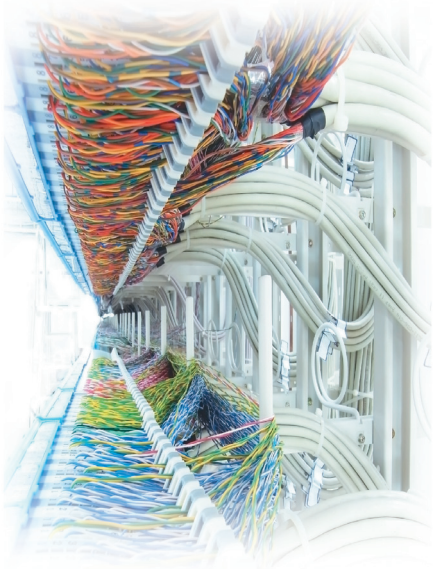
Network-Usage Changes Push Internet Traffic to the Edge



Neal Leavitt

Internet traffic patterns are changing significantly, with important ramifications for the network as a whole.

Internet traffic traditionally has flowed through network service providers' backbone networks to large networks. In many ways, the Internet infrastructure has been based on this pattern.

However, the prevailing traffic flow is rapidly changing, with important consequences for the Internet.

Increasingly, Internet traffic is growing faster at the network edge than at the core. The edges of the network are toward the areas where service providers communicate directly with one another or where they provide services to users.

A key cause of these changes is a revival of peering, in which networks directly connect to one another instead of paying upstream providers to carry and route their traffic.

Other contributing factors include the rise of huge Internet portals that carry large amounts of traffic; the growth of cloud computing, social networking, and wireless Internet access; and the increased use of so-called dark networks.

Additional issues include the growth of online video and the rapid proliferation of exchange points, connections through which ISPs communicate data directly with one another, said Craig Labovitz, chief scientist for Arbor Networks, a vendor of network security and monitoring systems.

And peer-to-peer (P2P) communications—which often use backbone or other long-range networks—are becoming a smaller portion of overall Internet traffic. Consequently, regional and metro-area traffic is growing at a faster rate than long-haul traffic.

These developments could increase network resilience. However, they could also necessitate greater network intelligence and give large traffic carriers undue influence over consumer services and network-related matters.

Some researchers say the traffic changes are altering the fundamental shape of the Internet, with serious consequences for its stability and security.

TRAFFIC CHANGES

There have been several dramatic changes to Internet traffic.

During the past year, noted Thomas Barnett, Cisco Systems' senior manager for provider marketing, increased broadband implementation and other developments have increased Internet traffic levels.

Much of this traffic has moved to the edges of the Internet.

Because of these factors, more bandwidth is necessary to provide connectivity to devices at the edge, added Simon Heron, principal for the UK office of Internet security firm Network Box.

Traffic volumes

Cisco reported that global IP traffic of all kinds grew 45.6 percent from 121 exabytes in 2008 to 176.2 exabytes in 2009, and that global Internet traffic grew 43.2 percent from 91.7 exabytes in 2008 to 131.3 exabytes in 2009.

By the end of 2009, Cisco said, video—excluding that shared via P2P—represented 33.2 percent of all consumer Internet traffic and will approach 40 percent by the end of this year. From 2009 to 2014, Barnett predicted, video traffic will increase sevenfold, as Figure 1 shows.

Much of this traffic increase is going to individual users on the edge of the network, utilizing devices such as mobile phones.

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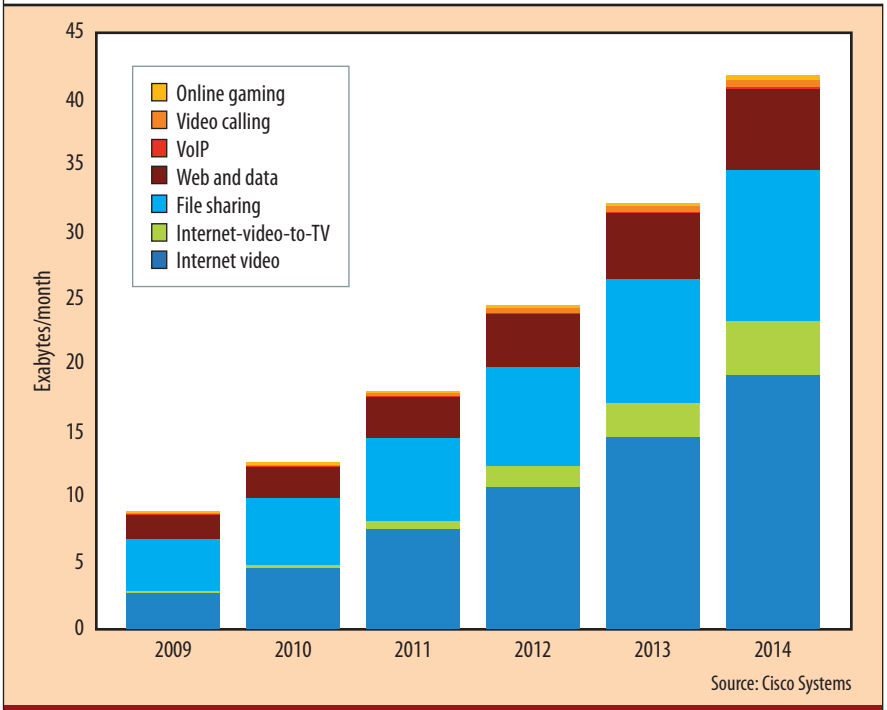

Figure 1. Cisco Systems predicts that Internet video traffic will increase through 2014. By then, it will represent a higher portion of Internet activity than peer-to-peer communications, which used to be the leading traffic type.

Therefore, explained Heron, service providers must make provisions for this.

Traffic patterns

Arbor Networks analyzed global Internet traffic data collected by 110 regional networks, content providers, cable operators, and international transit backbone networks between July 2007 and July 2009.

According to Arbor's Labovitz, the analysis showed that the top content and service providers were responsible for only 26 percent of all Internet traffic in July 2007, a figure that doubled to 52 percent by 2009.

Thus, much more of the traffic is passing directly from the providers to users along the edges on local and regional networks rather than on backbone networks.

Other changes

In addition to changes in traffic volumes and patterns, there have been other related new trends that affect the Internet.

Huge Internet portals

The increasing proliferation of huge portals, called *hypergiants*, has dramatically changed Internet traffic patterns, noted Labovitz.

Thirty large companies—such as Facebook, Google, Microsoft, and YouTube (now part of Google)—currently generate 30 percent of all Internet traffic.

During the past two years, Facebook has used 5 percent of the Internet's bandwidth; Google, 2.5 percent; Microsoft's Windows Update, 3.2 percent; Yahoo's image server, 2.9 percent; and YouTube, 10.2 percent, according to Network Box's Heron.

In the past, users accessed many different websites from servers physically dispersed around the world. Now, many of these sites are hosted on local servers belonging to a few cloud providers. Thus, most users connect with only a handful of providers on a daily basis.

This makes the Internet operate more efficiently, said Heron.

"However, this has also led to a few major players dominating content provision," he added. "How the failure of one of these hypergiants would affect the flow of traffic is unclear. Also, the Internet originally was supposed to be open and resilient with a multitude of independent distributed hubs and relays. But this appears to be at risk while the hypergiants play such a major role. It's also possible for them to dictate what [traffic] flows through them and what priority it's given."

The rise of peering

Peering harkens back to the dawn of the Internet when large organizations would directly connect networks to one another and the Internet instead of paying a provider to route traffic. This practice saved money and improved performance. In addition, Network Box's Heron said, there weren't as many ISPs available as there are now.

Now, huge peering fabrics are emerging worldwide because there are so many networks and so much content and because the large content providers are communicating directly with one another, said Melanie A. Posey, research director for hosting and telecommunications services for market research firm IDC.

Users in the Asia-Pacific region want to avoid having to handle their growing amount of local traffic via big ISPs that route the communications through hubs in the US or Europe, she added. They are thus particularly interested in developing local peering hubs, which would provide more speed and less latency.

Increased peering, with its emphasis on direct, local connections has caused more traffic to travel along the Internet's edge.

Providing many new paths along the Internet's edge for transmissions to travel could add network resilience in case of congestion or other problems, Posey noted.

However, having to route traffic less directly over long distances

would make packet loss more likely, said William Norton, peering expert and founder and executive director of the DrPeering International website.

P2P decline

In recent years, while P2P traffic has increased, the percentage of overall Internet traffic it represents has dropped, according to Cisco's Barnett.

"P2P will drop to 17 percent of consumer Internet traffic by 2014, down from 39 percent in 2009," he said.

"The decline changes traffic patterns significantly," he explained. "In P2P data transfers, traffic flows [directly] from users to other users; in other words, from one part of the edge to another.

Many P2P programs choose which other users to download content or data from by available bandwidth rather than geographical proximity.

Because P2P thus often accesses content from long distances, it increases traffic levels on backbone networks, noted Barnett.

Instead of using P2P, a greater number of users are now accessing content, particularly video, from large, centralized providers such as YouTube, noted Carnegie Mellon University assistant professor David Andersen.

"The shift means that the traffic sources are becoming more concentrated [locally], and these services often use optimization techniques to ensure that users download from a source near them," he said.

Wireless Internet

Mobile voice and data traffic has been doubling annually for the last five years, faster than any other type of Internet activity, according to Cisco. The company says mobile traffic currently represents 1.2 percent of all Internet activity, a portion it predicts will grow to 7.4 percent by the end of 2014.

"Advanced smart phones, tablet computers, and especially laptops with mobile broadband access are driving the traffic migration from fixed to mobile," said Cisco's Barnett.

"Individuals are now continuously connected and carrying devices that are increasing the traffic flow," explained Network Box's Heron.

That flow meets the Internet at the network edge, which is thus experiencing increased traffic levels, he said.

Dark networks

Some traffic passes through public peering points such as those that ISPs use, and some runs through *dark networks,* private systems created to move traffic more efficiently and cost-effectively than core networks.

Internet traffic is growing faster at the network edge than at the core.

Hypergiants like Google usually operate these networks to ensure their transmissions reach their destinations as quickly as possible, without having to traverse potentially congested large ISP networks.

The rise of giant distributed data centers built by companies such as Amazon, Google, IBM, and Microsoft, often as part of cloud computing services, has increased the dark Internet's size.

Because measuring dark-network traffic is difficult, noted Arbor's Labovitz, "the significant shift in Internet interdomain traffic patterns has gone largely undocumented in commercial and research literature."

Heron contends that as traffic has moved to the Internet's edge, the network has become stronger and more resistant to random failure and attack.

Increased peering at the edge provides greater connectivity options so that if one link fails, carriers could route data through another, he added. This, he explained, provides more resistance to random failure and attack.

Overall, as more devices of different types access the Internet and other global networks, the networks will need greater intelligence to handle, provide security for, and prioritize traffic. This challenge could be exacerbated in the future by an increase in machine-to-machine traffic, added Barnett.

Referring to the Internet's changing traffic patterns, Labovitz said, "I think the interesting trade-off is consolidation versus innovation. As the Internet consolidates, is there still room for innovation in underlying technology or will the Internet be controlled by a small handful of large content sites?"

Moreover, said Ed Moyle, an analyst with market research firm Security Curve, "As traffic becomes more centralized in a few large entities, I'm concerned about whether that will give them [more] control. Could that be used to selectively stifle competition? We don't know."

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