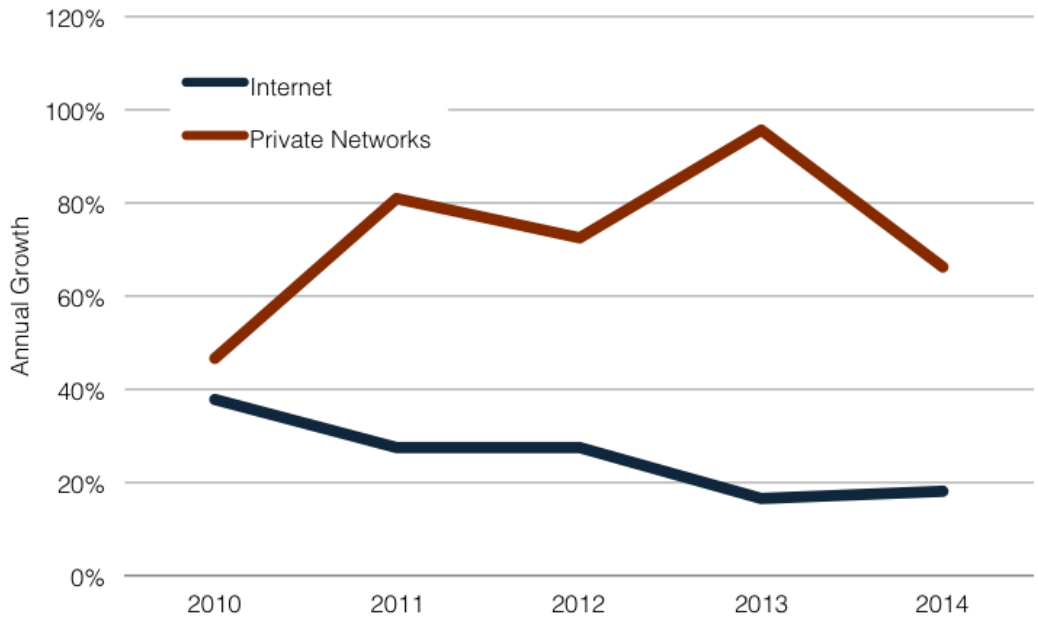
Executive Summary

The international bandwidth market is undergoing a transformation. The traditional dynamic by which carriers link broadband users to global networks is still a core part of the market, but on the largest routes, content companies have overtaken carriers as the biggest bandwidth consumers. The largest content providers, such as Google, Microsoft, and Facebook, have become major customers of long-haul capacity as they expand their own internal networks. Increasingly, these entities have capacity requirements that exceed those of the largest carriers. On the trans-Atlantic route, private network capacity growth has outpaced Internet bandwidth growth for several years (see Figure: Used Trans-Atlantic Capacity by Source, 2010-2014). In 2014, private network bandwidth on the trans-Atlantic route eclipsed Internet bandwidth for the first time in history, rising to 13.9 Tbps and accounting for 56 percent of used bandwidth.

FIGURE 1
Used Trans-Atlantic Capacity by Source, 2010-2014



Source: TeleGeography

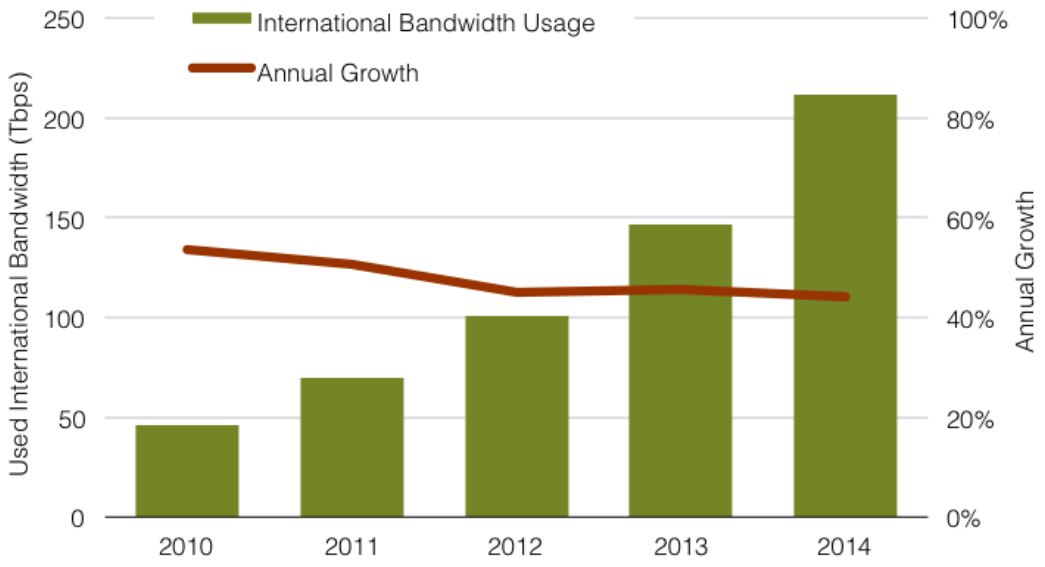
Although the market is evolving, some fundamental trends remain in place. Regardless of bandwidth consumption patterns, technological innovation drives the unit cost of bandwidth down, and competition drives prices downwards toward cost. TeleGeography's *Global Bandwidth Research Service* analyzes and quantifies the state of the long-haul network industry and assesses the factors that will shape demand growth and price erosion in the years ahead.

Supply and Demand

Global bandwidth demand continues to grow, spurring terrestrial and submarine cable network operators to undertake extensive network upgrades and deployments. Global demand for international bandwidth increased at a rate of 44 percent in 2014. The amount of capacity deployed on international Internet, private, and switched voice networks more than doubled between 2012 and 2014, rising to 211 Tbps (see Figure: Worldwide International Bandwidth Growth, 2010-2014).

FIGURE 2

Worldwide International Bandwidth Growth, 2010-2014

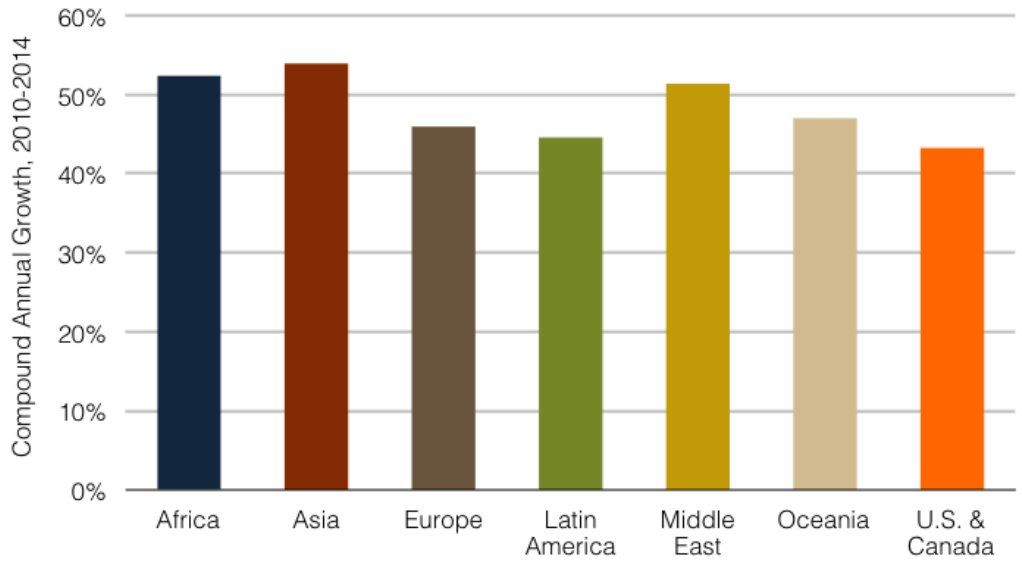


Source: TeleGeography

Regional bandwidth demand varies depending on the relative maturity of local communications markets, with the fastest growth rates occurring in emerging markets. Africa, Asia, and the Middle East registered international bandwidth demand increases exceeding 50 percent compounded annually between 2010 and 2014 (see Figure: Used International Bandwidth Growth by Region, 2010-2014).

FIGURE 3

Used International Bandwidth Growth by Region, 2010-2014

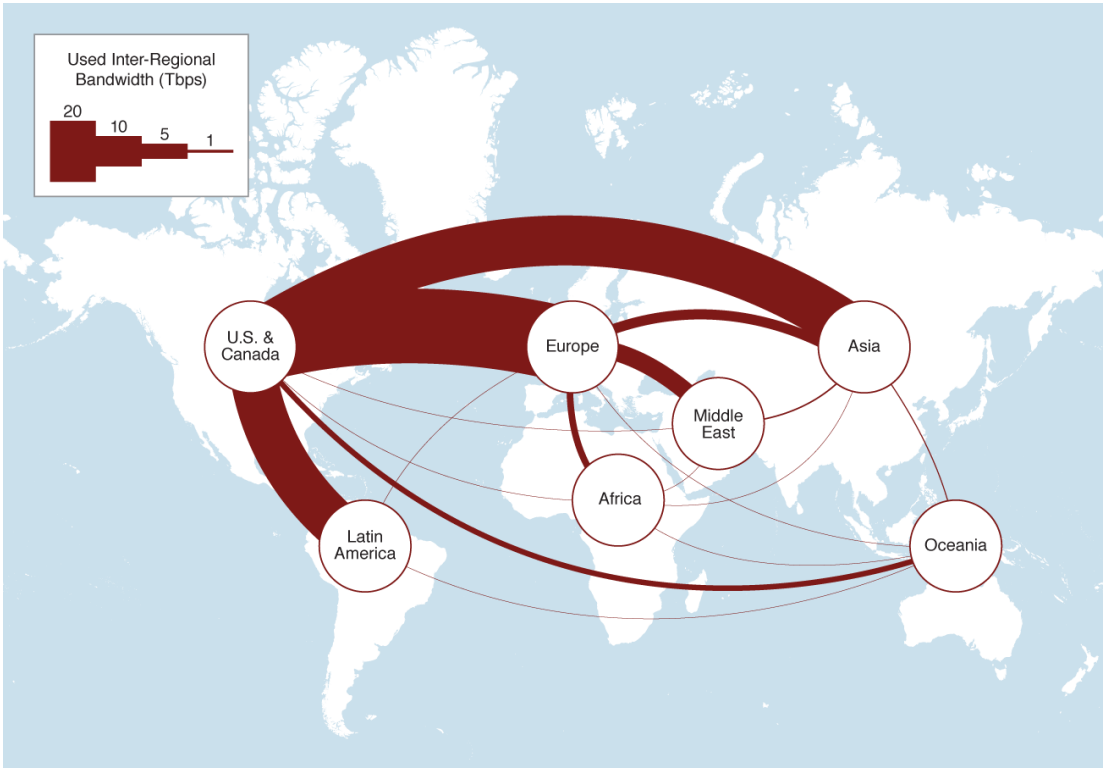


Source: TeleGeography

Despite strong growth in intra-regional international bandwidth, the highest-capacity inter-regional route groups connect North America with Europe, Asia, and Latin America (see Figure: Used Inter-Regional Bandwidth, 2014). Each of these routes exceeds 15 Tbps of capacity.

FIGURE 4

Used Inter-Regional Bandwidth, 2014



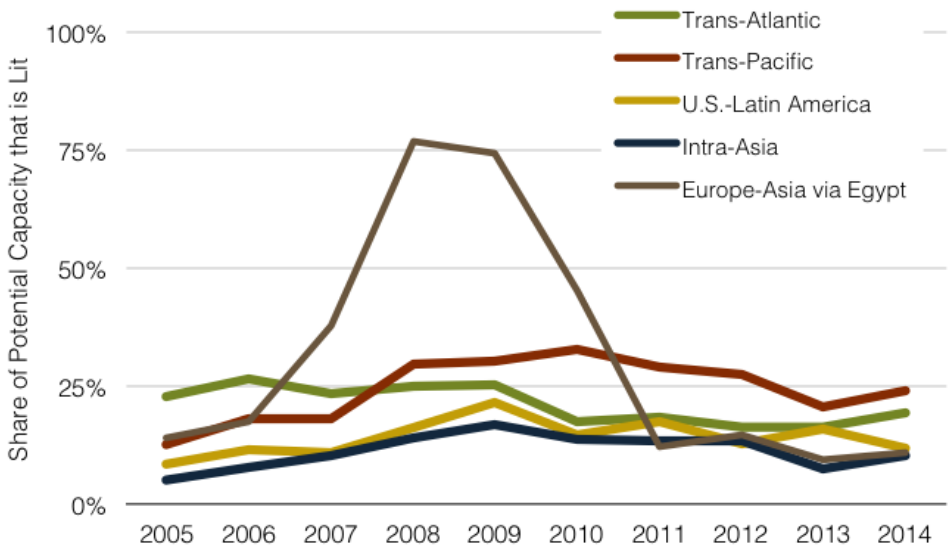
Notes: Data represent used bandwidth connected across international borders and excludes domestic bandwidth.

Source: TeleGeography

Submarine cables are the primary means of intercontinental communications. While the amount of lit capacity has increased on all major subsea routes, potential capacity is keeping pace, ensuring that a large amount remains untapped (see Figure: Percentage of Potential Capacity that is Lit on Major Submarine Cable Routes, 2005-2014). In one example, the percentage of potential trans-Atlantic capacity that is lit decreased from 25 percent to 19 percent between 2009 and 2014, even though lit capacity nearly tripled during this period. This was due to the increased viability of adopting 100 Gbps line rates on existing systems.

FIGURE 5

Percentage of Potential Capacity that is Lit on Major Submarine Cable Routes, 2005-2014



Notes: Data reflect the percentage of potential capacity that was lit at the end of the respective year. Potential capacity figures are based on operators' view of theoretical maximum capacity as of year-end and do not uniformly assume 100 Gbps wavelengths on all systems. Intra-Asia capacity only includes cables with landings in both Hong Kong and Japan. Trans-Pacific capacity excludes Southern Cross and Telstra Endeavour. Trans-Atlantic capacity excludes Atlantis-2.

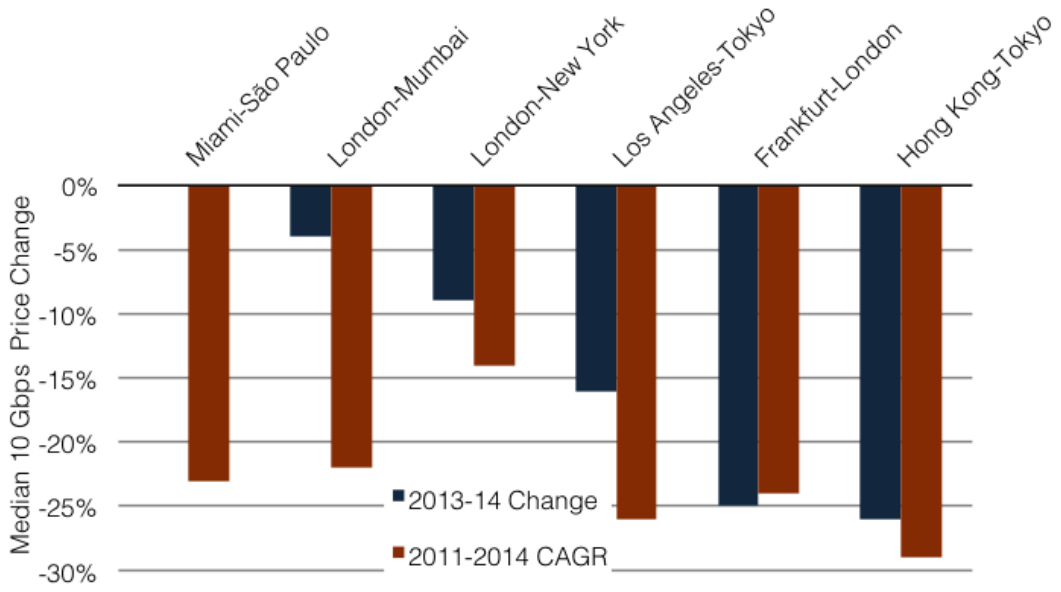
Source: TeleGeography

Pricing

Bandwidth prices continue to erode as volumes grow—even as market participants change. Prices vary widely by region due to differences stemming from available supply, competition, and cost of incremental upgrades. The common denominator of capacity remains 10 Gbps optical wavelengths with Ethernet interfaces, but a considerable number of lower and higher capacity products are also sold. Median monthly 10 Gbps wavelength lease prices for a selection of major routes exhibited declines of up to 26 percent between 2013 and 2014, and ranging from 14 percent and 29 percent compounded annually between 2011 and 2014 (see Figure: Median 10 Gbps Wavelength Price Declines on Major Routes, Q4 2011-Q4 2014).

FIGURE 6

Median 10 Gbps Wavelength Price Declines on Major Routes, Q4 2011-Q4 2014



Notes: Change in median monthly lease prices for unprotected 10 Gbps wavelengths, excluding local access and installation fees.

Source: TeleGeography

Achieving higher transmission line rates is a primary driver of unit cost reduction. As 100 Gbps line rates have become more widespread, wholesale transactions of 100 Gbps ports on the client side have begun to grow. One obvious requirement for the 100 Gbps proposition is demand for 100 Gbps on a single path, as opposed to an aggregate 10-wavelength purchase at 10 Gbps, which might include several paths. Where network operators need massive point-to-point capacity, managing a single wavelength, instead of 10, reduces complexity and cost. Discounts for bulk purchases of 10 Gbps relate to price multiples for 100 Gbps wavelengths. For instance, a carrier willing to offer a 25 percent discount on a 10-wavelength purchase at 10 Gbps might reasonably use that as a starting point for 100 Gbps pricing. Efficiencies in 100 Gbps transmission will, in turn, put pressure on 10 Gbps pricing.

Wavelengths and Ethernet have displaced SDH as the predominant bandwidth protocol. With less room for unit cost decline on aging SDH platforms, Ethernet is pricing SDH out of the market at sub-wavelength circuit sizes. Some carriers have already begun to price SDH services prohibitively high to encourage customers to migrate off of SDH and onto Ethernet and wavelengths. Nevertheless, SDH links remain important in many emerging markets and for certain applications.

Outlook

The international network industry continues to face the twin challenges of demand growth and persistent price erosion. Expanding bandwidth requirements compel carriers to upgrade

existing infrastructure and invest in new networks. At the same time, capacity prices around the world continue falling. The following are some of the key factors shaping the future of the long-haul capacity market.

Prominence of Content Providers

The amount of capacity deployed by private network operators has outpaced that of Internet backbone operators the past few years. Content providers will play a leading role in future global network development. They will participate more as anchor investors and consortium members in submarine cable systems. Eventually, content providers may opt to build their own private cables.

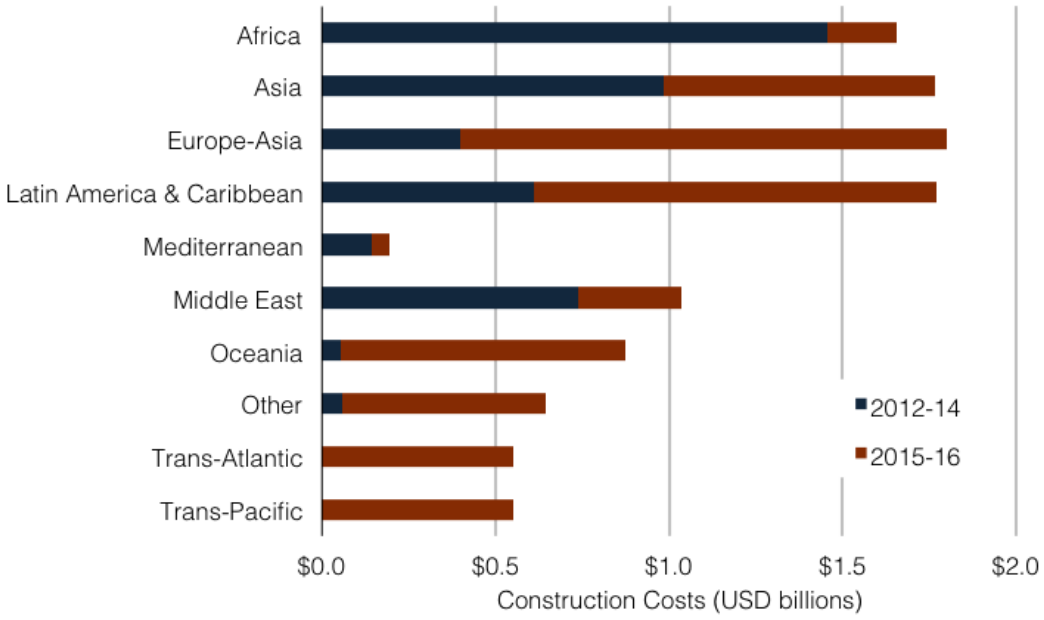
The largest content companies have clearly taken on the task of network operation as a core part of their business, and have achieved the scale to do so cost effectively. This development might imply little opportunity for stand-alone bandwidth purveyors if the largest consumers build their own networks. But while content companies operate their own networks, they have shown little appetite to engage in capacity sales. Traffic growth on content providers' internal networks has tended to devour available bandwidth, leaving little spare capacity for resale. Additionally, not all operators can achieve such large scale, leaving a substantial marketplace for more granular increments of capacity than multi-Tbps shares of entire transoceanic cable systems.

More New Cables on the Way

Even with large amounts of unlit capacity on many submarine cables, the construction of new systems continues. New cables are built to improve route diversity, to reach new or underserved markets, or purely for competitive reasons. Africa and Asia accounted for the bulk of new submarine cable investments over the past three years (see Figure: Construction Cost of New Submarine Cables Entering Service by Region, 2012-2016). The focus of new cable investment is shifting, with more than $1 billion worth of new cables expected in Latin America and also on the Europe-Asia route during the next few years.

FIGURE 7

Construction Cost of New Submarine Cables Entering Service by Region, 2012-2016



Notes: Construction costs based on the year that the cable entered service. Construction costs exclude the cost of subsequent capacity upgrades and annual O&M. 2012-2016 construction costs based on announced contract values and TeleGeography estimates. Not all planned cables may be constructed.

Source: TeleGeography

Content Localization

The push to move content closer to end-users serves as a countervailing trend against long-haul traffic growth. In recent years, operators have increased their use of CDNs and caching in order to curtail costly requirements for long-haul capacity and IP transit. CDNs and caching also improve user experience by lowering latency. As a result of these network strategies, some of the most widely-used Internet services, such as Netflix, generate very low amounts of long-haul traffic relative to the amount of content they deliver to end users nearer the edge of the network.

Location of Data Centers

Global telecom network expansion has undergone a long-term shift in focus, from connecting users to users, to linking users to data centers and—increasingly—data centers to each other. Data centers are often located near end-users in densely populated metropolitan areas. However, this is not always the case. Some data center sites are chosen to take advantage of favorable regulatory environments, affordable power, or other cost-saving measures. Deploying data centers in more isolated locations can lead to unusual patterns of network deployment. For example, Google, Microsoft, and Amazon operate data centers in Ireland

largely due to favorable taxation schemes. Consequently, bandwidth demand is growing between content centers along with links between content locations and end users.

Falling Costs, Falling Prices

Equipment cost has a significant effect on bandwidth pricing. Over time, the cost of wavelength cards and other equipment required to provide incremental capacity declines as bandwidth volumes increase. The lower unit cost of adding incremental capacity allows carriers to sell capacity at a lower price. The introduction of higher capacity transmission schemes will continue to reduce the cost per bit of bandwidth. In many cases, the new transmission technology expands the design capacity of existing systems, which compounds the cost basis decline and postpones the need to build new cables. Together, these forces will continue to result in increased supply and lower prices.

Optical transport capability is advancing with higher line rates, software-defined networking, and network function virtualization. These advances will lower capital and operational expenses for networks, and afford more options for on-demand provisioning and protection. Evolution in this direction will certainly impact the bandwidth market, leading to more dynamic, usage-based models.

The content on the preceding pages is a section from TeleGeography's Global Bandwidth Research Service

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