unitary, unpredictable priority of today's public Internet.

It's also reasonable to allow ISPs to sell access to dedicated voice and video circuits to third parties or directly to consumers. As 4G systems using LTE are deployed, the sale of the enhanced delivery service required by voice makes a great deal of economic sense.

Content delivery networks and private networks such as Google's and Limelight's which intersect the Internet at multiple points provide preferential treatment based on source and destination because:

- They're closed to packets from non-Google or non-Limelight sources; and
- They release packets close to end users in such a way as to ensure higher TCP throughput rates because of the way TCP controls packet rates.

This is preferential treatment by network design and deployment. It's a sound engineering practice which should not be disallowed. By the same token, no engineering practice that produces a similar effect should be disallowed either.

All of this is to say that a wholesale ban on "discrimination," broadly-defined, does not serve the public interest. The concern for policy makers is to ensure that the (hypothetical, at this point,) deployment and sale of enhanced delivery services over the public Internet increases competition and maximizes the public good. Policy has to distinguish the *good discrimination* which increases access to innovative new services from the Madison River-style *bad discrimination* that limits such access. As it's impossible to give all Internet traffic the highest priority and the lowest delay, the winning formula is to allocate latency intelligently in the public interest.

12) **Technical Tradeoffs:** "Openness" has to be put in context. While various kinds of "openness" are clearly advantageous to innovation and the public interest, no single

[9] A legacy classifier of this sort is part of the ANSI/IEEE 802.11e standard for wireless LANs.

design objective is paramount over all others, and at the end the day "openness" is simply a design objective, albeit one with great power.

Network utility depends on a series of successful tradeoffs between a number of design objectives, including reliability, performance, economy, modularity, and security. Open networks can, under certain constructions, represent severe challenges to many of these other objectives, especially security and performance. Hence there is no sound reason for network regulations to stress any one design objective to the detriment of all others. The need to combine multiple objectives is evident in the necessary "reasonable network management" footnote to the FCC's Internet Policy Statement. In a balanced formulation, network management is more than a footnote, as it enables security, reliability, and economy, without which "openness" has no value.

Similarly, the insistence that innovation happens only at the edge of a "stupid" network has absolutely no empirical support. The capability of the network to provide an essential set of delivery services is the enabler of innovation at the edge, and when that capability is improved by such means as the Internet's Differentiated Services and Integrated Services, the scope of innovation opportunities at the edge is increased, not decreased. Network utility is not simply a question of pitting the core against the edge in some sort of cosmic battle, it's a matter of establishing the most productive collaborative relationship between two important aspects of a single system.

13) **Content Delivery Networks:** While it's common for advocates to view the Internet as a simple end-to-end network in which network infrastructure simply moves packets without regard for their content, the reality is far different from this picture. Popular content, especially web pages and video files, is fetched repeatedly over remote network connections subject to saturation and overload. Consequently, popular content is distributed by Content Delivery Networks such as Akamai and Limelight which stage copies close to consumers or on unobstructed paths to eliminate the need for end-to-end access and the enormous resource costs it incurs for popular content (over-the-air television moves one copy of American Idol regardless of the number of viewers; end-to-end Internet delivery would require 30 million copies.) As video distribution becomes more common over the Internet, caching systems will need to be more widespread if networks are to retain their resiliency and responsiveness. The caching of local content is a service that ISPs are uniquely positioned to provide, and they should not be discouraged from doing so. Cached content is inherently delivered faster than non-cached content coming from remote sites, so caching amounts to acceleration or content "discrimination." The Plan should specify that content caching is a legitimate fee-based service providing enhanced Quality of Service.

14) **Research:** The Internet and broadband networking generally have benefited greatly from the availability of research funds, both for protocol adoption and for the early NSF backbone infrastructure. As Internet protocols for broadband networking are

nearing the end of their useful life, it's appropriate for the Plan to support a new round of research to create a replacement set of protocols. Of particular importance is research on *scalable routing architectures*, as the lack of one is the primary designed-in limit to growth in the current Internet. Another area of promise is recursive network architectures such as RNA and RINA that don't suffer from the Internet's naïve modularity; another still is protocols for content location and distribution.

15) **Spectrum Policy:** Spectrum management and licensing is a key concern. The Plan should call for the development of one or more new models of spectrum regulation that are neither as restrictive as licensing nor as permissive as unlicensed uses are today.[10] An ideal spectrum regime would permit obsolete and inefficient analog systems to be replaced by better digital systems, and would allocate frequencies for best use as determined by their inherent qualities and the unmet needs of citizens and their applications.

    One model that deserves exploration requires close cooperation between the regulator, an engineering standards organization such as IEEE 802, and a compliance tester such as the Wi-Fi Alliance. In this model, the government would license a range of frequencies to the compliance organization, which would be responsible for adopting an appropriate standard from the standards organization and ensuring compliance via a suite of tests. Any use of this approach would incorporate a provisional license for a limited time, renewable only as long as the end user keeps his or her system up to the current standard. This approach is a "third way" of spectrum regulation that avoids the pitfalls of our present system.

    Traditional licensing methods are still appropriate, and will remain so until an alternative regime can be shown to have better long-range utility. Exclusive licensing is highly efficient and has been shown to stimulate the development of new wireless applications, but the growth of 4G wireless will create the demand for massive new swaths of wireless spectrum.

16) **More than Broadband**: While the National Broadband Plan, by definition needs to focus on broadband, it is important to remember that broadband is a means, not an end. The end is the transformation of the United States to a digital economy and society where virtually all aspects of life – health, education, government, finance, transportation, communication, etc., become transformed by information technology and communications technologies. Many other nations have recognized this. For example, while initial plans by Korea and Japan focused on broadband leadership, their subsequent efforts (e.g., Digital Japan, and Korea's 8-3-9) are much broader, building on a world class broadband network, but focusing on broad digital transformation.

[10] The primary limitation on Wi-Fi systems today is the presence of analog devices such as FM baby monitors on the channels used by Wi-Fi systems.

Recommendations

First and foremost, America needs a national broadband strategy that focuses on both broadband supply as well as demand. In part because of significant market failures with regard to the provision of broadband, relying on market forces alone will not meet our country's future broadband needs. Targeted subsidies can bridge the gap between broadband coverage that can and will be provided by the market the extent of coverage envisaged by the Plan.

The United States National Broadband Plan needs to give companies incentives to upgrade and extend networks and to ensure that there is demand by increasing access to personal computers, encouraging broadband Internet usage in education, and encouraging the development of the types of applications (both government and commercial) that make users demand high-speed access.

A. Policies to Stimulate Broadband Supply

There are a number of steps U.S. policymakers should take to promote broadband infrastructure development:

1) **Enact more favorable tax policies to encourage investment, such as accelerated depreciation..** While competition can and often does encourage companies to upgrade their broadband networks competition alone will not be sufficient. Consequently, policymakers should give companies additional incentives by enacting more favorable tax policies. In particular, the federal government should allow companies investing in broadband networks to expense investments in new high-speed broadband networks (capable of delivering considerably faster speeds than today's average DSL or cable networks) in the first year. Currently, companies must depreciate telecommunications network investments over a period of fifteen years. Allowing companies to deduct the investment in the first year reduces the costs of making these investments and spurs faster deployment of higher speed networks.

2) **Continue to make more spectrum available for next generation wireless data networks.** While the government should not mandate the types of technologies companies may use to provide broadband access, it can help encourage the development of a variety of broadband services. In particular, as Worldwide Interoperability for Microwave Access (WiMAX) is deployed and the prime 700 MHz spectrum is auctioned more rural places will be able to gain access to wireless broadband. But ensuring that even more spectrum is available will be important. One way to do this is to revise the regulations for unlicensed spectrum in the white spaces between digital TV bands. The Commission's Report and Order sets the power level for mobile terminals too low for such devices to communicate over distances of a few hundred feet, effectively making the White Spaces nothing more than another home networking option. This is not the highest or best use of these frequencies, so the Order needs to be revised.

   Similarly, the Commission should examine the use of digital TV spectrum by

broadcasters. Most of America receives TV programming from a cable or satellite system that offers substantially more choice than over-the-air (OTA) delivery, so OTA television broadcasting has limited value. Moreover, many OTA broadcasters are using their spectrum allocations for multiple low-value program streams that do little for the public interest. If the public interest is better served by the re-allocation of digital TV spectrum, the Commission should not hesitate to examine the question and issue the appropriate order.

3) **Reform the Universal Service Fund (USF) program to extend support for broadband in high cost areas to all carriers.** Currently the federal USF program does not provide explicit support for broadband. However, in November 2007 the Federal Communications Commission Joint Board on Universal Service recommended the creation of three separate universal service funds, one of which would support rural broadband deployment. The Board also recommended using a reverse auction mechanism to allocate the funds. Companies would compete to win funding to provide broadband services in rural areas, which would go to the lowest bidder. The funding would consist of a one-time subsidy and the company would operate on limited contract (perhaps 5 or 10 years) and be required to meet minimum standards of performance. The one-time auctions would cover the higher capital costs and higher capitalized operating costs. These auctions should be open to any provider using any technology.

4) **Fund mechanisms to collect more accurate information on broadband access.** No national broadband strategy will be useful if a country does not know its true level of broadband penetration. Although the FCC's recent decision to revise its broadband definition and reporting requirements is a step in the right direction, it could do more to collect timely and accurate information. In particular, the FCC and other agencies should supplement current efforts by creating an online broadband data warehouse that enables various sources of broadband data to be aggregated in an interoperable form.

B. Policies to Stimulate Broadband Demand

U.S. policymakers should promote broadband take-up (demand) by:

5) **Funding digital literacy programs and personal computer purchases for schools and libraries.** Given that lack of computer ownership and digital literacy appear to be the major factors limiting broadband take-up, as opposed to unwillingness or inability to switch from dial-up, simply providing USF-like subsidies (such as Lifeline and Linkup) is unlikely to be enough. When telephones were first adopted, "telephone illiteracy" was not the major barrier to deployment because phones were relatively easy to use. Notwithstanding constant improvements in usability, computers and the Internet are, in comparison, quite complicated, and difficult to use. Despite the fact that an increasing number of applications rely on broadband, many people who cannot

live without a phone feel perfectly comfortable living without the Internet. This suggests that a universal service policy focusing solely on subsidizing costs will not be enough to maximize broadband adoption. Any policy to expand broadband use must begin with efforts to make non-users comfortable with, and interested in, computers and broadband. In the immediate term, the most effective strategy for expanding broadband access appears to be supporting corporate, government, and nonprofit efforts to help boost broadband demand. In support of these endeavors, Congress should enact and fund a competitive, community-based broadband access grant program, focused not just on broadband connectivity, but also on digital literacy and technological device access. Such a program could catalyze the creation of even more local, nonprofit, and voluntary approaches to bringing most, if not all, of a community's residents online. Related to this, a national effort is needed to coordinate such efforts and provide shared resources and tools to help these more local organizations be more effective.

6) **Exempt wired and wireless broadband Internet access from federal, state, and local taxes.** Internet access is a fundamental building block of our national digital economy, a key enabler of many applications and services, and a prerequisite for participating in our digital society. Government should provide unfettered access to this basic public good by eliminating non-USF taxes on Internet access, including broadband. Specifically, Congress should make permanent the current moratorium on Internet access taxes and eliminate the grandfather clause which allows certain free rider states to tax Internet access. In addition, the ban on Internet taxes should be clarified to include the underlying transport services acquired by ISPs, such as the wire, cable, or fiber used to carry traffic from customers to the Internet. Currently, some states tax the underlying transport for broadband Internet access, a cost which ISPs then pass on to consumers in the form of a tax recovery fee. In addition, Congress should ban state and local discriminatory taxes on wireless services. Given that the average tax on telecommunication services is 13.5 percent, more than twice the average tax rate on all other goods and services, Congress should act to ensure that the short-term fiscal interests of states do not trump the long-term strategic interests of the nation.

7) **Support new applications, including putting more public content online, improving e-government, and supporting tele-work, health IT, and e-learning programs**. As the U.S. economy and society becomes more and more digital, government needs to ensure that it does not fall behind. As a result, government officials at all levels can and should lead by example by leveraging their own IT efforts to achieve more effective and productive public sector management and administration. Among other things, this means government should not only actively promote e-government but should also look to how IT can be used help solve a wide array of pressing public challenges. Among other things this means spurring e-health applications. It means supporting tele-work applications, including among the government workforce. And it means helping to spur e-learning applications. One easy step to that would be to fund the Corporation for Public Broadcasting to make its content available online.

Imagine if school children studying the Civil War could watch Ken Burns' Civil War series on the Internet. Similarly, the Library of Congress has video content – such as classic films – that are in the public domain and which, if digitized, would likely be extremely popular and drive demand for broadband services.

Conclusion

We're greatly encouraged that the United States is finally on the way toward developing a national broadband strategy. Ubiquitous adoption of next-generation broadband technology can only help to improve America's competitiveness as well as our quality of life. While a substantial consensus is emerging on the broad strokes of the Plan, a great deal of work remains to resolve differences, some quite stark, over key elements of the plan. Drafting such a plan unavoidably places the debates over such issues as competition, technology, regulatory models, and business models into stark relief. The National Broadband Plan will produce effects for a generation to come, so it's important that the Commission strive to resolve as many of these issues as possible on a sound empirical basis. One advantage that we gain from our modest position in the international rankings is the ability to learn from both the successes and failures of our competitor nations, and we should use it wisely.