

Hyperconnectivity and the Approaching Zettabyte Era



This white paper is part of the Cisco® Visual Networking Index, an ongoing initiative to track and forecast the impact of visual networking applications. This paper presents some of the key findings of Cisco's global IP traffic forecast and explores the implications of IP traffic growth for service providers. For a more detailed look at the forecast and the methodology behind it, please see the paper "Cisco Visual Networking Index—Forecast and Methodology 2008–2013."

June 9, 2009

Executive Summary

Annual global IP traffic will exceed two-thirds of a zettabyte (667 exabytes) in four years. Last year's forecast anticipated a run rate of 522 exabytes per year in 2012. The economic downturn has only slightly tempered traffic growth, and this year's forecast predicts 510 exabytes per year in 2012, growing to 667 exabytes per year or 56 exabytes per month in 2013.

Global IP traffic will quintuple from 2008 to 2013. Overall, IP traffic will grow at a compound annual growth rate (CAGR) of 40 percent. One of the primary forces underlying this growth is visual networking: the usage of video increases as video becomes social, and the traffic associated with social networking multiplies as online social activity becomes visual.

Hyperconnectivity has emerged as an important dynamic that has the potential to greatly increase traffic. In the past year, it has become clear that visual networking applications are often used concurrently with other applications and sometimes even other visual networking applications, as the visual network becomes a persistent backdrop that remains "on" while the user multitasks or is engaged elsewhere. This trend accompanies what is sometimes called the widgetization of Internet and TV, as network traffic expands beyond the borders of the browser window and the confines of the PC.

There are four key enablers of hyperconnectivity, and all four are poised for strong growth. Multitasking and passive networking, the two key pillars of hyperconnectivity, are enabled by: (a) the growing penetration of high-speed broadband, (b) the expansion of digital screen surface area and resolution, (c) the proliferation of network-enabled devices, and (d) the increases in the power and speed of computing devices.

Global Internet Highlights

In 2013, the Internet will be nearly four times larger than it is in 2009. By year-end 2013, the equivalent of 10 billion DVDs will cross the Internet each month.

Peer-to-peer (P2P) is growing in volume, but declining as a percentage of overall IP traffic. P2P file sharing networks are now carrying 3.3 exabytes per month and will continue to grow at a moderate pace with a CAGR of 16 percent from 2008 to 2013. Other means of file sharing such as one-click file hosting will grow rapidly at a CAGR of 58 percent and will reach 3.2 exabytes per month in 2013. Despite this growth, P2P as a percentage of consumer Internet traffic will drop to 20 percent of consumer Internet traffic by 2013, down from 50 percent at the end of 2008. The decline in traffic-share is due primarily to the increasing share of video traffic.

Global Video Highlights

Internet video is now approximately one-third of all consumer Internet traffic, not including the amount of video exchanged through P2P file sharing. In 2010, Internet video will surpass P2P in volume. This will be the first time since 2000 that any application has displaced P2P as the top traffic driver.

The sum of all forms of video (TV, video on demand, Internet, and P2P) will account for over 91 percent of global consumer traffic by 2013. Internet video alone will account for over 60 percent of all consumer Internet traffic in 2013.

In 2013, Internet video will be nearly 700 times the U.S. Internet backbone in 2000. It would take well over half a million years to watch all the online video that will cross the network each month in 2013. Internet video will generate over 18 exabytes per month in 2013.

Video communications traffic growth is accelerating. Though still a small fraction of overall Internet traffic, video over instant messaging and video calling are experiencing high growth. Video communications traffic will increase ten-fold from 2008 to 2013.

Real-time video is growing in importance. Internet TV, video communications, and ambient video are all high-growth application categories. By 2013, Internet TV will be over 4 percent of consumer Internet traffic, and ambient video will be 8 percent of consumer Internet traffic. Live TV has gained substantial ground in the past few years: globally, P2P TV is now slightly over 7 percent of overall P2P traffic at over 200 petabytes per month.

Video-on-demand (VoD) traffic will double every two years through 2013. The twin trends of on-demand viewing and high-definition video are generating very rapid growth in cable video and IPTV traffic transported over IP in the metro. Consumer IPTV and CATV traffic will grow at a 53 percent CAGR between 2008 and 2013, compared to a CAGR of 40 percent for consumer Internet traffic.

Global Mobile Highlights

Globally, mobile data traffic will double every year through 2013, increasing 66x between 2008 and 2013. Mobile data traffic will grow at a CAGR of 131 percent between 2008 and 2013, reaching over two exabytes per month by 2013.

Almost 64 percent of the world's mobile data traffic will be video by 2013. Mobile video will grow at a CAGR of 150 percent between 2008 and 2013. Mobile video is the fastest growing application category measured within the Cisco VNI Forecast at this time.

Mobile broadband handsets with higher than 3G speeds and laptop aircards will drive over 80 percent of global mobile traffic by 2013. A single high-end phone (such as an iPhone or Blackberry) generates more data traffic than 30 basic-feature cell phones. A laptop aircard generates more data traffic than 450 basic-feature cell phones.

Regional Highlights

IP traffic is growing fastest in the Middle East and Africa, followed closely by Latin America. Traffic in Middle East and Africa will grow at a CAGR of 51 percent.

IP traffic in North America will reach 13 exabytes per month by 2013 at a CAGR of 39 percent. Monthly Internet traffic in North America will generate 2.4 billion DVDs worth of traffic, or 10 exabytes per month.

IP traffic in Western Europe will reach 12.5 exabytes per month by 2013 at a CAGR of 37 percent. Monthly Internet traffic in Western Europe will generate 2.2 billion DVDs worth of traffic, or 9 exabytes per month.

IP traffic in Asia Pacific will reach 21 exabytes per month by 2013 at a CAGR of 42 percent. Monthly Internet traffic in Asia Pacific will generate 4.1 billion DVDs worth of traffic, or 16.5 exabytes per month.

IP traffic in Japan will reach 3 exabytes per month by 2013 at a CAGR of 37 percent. Monthly Internet traffic in Japan will generate half a billion DVDs worth of traffic, or 2 exabytes per month.

IP traffic in Latin America will reach 2 exabytes per month by 2013 at a rate of 50 percent. Monthly Internet traffic in Latin America will generate 410 million DVDs worth of traffic, or 1.7 exabytes per month.

IP traffic in Central and Eastern Europe will reach 2 exabytes per month by 2013 at a rate of 49 percent. Monthly Internet traffic in Central and Eastern Europe will generate 340 million DVDs worth of traffic, or 1.4 exabytes per month.

IP traffic in the Middle East and Africa will reach 1 exabyte per month by 2013 at a rate of 51 percent. Monthly Internet traffic in the Middle East and Africa generate 140 million DVDs worth of traffic, or 550 petabytes per month.

Note: *An interactive Cisco VNI Forecast widget is available to enable users to create custom forecast charts by region, by country, by application, and by end-user segment. The Cisco VNI Forecast widget can be accessed from <http://vniwidget.ciscopulse.com/default.htm>.*

Global Business Highlights

Business IP traffic will grow at a CAGR of 33 percent from 2008 to 2013. Increased adoption of advanced video communications in the enterprise segment will cause business IP traffic to grow by a factor of 4 between 2008 and 2013.

Business IP WAN traffic will grow at a faster pace than business Internet. Today, total business Internet traffic is more than twice the volume of IP WAN. By 2013, however, video will have made its way onto the WAN, and inter-company WANs will have matured, so that IP WAN will grow at a CAGR of 36 percent, compared to a CAGR of 32 percent for business Internet.

Business IP traffic will grow fastest in Latin America. Business IP traffic in Latin America will grow at a CAGR of 43 percent, a substantially faster pace than the global average of 33 percent. North America, Western Europe, and Japan will have slower growth rates. In volume, Asia Pacific will have the largest amount of business IP traffic in 2013 at 4.8 exabytes per month. North America will be a distant second to Asia Pacific at 3.5 exabytes per month.

The Continuing Impact of Visual Networking on IP Traffic Growth

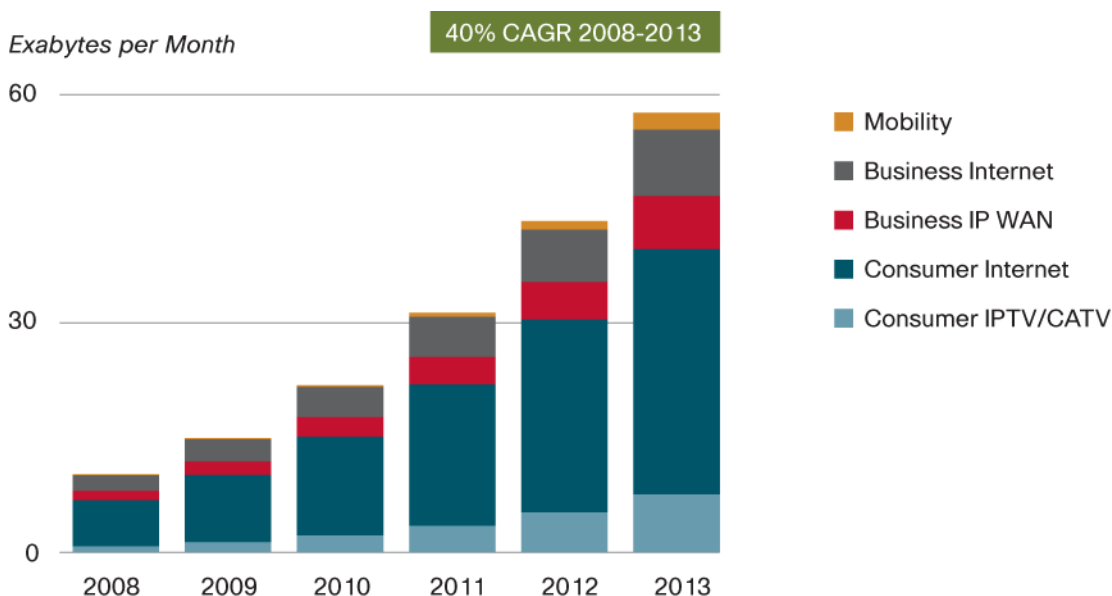
There is an increasing amount of evidence that the combination of video and social networking is more powerful than either alone:

- In China, music consumed within the QQ social networking site is more than twice the traffic from music downloads on QQ.*
- Global adoption of video communications has increased considerably since last year and traffic associated with these applications is now over 25 petabytes per month, greater than the entire US Internet backbone in 2000. Skype has stated that 28 percent of Skype-to-Skype calls are now video calls. Due to video, global Skype traffic has increased 62 percent over what it was last year.*
- Webcam streaming has regained popularity now that broadband speeds enable higher-quality broadcasting. As we reported in our December 2008 video update, a popular webcam such as ustream.tv's Shiba Inu puppypcam can generate as much traffic as a site like ESPN.com in a month.*
- Visual networking is not only video: Google Earth (virtual globe program) generates approximately 3 petabytes of traffic per month.*

* comScore Tech Metrix 2009

Largely due to visual networking in all its various forms, Cisco expects global IP traffic to quintuple from 2008 to 2013. As Figure 1 shows, overall IP traffic is expected to grow to 56 exabytes per month by 2013, and 40 of those are due to consumer traffic. Consumer traffic, in turn, is driven by IP transport of VoD over the metro (8 exabytes per month in 2013), Internet video streams and downloads (almost 18 exabytes per month in 2013), and the exchange of video and other files through P2P.

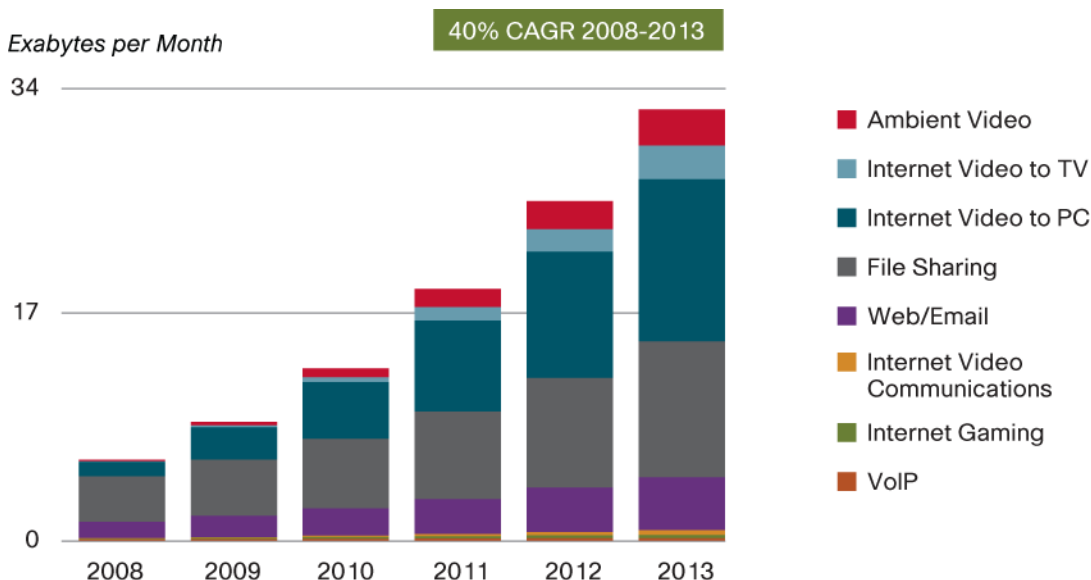
Figure 1. Cisco Forecasts 56 Exabytes per Month of IP Traffic in 2013



For more details, see the paper entitled "Cisco Visual Networking Index—Forecast and Methodology 2008–2013."
Source: Cisco VNI, 2009

Figure 2 shows the components of consumer Internet traffic growth. Of the 32 exabytes per month of consumer Internet traffic that will be generated every month in 2013, over 60 percent will be due to Internet video.

Figure 2. Cisco's Global Consumer Internet Traffic Forecast



Source: Cisco VNI, 2009

Hyperconnectivity Takes New Forms

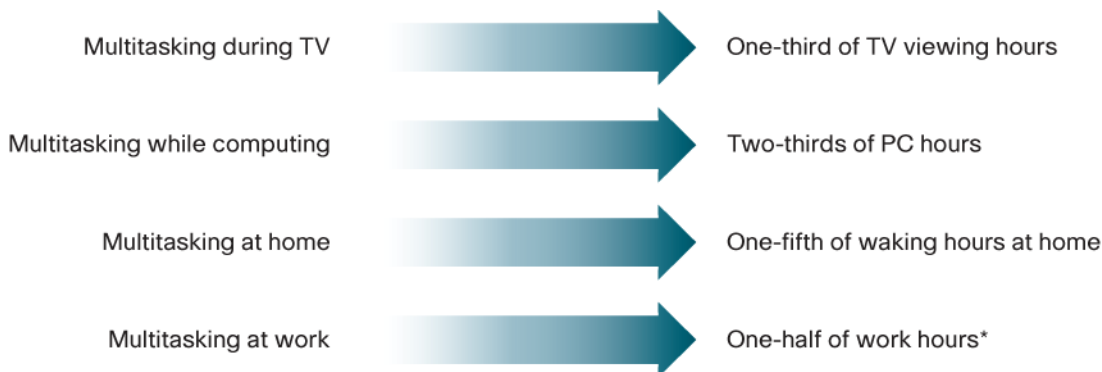
Hyperconnectivity refers to the persistence of many simultaneous connections over time: connections from people to people, from people to machines, and from machines to machines. Devices and applications with embedded network connectivity combine to form an immersive or ambient connected environment.

The two pillars of hyperconnectivity are active multitasking and passive networking.

Active Multitasking Finds Its Way to the Network

Multitasking has long been recognized as facet of human behavior in business, social, and private environments. Academic research indicates that one-fifth of all waking hours are spent multitasking and for information workers, one-half of work hours are multitasked.

Figure 3. Multitasking Adds 6 “Network Hours” to Every Day



Source: Cisco analysis of MTUS survey data, OECD, comScore, UC Irvine.

* Figures for information workers only

Little by little, each of the multitasked activities finds its way onto the network. There are many example of multitasking where both the primary and secondary tasks are online:

- Listening to online music while working online
- Instant messaging or microblogging while participating in a virtual meeting
- Watching VoD while paying bills online
- Monitoring RSS feeds while watching online videos
- Web browsing and instant messaging while talking on the phone
- Listening to the audio of a video presentation, sports, or current events running in the background while working on a main task

In the last example, the number of video minutes crossing the network can greatly exceed the number of video minutes the consumer watches. The video tags along with the audio, commanding attention periodically, but largely staying in the background. This type of multitasking could potentially have a large impact on Internet traffic: If every audio minute were a video minute, a consumer's video consumption would rise by 60 percent. In other words, a consumer who watches 4 hours of video per day might generate 6 hours of video traffic per day.

A similar example is a consumer who views video in the background from a "nannycam" or "petcam," known as "ambient video," while word processing.

Passive Networking Creates Constant Online Awareness

"Passive networking" means that connectivity pervades the background as well as the foreground. Examples of passive networking are:

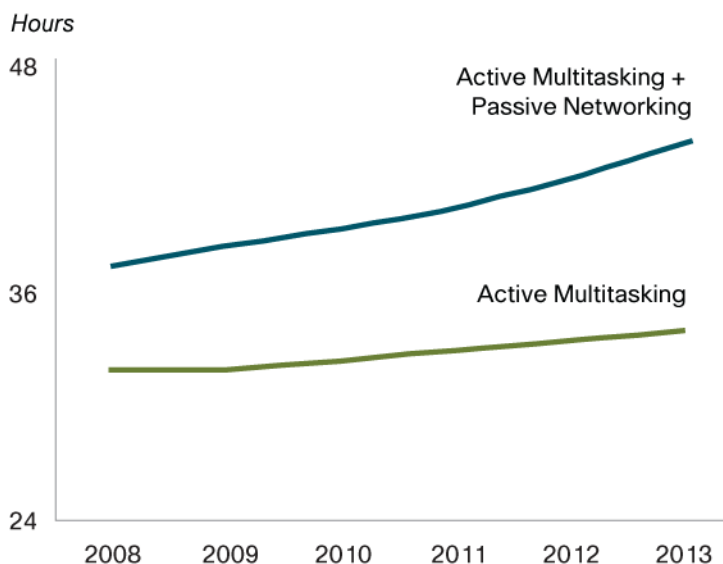
- Online backup
- Software updates
- Internet PVR
- Ambient video (nannycam, petcam, securitycam, etc.)

With multicore computing, online backups and software updates can occur in the background without adversely affecting the performance of the active applications. Users may set up media recorders to capture content for more than the number of hours that they actually watch. Software updates already routinely make appearances in charts of top traffic generators on service provider networks.

It is passive networking more than multitasking that allows the growth of traffic to outpace any change in behavior. For every hour of an Internet user's day, there are over 2 hours of P2P traffic, and over 1.5 hours of HTTP traffic. The latter is due to multitasking, while the former is due to passive networking. P2P was the first ambient application.

Overall, Cisco estimates that passive networking creates 75 minutes of traffic for every hour of network use, adding another six hours per day on top of the 6 hours that result from multitasking. There are currently 36 hours in a network day. By 2013, there will be almost two days in a network day.

Figure 4. Active Multitasking and Passive Networking Create 36 “Network Hours” Each Day

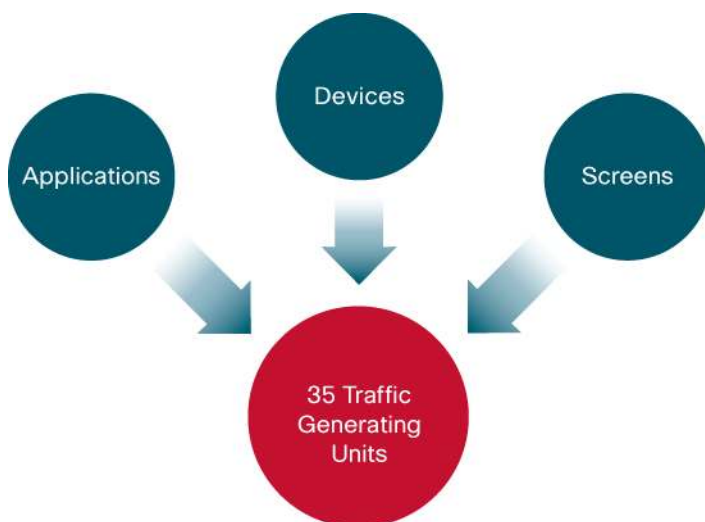


Source: Cisco VNI, 2009

Traffic-Generating Units: A New Metric for the Hyperconnected Age

The expansion of the network day is a natural consequence of the multiplication of “traffic-generating units.” A traffic-generating unit (TGU) is any device or application that generates network traffic. Suppose a household has two PCs, two TVs, two DVR’s, a gaming console, an Internet media device such as the Roku or Apple TV, a portable gaming device, an mp3 player, a smartphone, and an e-book reader. Each PC has 11 traffic-generating applications in regular use, and the smartphone has three traffic-generating applications in regular use. This household has 35 TGUs.

Figure 5. Traffic-Generating Units on the Rise



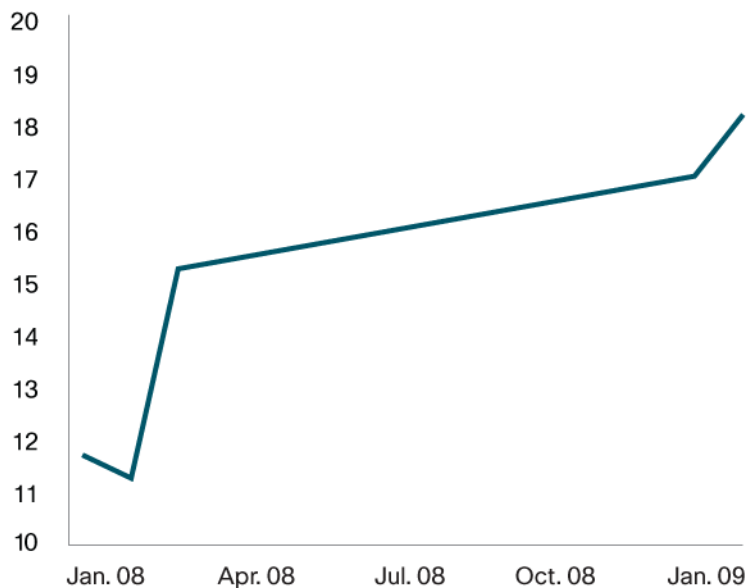
Source: Cisco, 2009

Internet traffic is not restricted to browser traffic. The number of applications generating (any amount of) traffic per PC has increased from 11 to 18 over the last year. The number of traffic-heavy applications is also on the rise: The number of applications such as software updates, media players and media downloaders, video calling applications etc are generating over 500 MB per month per PC increased 30 percent from 2008 to 2009.

Network traffic is not limited to the PC: Internet-enabled set-top boxes will generate nearly 10 percent of consumer Internet traffic by 2013.

Figure 6. Traffic-Generating Applications Have Increased 60 Percent over the Past Year

Traffic Generating Apps per PC



Source: Cisco VNI, 2009

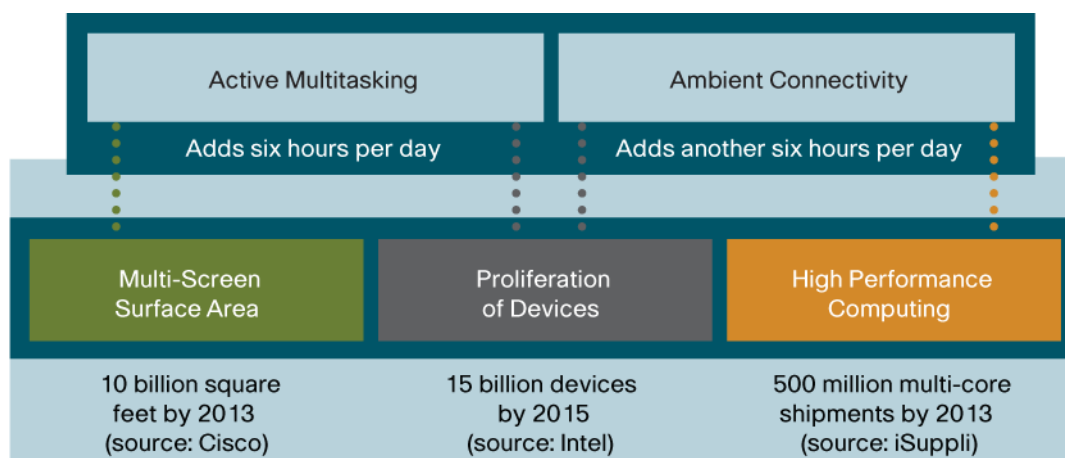
Enhanced Experience, Access and Processing Power: Enablers of Hyperconnectivity

There are three primary enablers of multitasking and passive networking:

- **Enhanced Experience:** The increasing number, size, and resolution of digital screens
- **Access:** The proliferation of IP-enabled devices
- **Processing Power:** The advancement of computer processing speeds

A fourth enabler underlying these three enablers is the digitization of content, which is driving an increase in the number of applications that each user and device runs. For example, e-book readers such as the Amazon Kindle have turned a previously offline activity into an online application.

Figure 7. Broader Screen Surfaces, More Devices, and Faster Processors Enable Hyperconnectivity



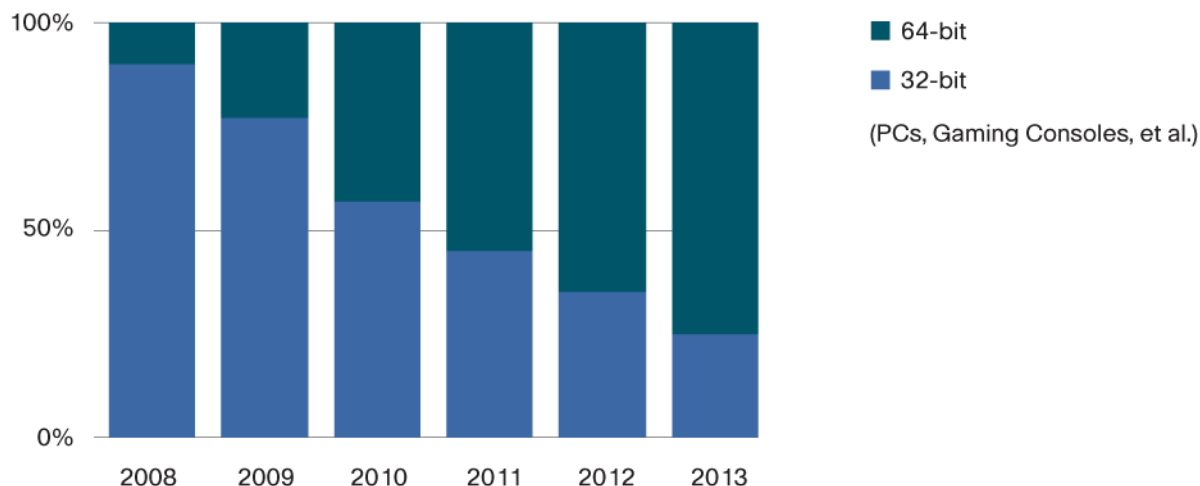
Source: Cisco VNI, 2009

High-Performance Computing

A multicore system with a 64-bit operating system can make use of 4 billion times the RAM, compared to a 32-bit system. Quad-core systems such as the Intel Core i7 are now shipping. Once software is developed to take full advantage of the new processing capabilities, each core has the potential to generate as much traffic as a single PC.

Figure 8. 64-Bit Devices Will Comprise Approximately 75 Percent of Internet Traffic by 2013

PB per Month



Source: Cisco VNI, 2009

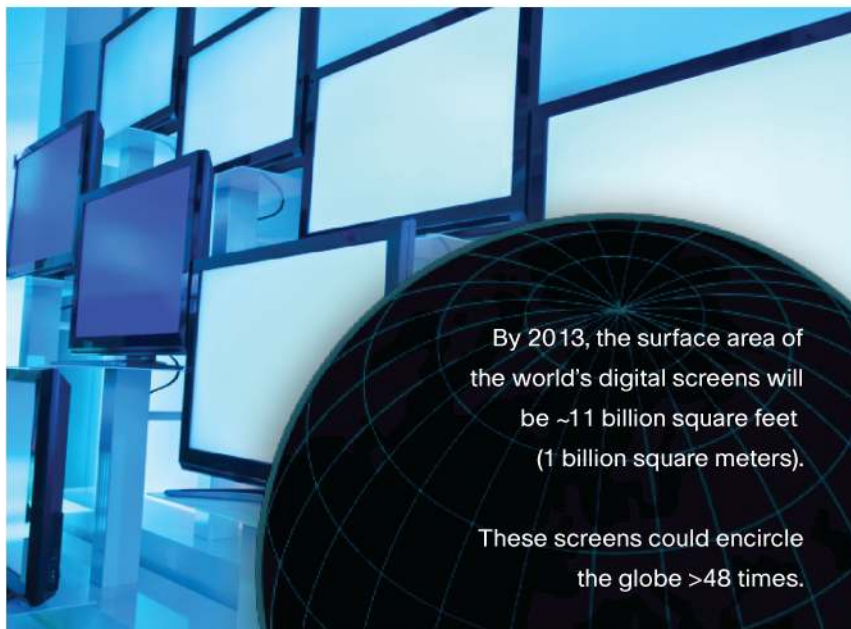
Screen Size and Resolution

With the cost of large LCD screens continuing to decline, consumers and businesses alike can afford to expand the number and size of their digital screens. The increased global adoption of flat-panel screens also allows residential consumers and business users to expand their screen surface area without sacrificing any floor space.

In addition to acquiring more and larger TV and PC screens, digital screens are proliferating along with other consumer devices: e-book readers, handheld gaming consoles, large-screen mobile handsets, in-vehicle GPS display screens, digital picture frames, picoprojectors, TelePresence screens, IP phone screens, and digital

advertising and sales displays. The total surface area of all digital screens across the globe increased 43 percent from 2003 to 2008 and will increase another 64 percent by 2013.

Figure 9. Global Digital Screen Surface Area Will Nearly Double Between 2008 and 2013



Source: Cisco VNI, 2009

Here's a hypothetical example: If a digital-ready home in North America or Western Europe with two TVs and two PCs adds two additional large screens, an e-book reader, and a Wi-Fi digital photo frame, that household will have almost 16 square feet of screen space by 2013.

Figure 10. A Digital Home Could Have as Much as 16 Square Feet of Screen Space by 2013



Source: Cisco VNI, 2009

Screens with high resolution appear to be enabling new behavior:

- Video chat's overall share of total traffic doubles for higher screen resolutions.
- Users with 1920 x 1200 screens increased their Google earth traffic from 58 MB per PC to 112 MB per PC, an increase of 93 percent over the course of a single month (March 2009).*
- Metacafe video traffic on screens with 1680 x 1050 increased from 81 MB per PC to 284 MB per PC in March 2009, an increase of over 250 percent.*
- Skype traffic on 1920 x 1200 screens increased 202 percent from February to March 2009.*
- P2P traffic grew 210 percent for users with 1920 x 1200 resolution screens from February to March 2009. This stands in contrast to the category as a whole, since total P2P growth was flat over the same time period. The difference most likely stems from the users with higher-resolution screens downloading more high-definition video files using P2P.*

* Source: comScore Tech Metrix 2009

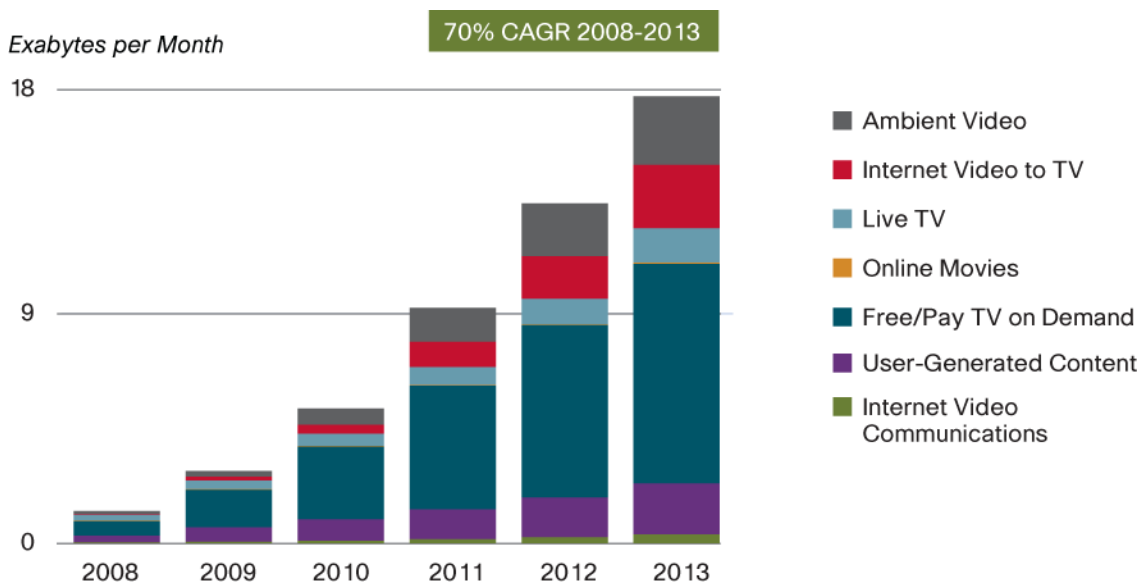
Global IP Traffic Growth: Residential

Looking at the proliferation of personal web pages on the Net, it looks like very soon everyone on Earth will have 15 megabytes of fame. –M.G. Sriram, PhD

M.G. Sriram's milestone prediction has long since passed. Each of us now has much more than 15 megabytes of fame: there is a gigabyte of traffic that crosses the Internet every month *per capita*. One-third of that gigabyte is comprised of video content, and by 2013, over 60 percent of consumer Internet will be video.

While the overall application mix is shifting toward video, video is undergoing internal shifts of its own. In particular, real-time video is growing in importance. Real-time video includes Internet TV, video communications, and ambient video. Live content is gaining ground fast: globally, P2P TV is now 10 percent of overall P2P traffic at over 180 petabytes per month.

Figure 11. Internet TV and Ambient Video Are Key Drivers of Internet Video Growth



Source: Cisco VNI, 2009

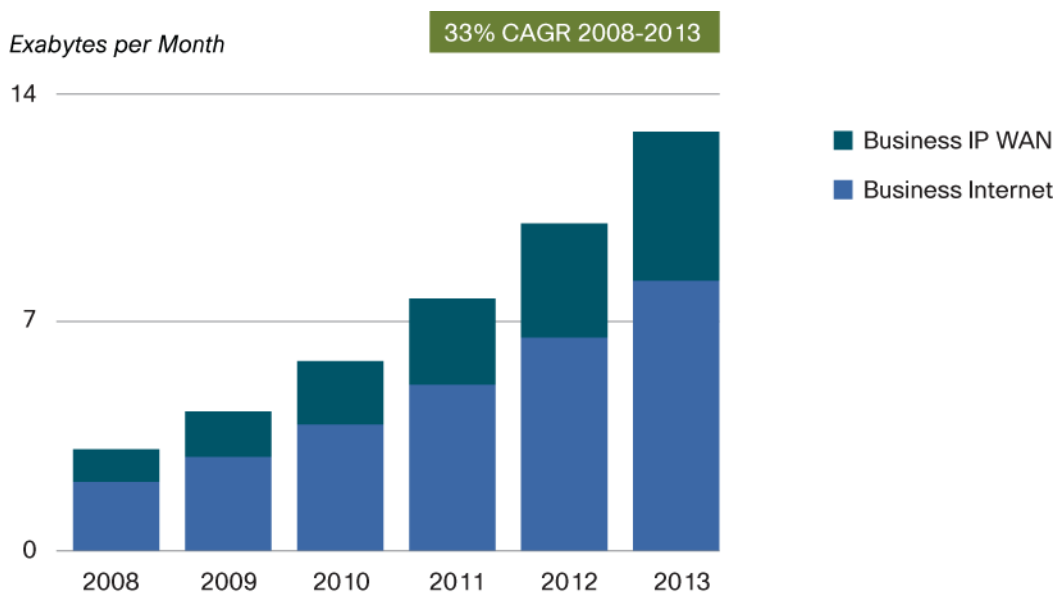
Global IP Traffic Growth: Business

The inbox culture is dead. To solve problems and make decisions efficiently, we must often come together in real time rather than wait for the email, the file, or for somebody else's input. –Evan Rosen, Author of “The Culture of Collaboration”

A connected world places an enormous premium on people who are fluent in communications. –Geoffrey Moore, Author of Blog “Dateline Davos: The shifting power equation”

Total business Internet traffic is more than twice the volume of IP WAN. By 2013, however, video will have made its way onto the WAN, and IP WAN traffic will nearly match business Internet traffic in volume.

Figure 12. Global Business IP Traffic Will Grow at a CAGR of 33 Percent

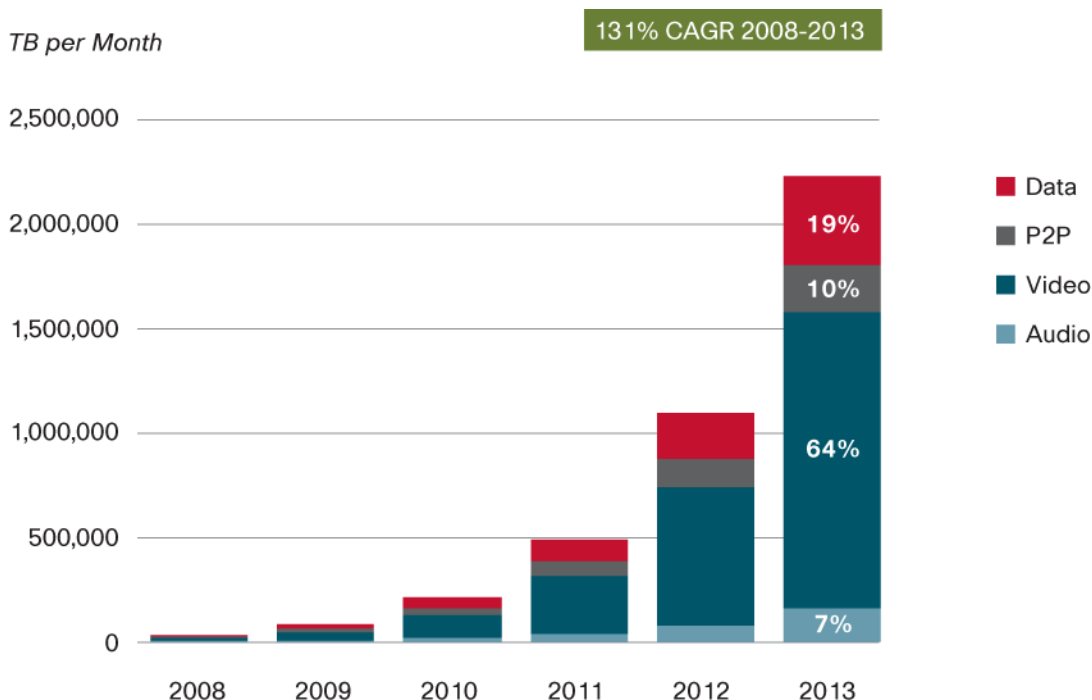


Source: Cisco VNI, 2009

Global IP Traffic Growth: Mobile

Video will be responsible for the majority of the traffic growth between 2008 and 2013. As Figure 13 shows, overall mobile data traffic is expected to grow to 2 exabytes per month by 2013, and over 1.4 of those are due to mobile video traffic.

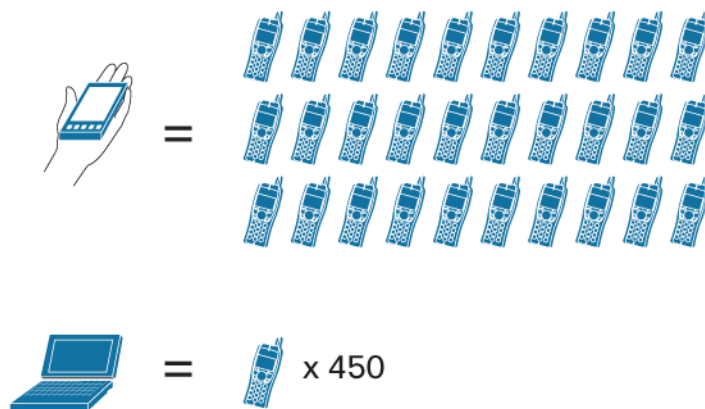
Figure 13. Global Mobile IP Traffic Will Grow at a CAGR of 131 Percent



Source: Cisco VNI, 2009

The advent of laptops and high-end handsets onto mobile networks is a key driver of traffic, since these devices offer the consumer content and applications not supported by the previous generation of mobile devices. Chief among these new sources of traffic is video, but other applications such as P2P are already making an impact. Despite the relatively small number of laptops with mobile broadband aircards today, P2P traffic from those devices already accounts for 20 percent of all mobile data traffic globally. As shown in Figure 14, a single laptop can generate as much traffic as 450 basic feature phones, and a high end handset such as an iPhone or Blackberry device creates as much traffic as 30 basic feature phones.

Figure 14. High-End Devices and Laptops Can Multiply Mobile Data Traffic



Source: Cisco VNI, 2009

For More Information

For more information on Cisco's IP traffic forecast, please see the paper "Cisco Visual Networking Index—Forecast and Methodology 2008–2013 and visit the other resources and updates at www.cisco.com/go/vni. Inquiries can be directed to traffic-inquiries@cisco.com.

Appendix A: Cisco's Global IP Traffic Forecast

Table 1 shows the summary of Cisco's global IP traffic forecast. For more information, please see the paper "Cisco Visual Networking Index—Forecast and Methodology 2008–2013."

Table 1. Global IP Traffic, 2008–2013

IP Traffic, 2008–2013							
	2008	2009	2010	2011	2012	2013	CAGR 2008–2013
By Type (PB per month)							
Internet	8,140	11,716	16,701	23,843	31,839	40,428	38%
Non-Internet IP	2,001	3,031	4,569	6,647	9,394	12,975	45%
Mobile Data	33	85	207	482	1,076	2,184	131%
By Segment (PB per month)							
Consumer	7,023	10,399	15,354	22,606	31,067	40,543	42%
Business	3,103	4,258	5,805	7,722	10,022	12,833	32%
Mobile	33	85	207	482	1,076	2,184	131%
By Geography (PB per month)							
North America	2,578	3,666	5,309	7,797	10,498	13,431	39%
Western Europe	2,593	3,623	4,995	7,126	9,707	12,593	37%
Asia Pacific	3,661	5,503	8,089	11,503	15,877	21,177	42%
Japan	644	950	1,355	1,919	2,490	3,107	37%
Latin America	308	503	800	1,196	1,690	2,360	50%
Central Eastern Europe	280	421	665	1,021	1,441	2,042	49%
Middle East and Africa	110	165	264	408	606	877	51%
Total (PB per month)							
Total IP traffic	10,160	14,743	21,367	30,811	42,165	55,560	40%

Source: Cisco VNI, 2009

Definitions

Consumer: includes fixed IP traffic generated by households, university populations, and Internet cafés

Business: includes fixed IP WAN or Internet traffic, excluding backup traffic, generated by businesses and governments

Mobility: includes mobile data and Internet traffic generated by handsets, notebook cards, WiMAX

Internet: denotes all IP traffic that crosses an Internet backbone

Non-Internet IP: includes corporate IP WAN traffic, IP transport of TV/VoD, and mobile "walled garden" traffic



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