White Paper

The Zettabyte Era: Trends and Analysis

May 2015

This document is part of the Cisco® Visual Networking Index (VNI), an ongoing initiative to track and forecast the impact of visual networking applications. The document presents some of the main 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, visit Cisco VNI: Forecast and Methodology, 2014–2019.

Executive Summary

Annual global IP traffic will pass the zettabyte (1000 exabytes) threshold by the end of 2016, and will reach 2 zettabytes per year by 2019. By 2016, global IP traffic will reach 1.1 zettabytes per year, or 88.4 exabytes (nearly one billion gigabytes) per month, and by 2019, global IP traffic will reach 2.0 zettabytes per year, or 168 exabytes per month.

Global IP traffic has increased fivefold over the past five years, and will increase threefold over the next five years. Overall, IP traffic will grow at a compound annual growth rate (CAGR) of 23 percent from 2014 to 2019.

Busy-hour Internet traffic is growing more rapidly than average Internet traffic. Busy-hour (or the busiest 60-minute period in a day) Internet traffic increased 37 percent in 2014, compared with 29 percent growth in average traffic. Busy-hour Internet traffic will increase by a factor of 3.9 between 2014 and 2019, and average Internet traffic will increase by a factor of 3.2. Busy-hour Internet traffic will reach 1.4 petabits per second (Pbps) in 2019, and average Internet traffic will reach 414 terabits per second (Tbps).

Metro traffic surpassed long-haul traffic in 2014, and will account for 66 percent of total IP traffic by 2019. Metro traffic will grow more than twice as fast as long-haul traffic from 2014 to 2019. The higher growth in metro networks is due in part to the increasingly significant role of content delivery networks (CDNs), which bypass long-haul links and deliver traffic to metro and regional backbones.

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

Content delivery networks (CDNs) will carry nearly two-thirds of Internet traffic by 2019. Sixty-two percent of all Internet traffic will cross CDNs by 2019 globally, up from 39 percent in 2014.

Two-thirds of all IP traffic will originate with non-PC devices by 2019. In 2014, only 40 percent of total IP traffic originated with non-PC devices, but by 2019 the non-PC share of total IP traffic will grow to 67 percent. PC-originated traffic will grow at a CAGR of 9 percent, and TVs, tablets, smartphones, and machine-to-machine (M2M) modules will have traffic growth rates of 17 percent, 65 percent, 62 percent, and 71 percent respectively.

Traffic from wireless and mobile devices will exceed traffic from wired devices by 2016. By 2016, wired devices will account for 47 percent of IP traffic, and Wi-Fi and mobile devices will account for 53 percent of IP traffic. In 2014, wired devices accounted for the majority of IP traffic, at 54 percent.

Global Internet traffic in 2019 will be equivalent to 66 times the volume of the entire global Internet in 2005. Globally, Internet traffic will reach 37 gigabytes (GB) per capita by 2019, up from 15.5 GB per capita in 2014.

The number of devices connected to IP networks will be more than three times the global population by 2019. There will be more than three networked devices per capita by 2019, up from nearly two networked devices per capita in 2014. Accelerated in part by the increase in devices and the capabilities of those devices, IP traffic per capita will reach 22 GB per capita by 2019, up from 8 GB per capita in 2014.

Broadband speeds will more than double by 2019. By 2019, global fixed broadband speeds will reach 42.5 Mbps, up from 20.3 Mbps in 2014.

Global Internet Video Highlights

It would take an individual more than 5 million years to watch the amount of video that will cross global IP networks each month in 2019. Every second, nearly a million minutes of video content will cross the network by 2019.

Globally, IP video traffic will be 80 percent of all IP traffic (both business and consumer) by 2019, up from 67 percent in 2014. This percentage does not include the amount of video exchanged through peer-to-peer (P2P) file sharing. The sum of all forms of video (TV, video on demand [VoD], Internet, and P2P) will continue to be in the range of 80 to 90 percent of global consumer traffic by 2019.

Internet video to TV grew 47 percent in 2014. This traffic will continue to grow at a rapid pace, increasing fourfold by 2019. Internet video to TV will be 17 percent of consumer Internet video traffic in 2019, up from 16 percent in 2014.

Consumer VoD traffic will nearly double by 2019. The amount of VoD traffic in 2019 will be equivalent to 7 billion DVDs per month.

Global Mobile Highlights

Globally, mobile data traffic will increase 10-fold between 2014 and 2019. Mobile data traffic will grow at a CAGR of 57 percent between 2014 and 2019, reaching 24.3 exabytes per month by 2019.

Global mobile data traffic will grow three times faster than fixed IP traffic from 2014 to 2019. Global mobile data traffic was 4 percent of total IP traffic in 2014, and will be 14 percent of total IP traffic by 2019.

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

Regional Highlights

IP traffic is growing fastest in the Middle East and Africa, followed by Asia Pacific. Traffic in the Middle East and Africa will grow at a CAGR of 44 percent between 2014 and 2019.

Summary of regional growth rates:

- IP traffic in North America will reach 49.7 exabytes per month by 2019; growing at a CAGR of 20 percent.
- IP traffic in Western Europe will reach 24.7 exabytes per month by 2019; growing at a CAGR of 21 percent.
- IP traffic in Asia Pacific will reach 54.4 exabytes per month by 2019; growing at a CAGR of 21 percent.
- IP traffic in Latin America will reach 12.9 exabytes per month by 2019; growing at a CAGR of 25 percent.
- IP traffic in Central and Eastern Europe will reach 16.9 exabytes per month by 2019; growing at a CAGR of 33 percent.
- IP traffic in the Middle East and Africa will reach 9.4 exabytes per month by 2019; growing at a CAGR of 44 percent.

Note: Several interactive tools are available to allow you to create custom highlights and forecast charts by region, by country, by application, and by end-user segment (refer to the Cisco VNI Forecast Highlights tool and the Cisco VNI Forecast Widget tool).

Global Business Highlights

Business IP traffic will grow at a CAGR of 20 percent from 2014 to 2019. Increased adoption of advanced video communications in the enterprise segment will cause business IP traffic to grow by a factor of 2 between 2014 and 2019.

Business Internet traffic will grow at a faster pace than IP WAN. IP WAN will grow at a CAGR of 9 percent, compared with a CAGR of 20 percent for fixed business Internet and 51 percent for mobile business Internet.

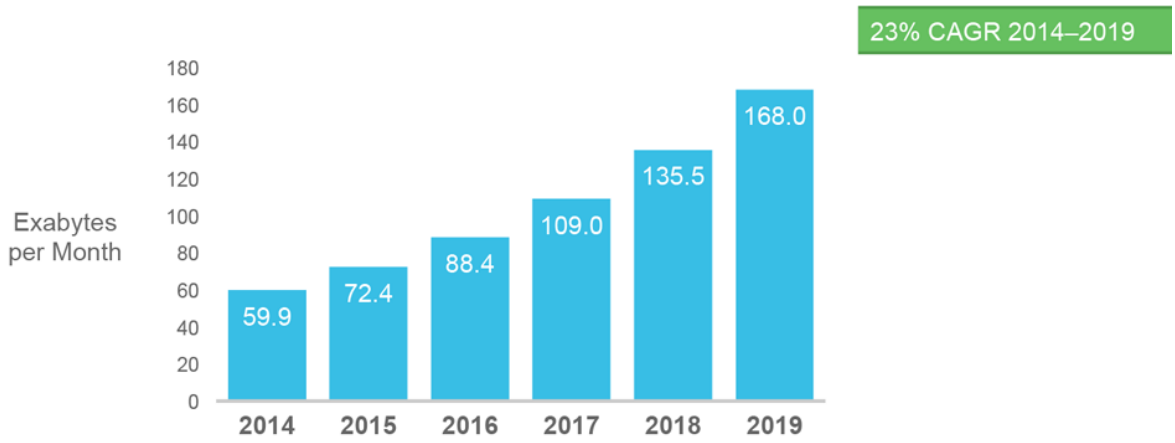
Business IP traffic will grow fastest in the Middle East and Africa. Business IP traffic in the Middle East and Africa will grow at a CAGR of 26 percent, a faster pace than the global average of 20 percent. In volume, Asia Pacific will have the largest amount of business IP traffic in 2018, at 9.5 exabytes per month. North America will be second, at 8.0 exabytes per month.

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

Forecast Overview

The current Cisco Visual Networking Index (VNI) forecast projects global IP traffic to nearly triple from 2014 to 2019. See Appendix A for a detailed summary. Overall IP traffic is expected to grow to 168 exabytes per month by 2019, up from 59.9 exabytes per month in 2014, a CAGR of 23 percent (Figure 1).

Figure 1. Cisco VNI Forecasts 168 Exabytes per Month of IP Traffic by 2019



Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

For more details about Cisco's forecasting methodology, refer to the paper "Cisco VNI: Forecast and Methodology, 2014–2019."

To understand the magnitude of IP traffic volumes, it helps to look at the numbers in more familiar terms:

- By 2019, the gigabyte equivalent of all movies ever made will cross the global Internet every 2 minutes.
- Globally, IP traffic will reach 511 Tbps in 2019, the equivalent of 142 million people streaming Internet HD video simultaneously, all day, every day.
- Global IP traffic in 2019 will be equivalent to 504 billion DVDs per year, 42 billion DVDs per month, or 58 million DVDs per hour.

Total Internet traffic has experienced dramatic growth in the past two decades. More than 20 years ago, in 1992, global Internet networks carried approximately 100 GB of traffic per day. Ten years later, in 2002, global Internet traffic amounted to 100 gigabytes per second (GBps). In 2014, global Internet traffic reached 16,144 GBps. Table 1 provides a view of the historical benchmarks for total Internet traffic.

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

Table 1. The Cisco VNI Forecast—Historical Internet Context

Year	Global Internet Traffic
1992	100 GB per day
1997	100 GB per hour
2002	100 GBps
2007	2000 GBps
2014	16,144 GBps
2019	51,794GBps

Source: Cisco VNI, 2015

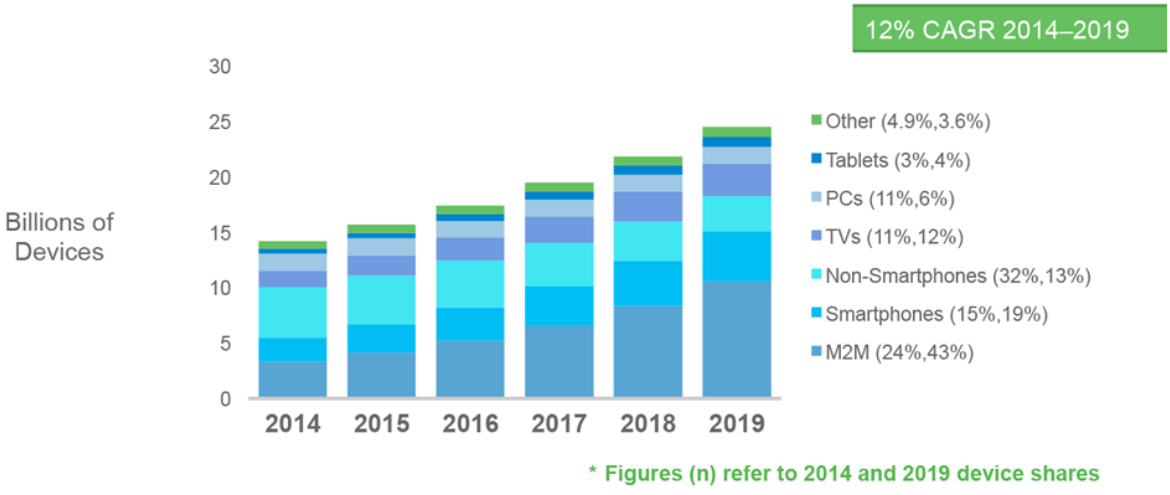
Per capita IP and Internet traffic growth has followed a similarly steep growth curve over the past decade. Globally, IP traffic will reach 22 GB per capita by 2019, up from 8 GB per capita in 2014, and Internet traffic will reach 18 GB per capita by 2019, up from 6 GB per capita in 2014. Not long ago, in 2008, per capita Internet traffic was 1 GB per month. In 2000, per capita Internet traffic was 10 megabytes (MB) per month.

The sections that follow explore the trends contributing to the continued growth of global IP traffic.

Trend 1: Continued Shifts in Mix of Devices and Connections

Globally, devices and connections (11.5 percent CAGR) are growing faster than both the population (1.1 percent CAGR) and Internet users (6.9 percent CAGR). See Figure 2. This trend is accelerating the increase in the average number of devices and connections per household and per Internet user. Each year, various new devices in different form factors with increased capabilities and intelligence are introduced and adopted in the market. A growing number of M2M applications, such as smart meters, video surveillance, healthcare monitoring, transportation, and package or asset tracking, also are causing connection growth. By 2019, M2M connections will be 43 percent of the total devices and connections.

Figure 2. Global Devices and Connections Growth



Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

M2M connections will be the fastest-growing category, growing more than threefold during the forecast period, at 26 percent CAGR, to 10.5 billion connections by 2019. Tablets and smartphones will grow the second fastest, at 17 percent CAGR (increasing by a factor of 2.2). Connected TVs (which include flat-panel TVs, set-top boxes, digital media adapters (DMAs), Blu-ray disc players, and gaming consoles) will nearly double, to 2.9 billion by 2019. PCs will continue to stabilize (less than a quarter of 1 percent decline) over the forecast period. There will be nearly as many tablets as laptops by the end of 2019 (919 million laptops and 922 million tablets).

By 2019, the consumer share of the total devices, including both fixed and mobile devices, will be 79 percent, with business claiming the remaining 21 percent. Consumer share will grow slightly more slowly, at 11 percent CAGR, relative to the business segment, which will grow at 13.7 percent CAGR. For more details about the growth in devices and connections in residential, consumer mobile, and business segments, refer to the Cisco VNI Service Adoption Forecast, 2014–2019.

Globally, the average number of devices and connections per capita will grow from 2 in 2014 to 3.2 by 2019 (Table 2).

Table 2. Average Number of Devices and Connections per Capita

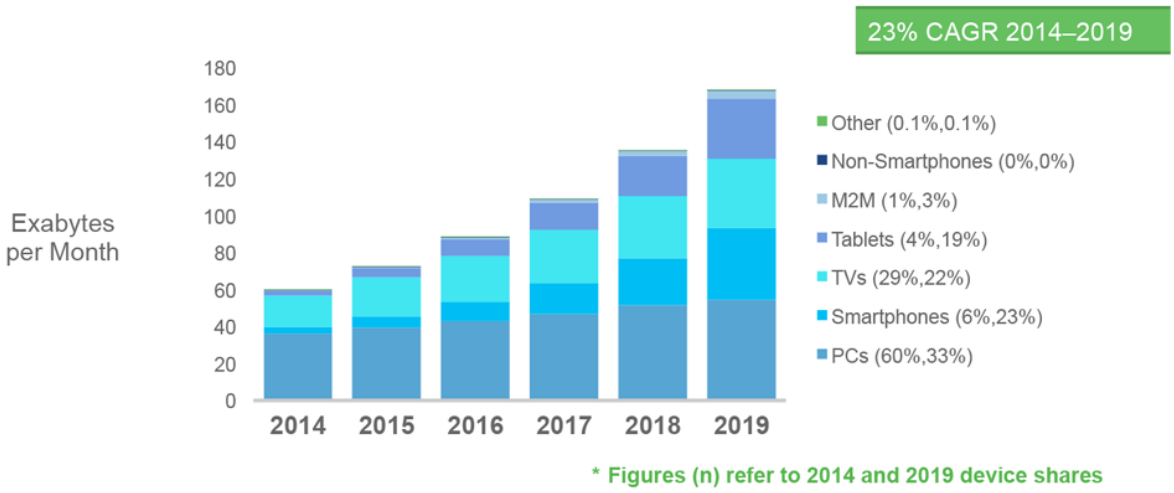
	2014	2019	CAGR
Asia Pacific	1.60	2.55	9.8 %
Central and Eastern Europe	2.40	4.29	12.3%
Latin America	1.97	2.92	8.2%
Middle East and Africa	0.99	1.36	6.4%
North America	6.14	11.6	13.5%
Western Europe	4.43	8.18	13.1%
Global	1.95	3.20	10.4%

Source: Cisco VNI, 2015

The changing mix of devices and connections and growth in multi-device ownership affects traffic and can be seen in the changing device contribution to total IP traffic. At the end of 2014, 40 percent of IP traffic and 22.5 percent of consumer Internet traffic originated from non-PC devices. By 2019, 67 percent of IP traffic and 64 percent of consumer Internet traffic will originate from non-PC devices (Figure 3).

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

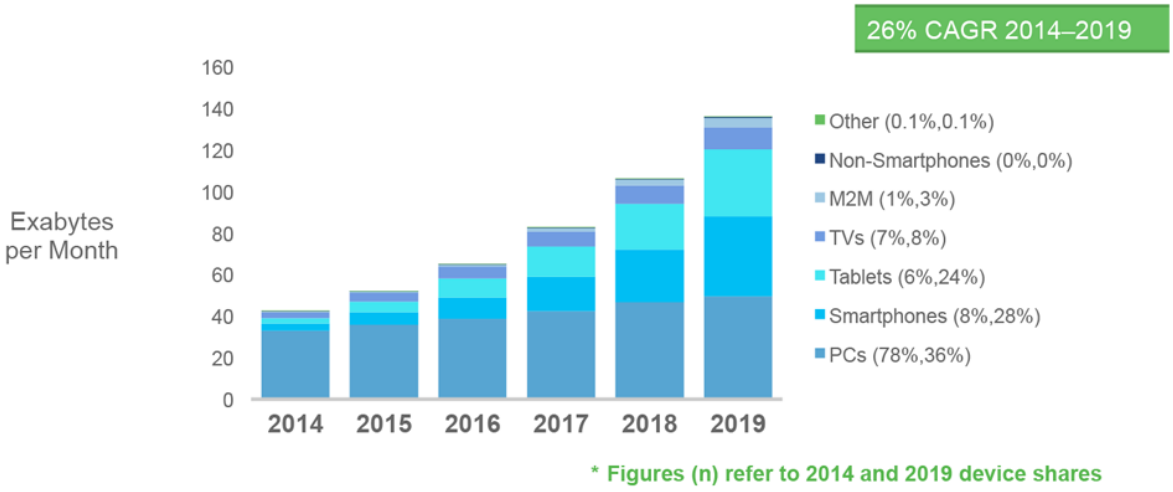
Figure 3. Global IP Traffic by Devices



Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

As in the case of mobile networks, video devices can have a multiplier effect on traffic. An Internet-enabled HD television that draws 45 minutes of content per day from the Internet would generate as much Internet traffic as an entire household today. With the growth of video viewing on tablets, traffic from tablets is growing as a percentage of total Internet traffic. Tablets will account for 24 percent of total global Internet traffic by 2019, up from 6 percent in 2014 (Figure 4).

Figure 4. Global Internet Traffic by Device Type

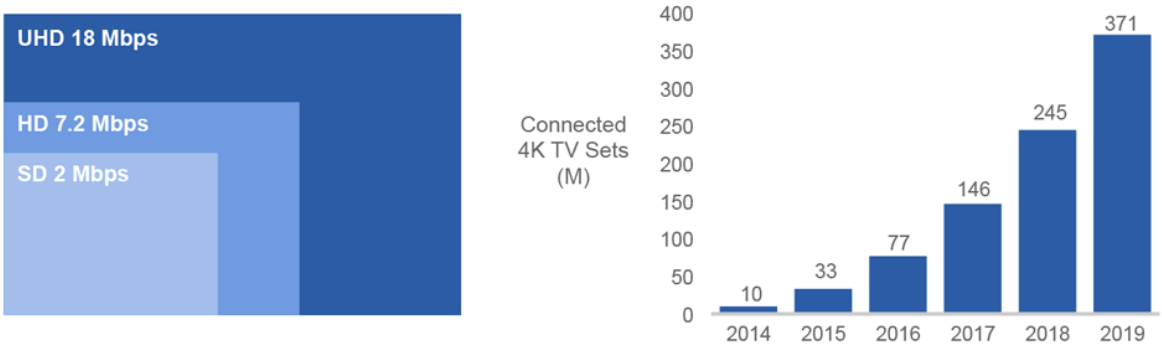


Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

The video impact of the devices on the traffic is more pronounced due to the introduction of ultra-high-definition (UHD), or 4K, video streaming. This technology has such an impact because the bit rate for 4K video at about 18 Mbps is more than double the HD video bit rate and nine times more than standard-definition (SD) video bit rate. We estimate that by 2019, 31 percent of the installed flat-panel TV sets will be UHD, up from 2.7 percent in 2014 (Figure 5).

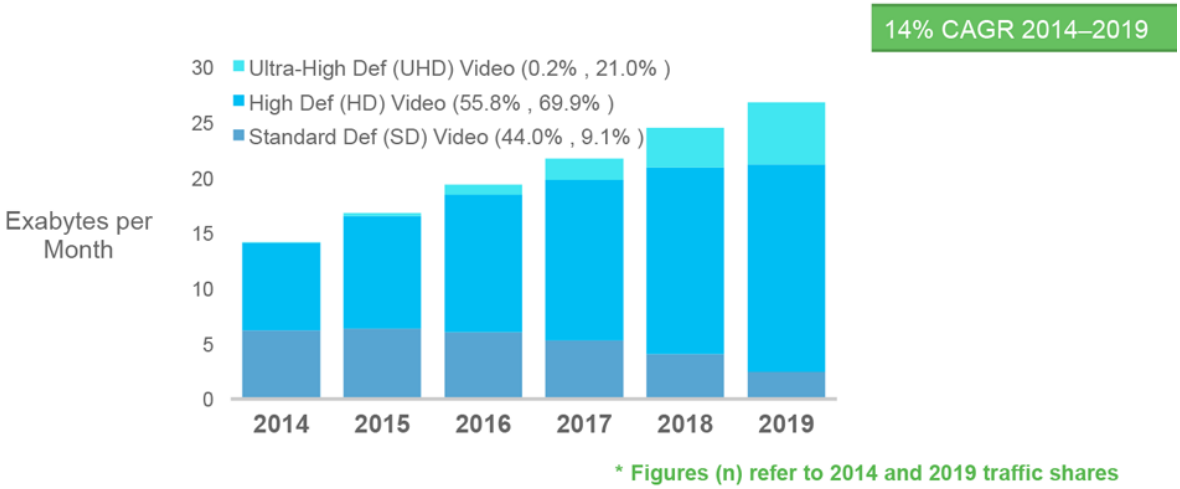
Figure 5. Increasing Video Definition: By 2019, More Than 30 Percent of Connected Flat-Panel TV Sets Will Be 4K



Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

Ultra-HD (or 4K) IP VoD will account for 21 percent of global VoD traffic in 2019 (Figure 6).

Figure 6. Global 4K Video Traffic



Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

Trend 2: IPv6 Adoption Enables Internet of Everything Connectivity

The transition from an IPv4 environment to an IPv6 environment is making excellent progress, with increases in IPv6 device capabilities, content enablement, and operators implementing IPv6 in their networks. These developments are particularly important because Asia, Europe and Latin America have already exhausted their IPv4 allotments, and North America is expected to exhaust its allotment this summer and Africa by 2019.

Table 3 shows the projected exhaustion dates as of May 2015, according to the Regional Internet Registries (RIR).

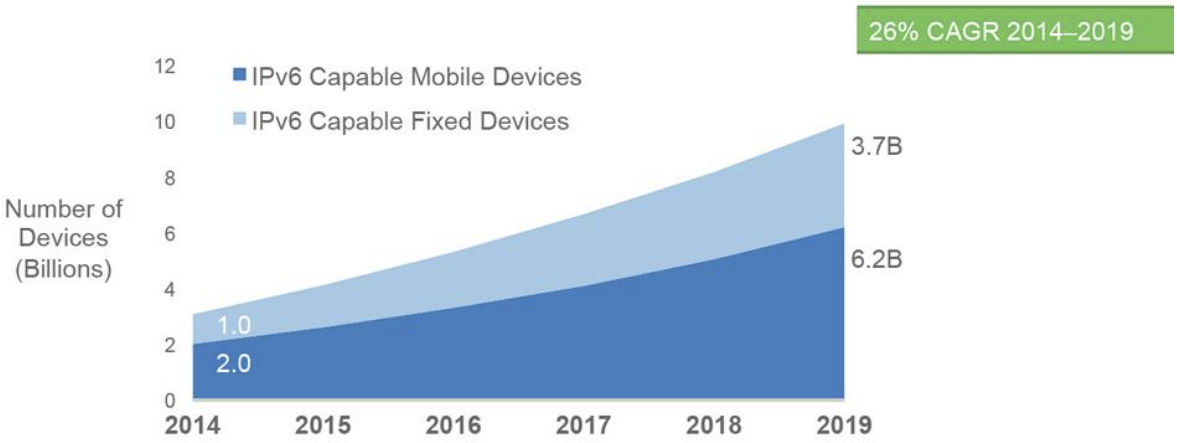
Table 3. IPv4 Address Exhaustion Dates

Regional Internet Registries	Exhaustion Date
Asia-Pacific Network Information Centre (APNIC)	April 19, 2011 (actual)
Réseaux IP Européens Network Coordination Centre (RIPE NCC)	September 14, 2012 (actual)
Latin America and Caribbean Network Information Centre (LACNIC)	June 10, 2014 (actual)
American Registry for Internet Numbers (ARIN)	July 10, 2015 (projected)
African Network Information Center (AFRINIC)	February 19, 2019 (projected)

Building on the VNI IPv6-capable devices analysis, the forecast estimates that globally there will be 10 billion IPv6-capable fixed and mobile devices by 2019, up from 3 billion in 2014, a CAGR of 26 percent. In terms of percentages, 41 percent of all fixed and mobile networked devices will be IPv6-capable by 2019, up from 22 percent in 2014 (Figure 7).

This estimate is based on the capability of the device and the network connection to support IPv6, and is not a projection of active IPv6 connections. Mobile-device IPv6 capability is assessed based on OS support of IPv6 as well as by estimating the type of mobile network infrastructure to which the device is capable of connecting (3.5G or higher.) Fixed-device IPv6 capability is assessed based on device support of IPv6 as well as an estimation of the capability of the residential customer premises equipment (CPE) or business routers to support IPv6, depending on the device end-user segment.

Figure 7. Global IPv6-Capable Devices and Connections Forecast 2014–2019



Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

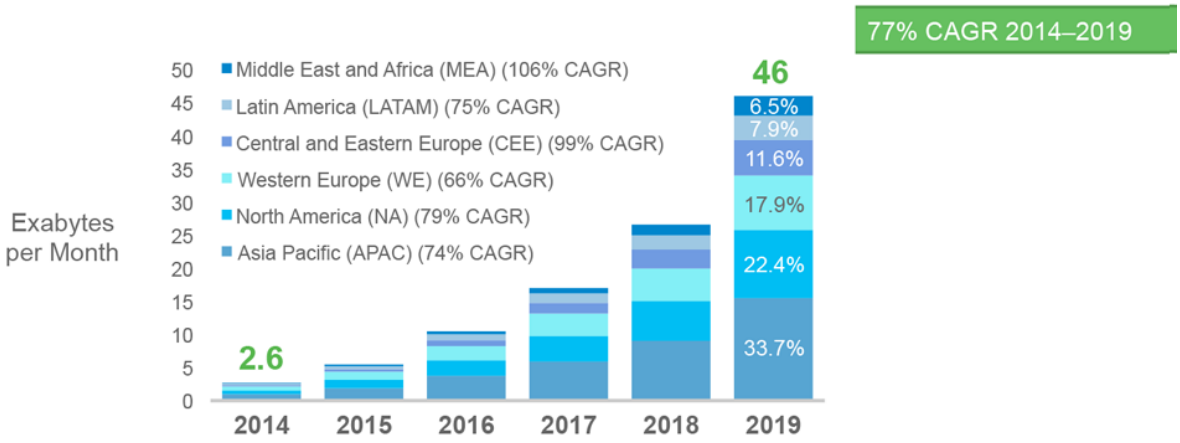
Globally, 81 percent of smartphones and tablets will be IPv6-capable by 2019, up from 56 percent in 2014. Globally, there will be 4.5 billion IPv6-capable smartphones and tablets by 2019, up from 1.4 billion in 2014. By 2019, 21 percent of M2M connections will be IPv6-capable, reaching 2.2 billion, a 64 percent compound annual growth rate.

According to the World IPv6 Launch Organization in May 2015, fixed and mobile network operators worldwide are deploying IPv6 and starting to report notable IPv6 traffic generation. KDDI reported nearly18 percent, Romania's RCS & RDS reported nearly 20 percent, France's Free Telecom reported 29 percent, Comcast reported 37 percent, AT&T reported 52 percent, and Verizon Wireless reported 69 percent. According to Google, in May 2015 the percentage of users who access Google through IPv6 is about 6 percent. Akamai reported threefold growth in its IPv6 traffic volume worldwide since last year, with about 900,000 IPv6 hits per second in May 2015, compared to nearly 270,000 IPv6 hits per second in May 2014.

Amid these industry developments, this year's VNI forecast is undertaking an effort to estimate the potential IPv6 network traffic that could be generated if a percentage of IPv6-capable devices become actively connected to an IPv6 network, given the estimated global average for monthly traffic per device type.

Looking to 2019, if 60 percent of IPv6-capable devices are actively connected to an IPv6 network, the forecast estimates that globally IPv6 traffic would amount to 45.7 exabytes per month, or 34 percent of total Internet traffic. (Figure 8).

Figure 8. Projected Global Fixed and Mobile IPv6 Traffic Forecast 2014–2019



Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

This initial estimation of potential IPv6 traffic is based on the assumptions that IPv6 device capability, IPv6 content enablement, and IPv6 network deployment will keep pace with current trends and may even accelerate during the forecast period. Considering the interdependence of these variables, forecast assumptions could be subject to refinement as our analysis continues.

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

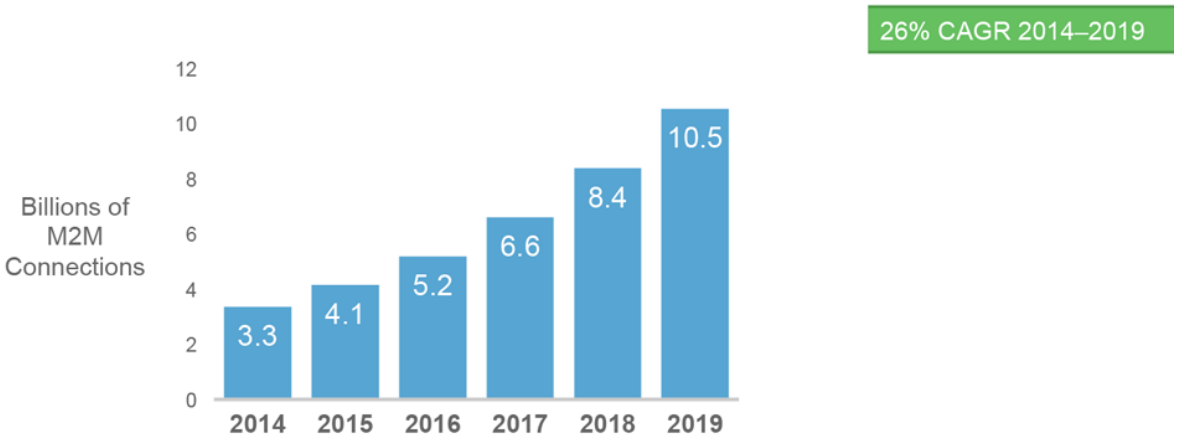
Content providers are also moving to increase the IPv6 enablement of their sites and services. Eight percent of Facebook's members worldwide use IPv6 to reach its content today, and in the United States this number is 17.5 percent and doubling each year. Google logs just over 6 percent of its visitors coming over IPv6. According to Cisco's IPv6 labs, by 2019 the content available over IPv6 will be about 25 percent. There can be, however, variation depending on the popularity of websites across regions and countries. In addition, specific country initiatives and content provider deployments have had a positive impact on local IPv6 content reachability.

Overall, the likelihood that a significant portion of Internet traffic will be generated over IPv6 networks holds considerable opportunity for network operators, content providers, and end users seeking to gain the scalability and performance benefits of IPv6 and enable the Internet of Everything (IoE).

Trend 3: M2M Applications Across Many Industry Verticals Drive IoE Growth

The Internet of Everything phenomenon, in which people, processes, data, and things connect to the Internet and each other, is showing tangible growth. Globally, M2M connections will grow more than threefold, from 3.3 billion in 2014 to 10.5 billion by 2019 (Figure 9). There will be nearly one-and-a-half M2M connections for each member of the global population by 2019.

Figure 9. Global M2M Connection Growth

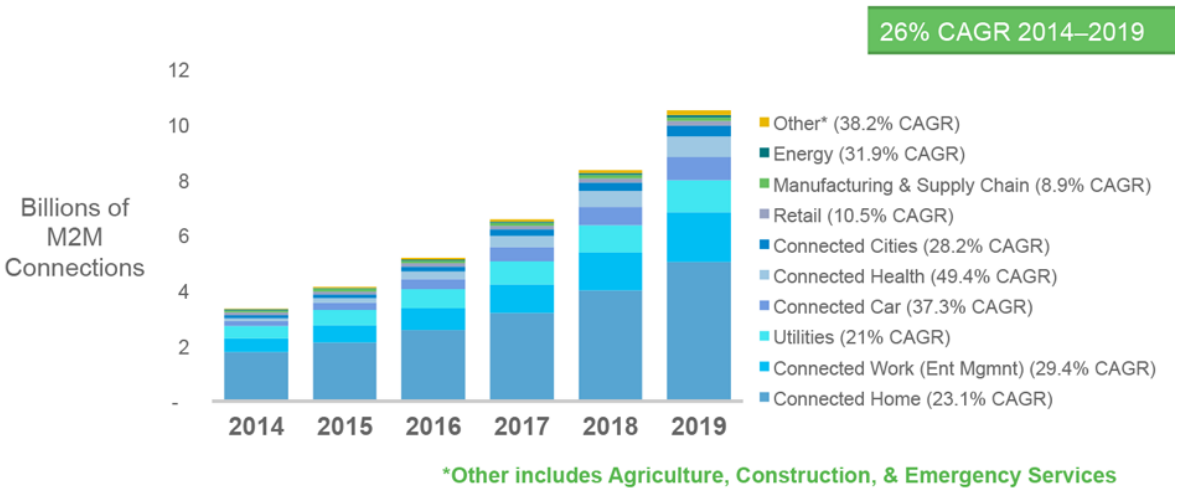


Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

Connected home applications, such as home automation, home security and video surveillance, connected white goods, and tracking applications, will represent 48 percent, or nearly half, of the total M2M connections by 2019, showing the pervasiveness of M2M in our lives (Figure 10). Connected healthcare, with applications such as health monitors, medicine dispensers, first-responder connectivity, and telemedicine, will be the fastest growing industry segment, at 49 percent CAGR. Connected car applications will have the second fastest growth, at 37 percent CAGR. Chips for pets and livestock, digital health monitors, and numerous other next-generation M2M services are promoting this growth.

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

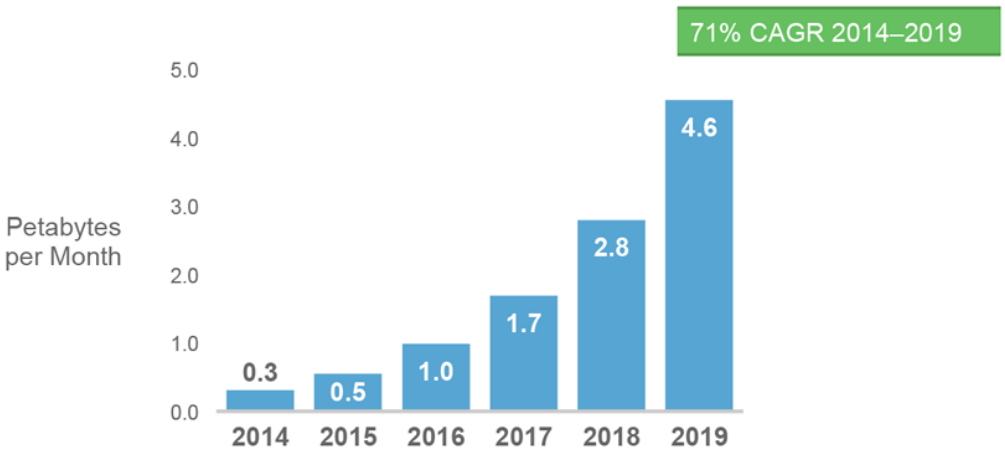
Figure 10. Global M2M Connection Growth by Industry Verticals



Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

Although the number of connections is growing threefold, global M2M IP traffic will grow 15-fold over this same period, from 308 petabytes in 2014 (0.5 percent of global IP traffic) to 4.6 exabytes by 2019 (2.7 percent of global IP traffic). See Figure 11. The amount of traffic is growing faster than the number of connections because more video applications are being deployed on M2M connections and because of the increased use of applications, such as telemedicine and smart car navigation systems, that require greater bandwidth and lower latency.

Figure 11. Global M2M Traffic Growth: Petabytes



Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

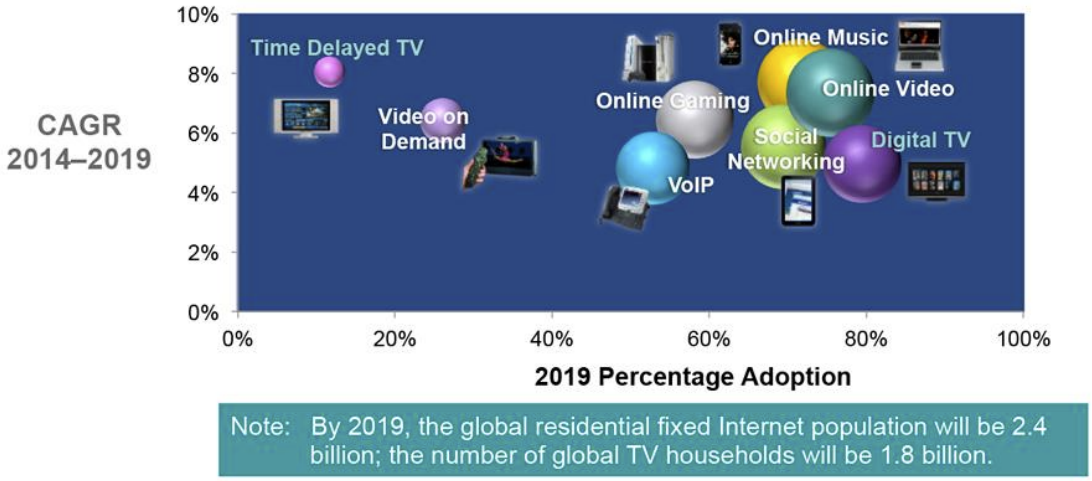
© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

Trend 4: Service Adoption Trends: Residential, Consumer Mobile, and Business Services

Global Residential Services: Video Continues to Grow

Between 2013 and 2014, the highest growth happened on the Internet side in online video, with 18 percent year-over-year (YoY) growth. Social networking was the most widely adopted residential Internet service, with YoY growth of 4 percent, growing from 1.2 billion users in 2013 to 1.3 billion users in 2014. See Figure 12.

Figure 12. Global Residential Services Adoption and Growth



Source: Cisco VNI Service Adoption Forecast, 2014–2019

By 2019, digital TV and online video will be the two services with the highest penetration rates, with 79 percent and 75 percent respectively. The fastest growth will come from time-delayed TV services such as personal video recorder (PVR) and digital video recorder (DVR) services, at 8 percent CAGR. Online music (8 percent CAGR) will be the fastest growing residential Internet service. Online music and video are both driven by cloud-based personal storage and sharing sites, in addition to both copyrighted and user-generated content use. Among the digital-TV services, time-delayed or DVR/PVR service will grow the fastest, at 14 percent CAGR.

Global Consumer Mobile Services

Between 2013 and 2014, all consumer mobile services grew more than 10 percent YoY. The highest growth was in consumer location-based services (LBS), with YoY growth of 47 percent, from a base of 406 million users in 2013 to 597 million in 2014. Other significant YoY growth was in mobile banking and commerce (46 percent), followed by mobile video (39 percent). Regions such as Latin America (71.4 percent YoY growth) and the Middle East and Africa (70.7 percent YoY growth) had the fastest growth in consumer mobile LBS. Mobile banking and commerce also grew the fastest in Latin America, at 76 percent YoY growth, and mobile video growth was led by Central and Eastern Europe, at 68 percent YoY growth (Figure 13).

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

Figure 13. Global Consumer Mobile Services Adoption and Growth

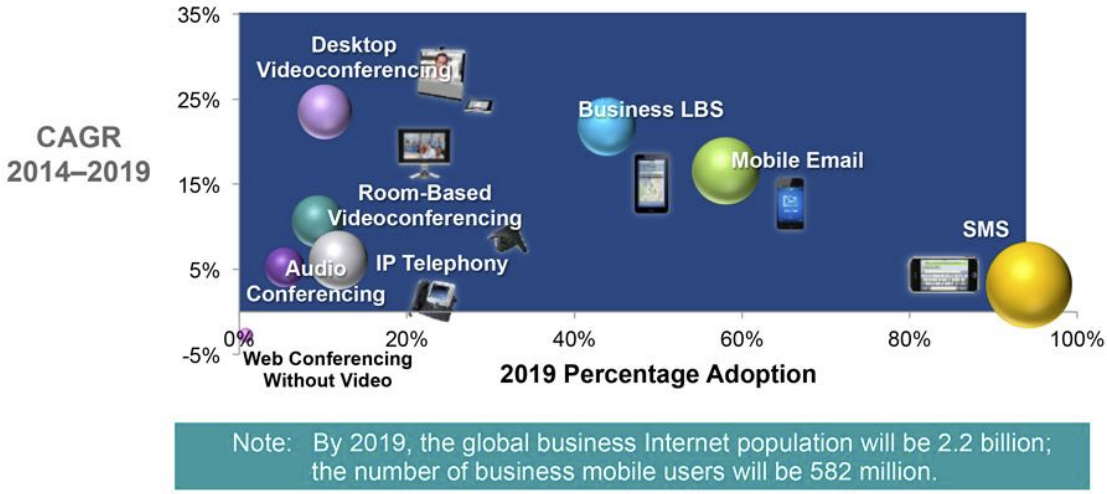
Source: Cisco VNI Service Adoption Forecast, 2014–2019

From 2014 to 2019, seven out of eight consumer mobile services will grow at more than 15 percent CAGR, and two will grow at more than 25 percent CAGR. The fastest growth will be in consumer LBS (27.5 percent), followed by mobile commerce (25 percent). Regions with especially high rates of growth in mobile commerce services are the Middle East and Africa, Latin America, and Asia Pacific, which have historically been underserved (or not reached) by traditional brick-and-mortar financial institutions.

Global Business Services

Between 2013 and 2014, the highest YoY growth was in business LBS, with a 41 percent increase: from 68 million users in 2013 to 95 million in 2014. Other significant YoY growth was in desktop videoconferencing (30 percent). See Figure 14.

Figure 14. Global Business Services Adoption and Growth



Source: Cisco VNI Service Adoption Forecast, 2014–2019

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

Business LBS includes services used by corporate subscribers in which the subscription is generally paid by the employer. These services include salesforce and field-force automation, fleet management, etc., among others

This year's study suggests further slowdown in the growth of room-based videoconferencing. Single-codec videoconferencing systems grew except in Central and Eastern Europe and Middle East and Africa. All regions, with the exception of Asia Pacific and Latin America, experienced a decline in executive conferencing systems, and all regions except Latin America experienced a decline in multicodec systems. Multicodec systems are typically fully managed and so are expensive to maintain and operate. As unit sales drop, so does the network of units to connect to, and therefore use may be limited. Low-use systems are decommissioned over time due to the high fixed cost of managing these systems. We see that personal or desktop videoconferencing is increasingly replacing room-based conferencing as video becomes simpler and more integrated into unified communications business service offers.

From 2014 to 2019, the fastest-growing business service is expected to be desktop or personal videoconferencing. The growth in personal videoconferencing, specifically unified communications–based videoconferencing, has recently accelerated due to the higher quality and lower price of new services and products, and also due to the availability of desktop videoconferencing offers, which can be standalone or integrated. Also, the growth in mobile clients will support videoconferencing growth. Conversely, the use of web conferencing without video will show a decline of 3 percent CAGR over the forecast period.

For details about all aspects of the service adoption study, use the Cisco VNI Service Adoption Highlights tool.

Trend 5: Applications Traffic Growth

The sum of all forms of IP video, which includes Internet video, IP VoD, video files exchanged through file sharing, video-streamed gaming, and videoconferencing, will continue to be in the range of 80 to 90 percent of total IP traffic. Globally, IP video traffic will account for 80 percent of traffic by 2019 (Figure 15).

Figure 15. Global IP Traffic by Application Category

Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

The implications of video growth are difficult to overstate. With video growth, Internet traffic is evolving from a relatively steady stream of traffic (characteristic of P2P) to a more dynamic traffic pattern.

In the past year, service providers have observed a pronounced increase in traffic associated with gaming downloads. Newer consoles such as the Xbox One and PlayStation 4 have sufficient on-board storage to enable gamers to download new games rather than buy them on disc. These graphically intense games are large files, and gaming downloads are already 2 percent of consumer fixed Internet traffic, and will reach 5 percent of consumer fixed Internet traffic by 2019. Furthermore, these downloads tend to occur during peak usage periods, with gaming downloads reaching up to 10 percent of busy-hour traffic.

Impact of Video on Traffic Symmetry

With the exception of short-form video and video calling, most forms of Internet video do not have a large upstream component. As a result, traffic is not becoming more symmetric, which many expected when user-generated content first became popular. The emergence of subscribers as content producers is an extremely important social, economic, and cultural phenomenon, but subscribers still consume far more video than they produce. Upstream traffic has been slightly declining as a percentage for several years.

It appears likely that residential Internet traffic will remain asymmetric for the next few years. However, numerous scenarios could result in a move toward increased symmetry; for example:

- Content providers and distributors could adopt P2P as a distribution mechanism. There has been a strong case for P2P as a low-cost CDS for many years, yet most content providers and distributors have opted for direct distribution, with the exception of applications such as PPStream and PPLive in China, which offer live video streaming through P2P and have had great success. If content providers in other regions follow suit, traffic could rapidly become highly symmetric.
- High-end video communications could accelerate, requiring symmetric bandwidth. PC-to-PC video calling is gaining momentum, and the nascent mobile video calling market appears to have promise. If high-end video calling becomes popular, traffic could move toward greater symmetry.

Generally, if service providers provide ample upstream bandwidth, applications that use upstream capacity will begin to appear.

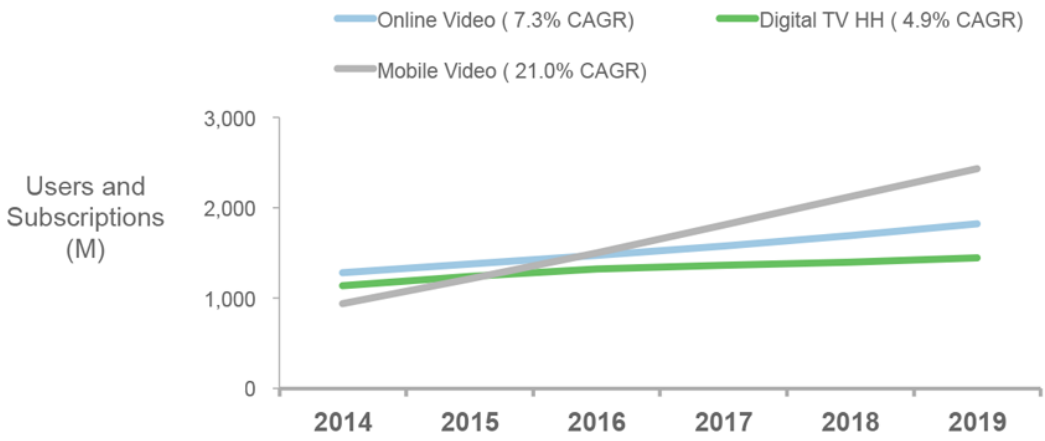
Trend 6: “Cord-Cutting” Analysis

In the context of the VNI Forecast, “Cord-cutting” refers to the trend in which traditional and subscription television viewing is increasingly being supplanted by other means of video viewing, such as online and mobile video, which are available to viewers through fixed and mobile Internet connections.

We are seeing a trend in which the growth in digital television service that denotes television viewing across all digital platforms (cable, IPTV, satellite, etc.) is growing much slowly relative to online video and mobile video (Figure 16). This trend is more pronounced in regions such as North America and Western Europe, where the penetration of digital TV is already high. Also, in emerging regions mobile video growth rates are even higher, as these regions are skipping over fixed connectivity.

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

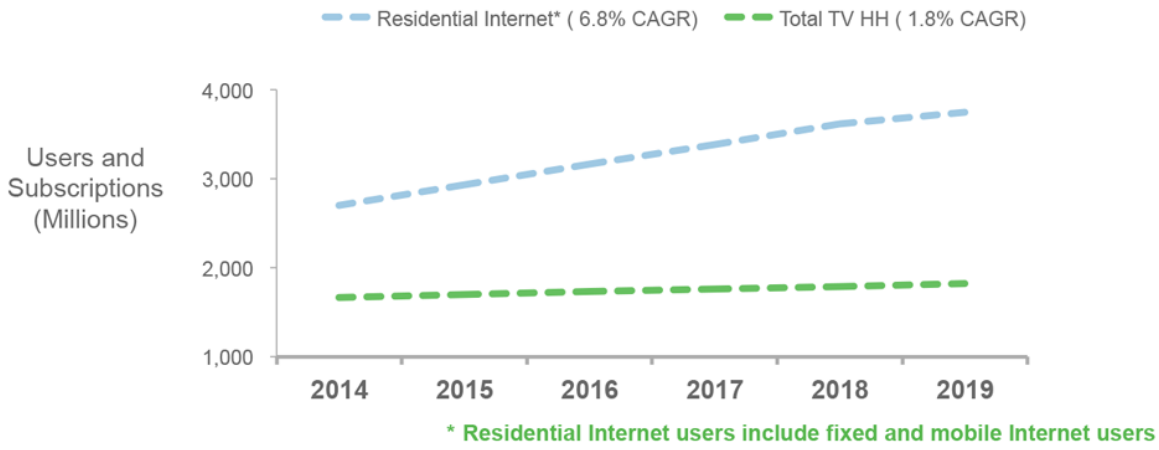
Figure 16. Global Online and Mobile Video Growing Faster Than Digital TV



Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

Another argument supporting this trend is that the total addressable markets for these services—residential Internet users (for online and mobile video) and total TV households (for digital-TV households)—show significantly different growth patterns (Figure 17). Residential Internet users are expected to increase at a CAGR of nearly 7 percent, whereas the number of TV households is flattening, with a meager 2 percent forecasted CAGR.

Figure 17. Growth in Global Residential Internet Users Compared to Growth in Global TV Households

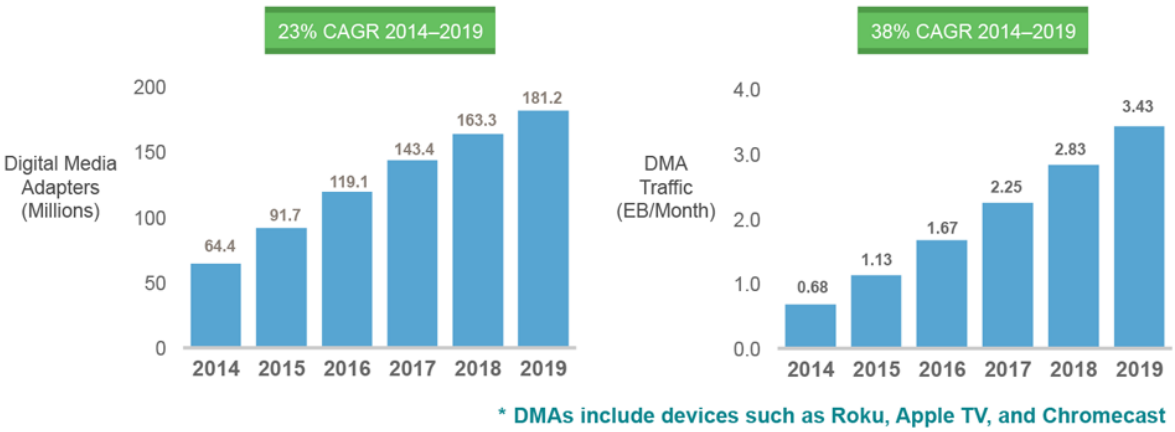


Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

Also, if we look at Internet devices such as DMAs, we find that although they represent only 7 percent of all Internet connected set-top boxes (STBs)—including, service provider STBs, gaming consoles, and directly connected Internet TV sets—by 2019, they will represent 32 percent of global Internet STB traffic. This trend again shows that there is increasingly less reliance on STBs managed by service providers for Internet access in general and for video specifically (Figure 18).

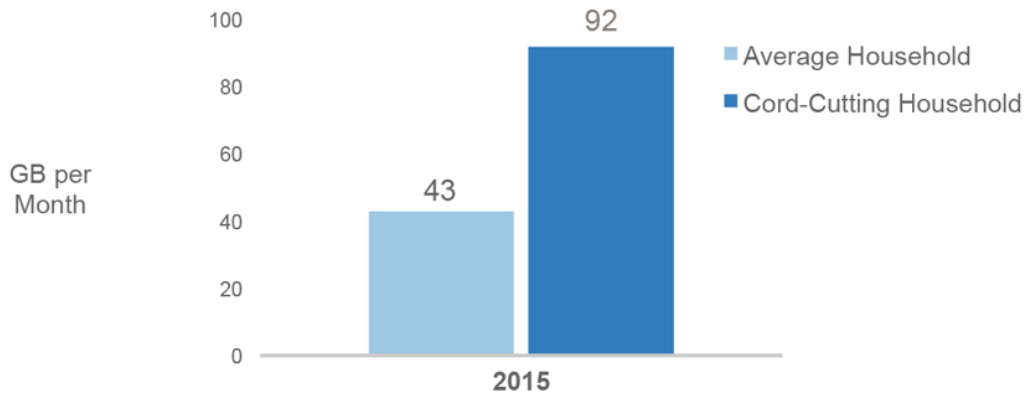
Figure 18. Growth in Global Digital Media Adapters



Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

From a traffic perspective, we expect that on average a household that is still on linear TV will generate much less traffic than a household that has cut the cord and is relying on Internet video (Figure 19). A cord-cutting household will generate 92 GB per month in 2015, compared to 43 GB per month for an average household. This difference occurs because linear television generates much less traffic (one stream of video shared across a number of linear-TV households) than Internet video, which is unicast to each Internet video device.

Figure 19. Global Cord Cutting Generates Double the Traffic



Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

Trend 7: Impact of Accelerating Speeds on Traffic Growth

Fixed Speeds

Broadband speed is a crucial enabler of IP traffic. Broadband speed improvements result in increased consumption and use of high-bandwidth content and applications. The global average broadband speed continues to grow and will more than double from 2014 to 2019, from 20.3 Mbps to 42.5 Mbps. Table 4 shows the projected broadband speeds from 2014 to 2019. Several factors influence the fixed broadband speed forecast, including the deployment and adoption of fiber to the home (FTTH), high-speed DSL, and cable broadband adoption, as well as overall broadband penetration. Among the countries covered by this study, Japan, South Korea, and Sweden lead in terms of broadband speed largely due to their wide deployment of FTTH.

Table 4. Fixed Broadband Speeds (in Mbps), 2014–2019

Region	2014	2015	2016	2017	2018	2019	CAGR (2014-2019)
Global	20.3	24.7	29.2	33.6	38.1	42.5	16%
Asia Pacific	23.2	28.1	31.1	36.3	41.5	48.9	16%
Latin America	7.2	7.6	8.5	10.5	13.1	16.9	18%
North America	21.8	25.4	28.7	33.7	38.7	43.7	15%
Western Europe	21.8	22.8	26.8	32.5	39.7	49.1	18%
Central and Eastern Europe	22.2	28.3	33.4	37.7	41.8	45.3	15%
Middle East and Africa	6.1	7.0	8.5	11.1	13.0	14.9	20%

Source: Cisco VNI, 2015

Consider how long it takes to download an HD movie at these speeds: at 10 Mbps, it takes 20 minutes; at 25 Mbps, it takes 9 minutes; but at 100 Mbps, it takes only 2 minutes. High-bandwidth speeds will be essential to support consumer cloud storage, making the download of large multimedia files as fast as a transfer from a hard drive. Table 5 shows the percentage of broadband connections that will be faster than 10 Mbps, 25 Mbps, and 100 Mbps by region.

Table 5. Broadband Speed Greater Than 10 Mbps, 2014–2019

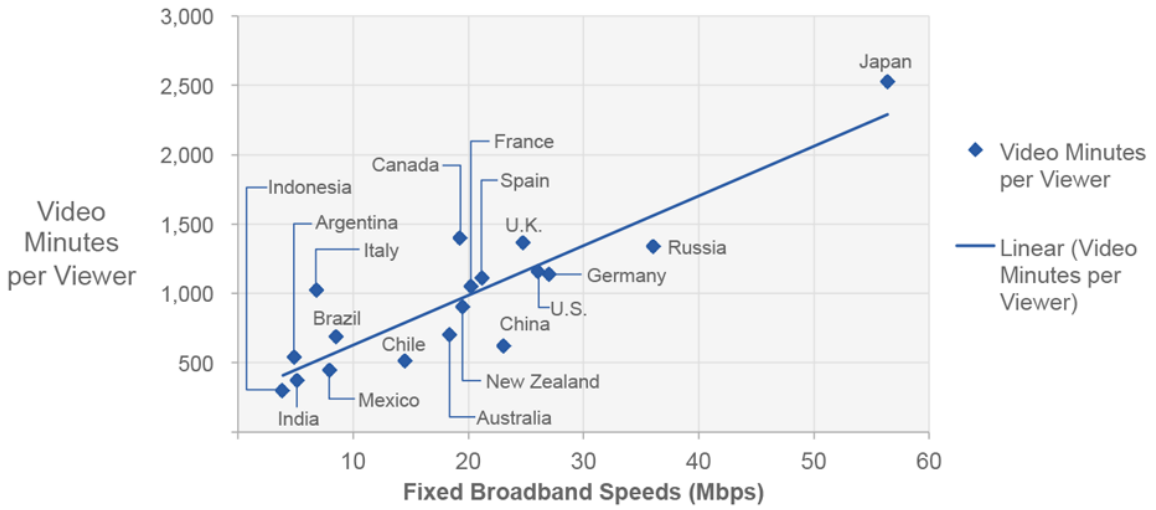
Region	Greater Than 10 Mbps		Greater Than 25 Mbps		Greater Than 100 Mbps	
	2014	2019	2014	2019	2014	2019
Global	48%	68%	29%	33%	3%	7%
Asia Pacific	46%	73%	26%	37%	3%	8%
Latin America	27%	33%	9%	12%	1%	3%
North America	58%	74%	33%	45%	2%	8%
Western Europe	51%	62%	28%	37%	4%	10%
Central and Eastern Europe	53%	76%	34%	41%	2%	6%
Middle East and Africa	16%	20%	6%	8%	0.3%	1%

Source: Cisco VNI, 2015

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

There is a strong correlation between experienced speeds and number of video minutes viewed per viewer (Figure 20). As speeds increase in each country covered in the study, the number of video minutes per viewer also increases.

Figure 20. Increase in Experienced Speeds (Kbps) Increases Internet Video Viewership (Minutes)



Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

Mobile Speeds

Globally, the average mobile network connection speed in 2014 was 1.7 Mbps. The average speed will double and will be nearly 4 Mbps by 2019. Smartphone speeds, generally third-generation (3G) and higher, are currently almost three times higher than the overall average. Smartphone speeds will nearly double by 2019, reaching 10.4 Mbps.

Anecdotal evidence supports the idea that overall use increases when speed increases, although there is often a delay between the increase in speed and the increased use, which can range from a few months to several years. The reverse can also be true with the burstiness associated with the adoption of tablets and smartphones, where there is a delay in experiencing the speeds that the devices are capable of supporting. The Cisco VNI Forecast relates application bit rates to the average speeds in each country. Many of the trends in the resulting traffic forecast can be seen in the speed forecast, such as the high growth rates for developing countries and regions relative to more developed areas (Table 6).

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

Table 6. Projected Average Mobile Network Connection Speeds (in Kbps) by Region and Country

	2014	2015	2016	2017	2018	2019	CAGR (2014–2019)
Global							
Global speed: All handsets	1,683	1,747	2,017	2,629	3,248	3,963	19%
Global speed: Smartphones	6,097	6,899	7,686	8,468	8,829	10,403	11%
Global speed: Tablets	8,697	10,203	10,907	12,119	12,403	13,054	8%
By Region							
Asia Pacific	2,026	2,233	2,443	2,730	3,047	3,509	12%
Latin America	1,378	1,556	1,781	2,077	2,463	2,949	16%
North America	2,816	3,052	3,542	4,299	5,196	6,399	18%
Western Europe	2,037	2,452	2,916	3,408	3,910	4,687	18%
Central and Eastern Europe	1,620	1,939	2,353	2,762	3,167	3,671	18%
Middle East and Africa	582	700	742	1,095	1,577	2,097	29%

Source: Cisco VNI Mobile, 2015

Current and historical speeds are based on data from Ookla's Speedtest. Forward projections for mobile data speeds are based on third-party forecasts for the relative proportions of 2G, 3G, 3.5G, and 4G among mobile connections through 2019.

A crucial factor promoting the increase in mobile speeds over the forecast period is the increasing proportion of fourth-generation (4G) mobile connections. The impact of 4G connections on traffic is significant, because 4G connections, which include mobile WiMAX and Long-Term Evolution (LTE), generate a disproportionate amount of mobile data traffic.

Wi-Fi Speeds from Mobile Devices

Globally, Wi-Fi connection speeds originated from dual-mode mobile devices will nearly double by 2019. The average Wi-Fi network connection speed (10.6 Mbps in 2014) will exceed 18.5 Mbps in 2019. North America will experience the highest Wi-Fi speeds, of 29 Mbps, by 2019 (Table 7).

Wi-Fi speeds inherently depend on the quality of the broadband connection to the premises. The speed also depends on the Wi-Fi standard in the CPE device. The latest standard, IEEE 802.11ac, is considered a true wired complement and can enable higher-definition video streaming and services that require higher data rates. Also an important factor in the use of Wi-Fi technology is the number and availability of hotspots.

Table 7. Projected Average Wi-Fi Network Connection Speeds (in Mbps) by Region and Country

Region	2014	2015	2016	2017	2018	2019	CAGR (2014-2019)
Global	10.6	12.5	13.9	15.4	17.0	18.5	12%
Asia Pacific	10.3	11.4	12.4	13.5	14.5	15.6	9%
Latin America	5.8	5.9	6.7	7.3	7.9	8.6	8%
North America	14.3	17.4	20.3	23.2	26.1	29.0	15%
Western Europe	13.0	13.9	15.9	17.5	19.2	20.9	10%
Central and Eastern Europe	11.7	13.4	15.7	17.8	19.9	22.0	14%
Middle East and Africa	3.9	4.0	4.2	4.3	4.5	4.7	3%

Source: Cisco VNI, 2015

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

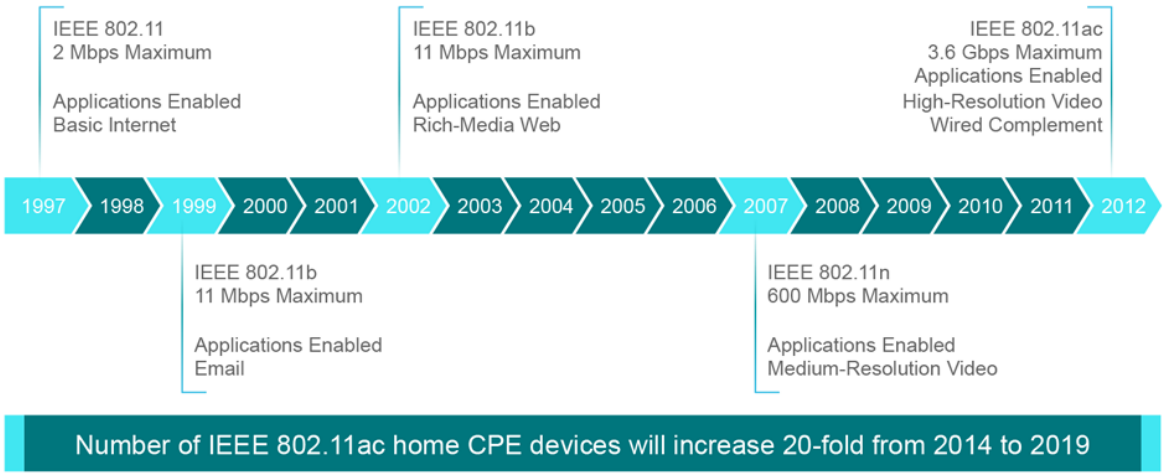
Trend 8: Mobility (Wi-Fi) Continues to Gain Momentum

Globally, there will be nearly 341 million public Wi-Fi hotspots by 2018, up from 48 million hotspots in 2014, a sevenfold increase, according to a study conducted by iPass Inc. and Maravedis and Rethink. Europe will have the greatest number of hotspots, with 115 million hotspots by 2018, with North America a close second, with 109 million hotspots. Public Wi-Fi along with community hotspots are taken into account as well. Community hotspots or homespots are just emerging as a potentially significant element of the public Wi-Fi landscape. In this model, subscribers allow part of the capacity of their residential gateway to be open to casual use. The homespot may be provided by a broadband or other provider directly or through a partner.

Critical enablers of Hotspot 2.0 adoption are higher-speed Wi-Fi gateways and the adoption of the IEEE 802.11ac and 802.11n standards. Globally, the prevalence of IEEE 802.11ac, the latest Wi-Fi standard, will gain momentum from 2014 through 2019. Globally, shipments of home Wi-Fi routers with IEEE 802.11ac will grow 20-fold from 2014 through 2019, and routers with IEEE 802.11n (CY2014 was the last year of increase in shipments of IEEE 802.11n BB CPE) will continue to be replaced by IEEE 802.11ac even beyond the forecast period.

IEEE 802.11n, which was ratified in 2007, provides a range of speeds that allow users to view medium-resolution video streaming due to higher throughput. The latest standard, IEEE 802.11ac, with very high theoretical speeds, is considered a true wired complement and can enable higher-definition video streaming and services with use cases that require higher data rates (Figure 21).

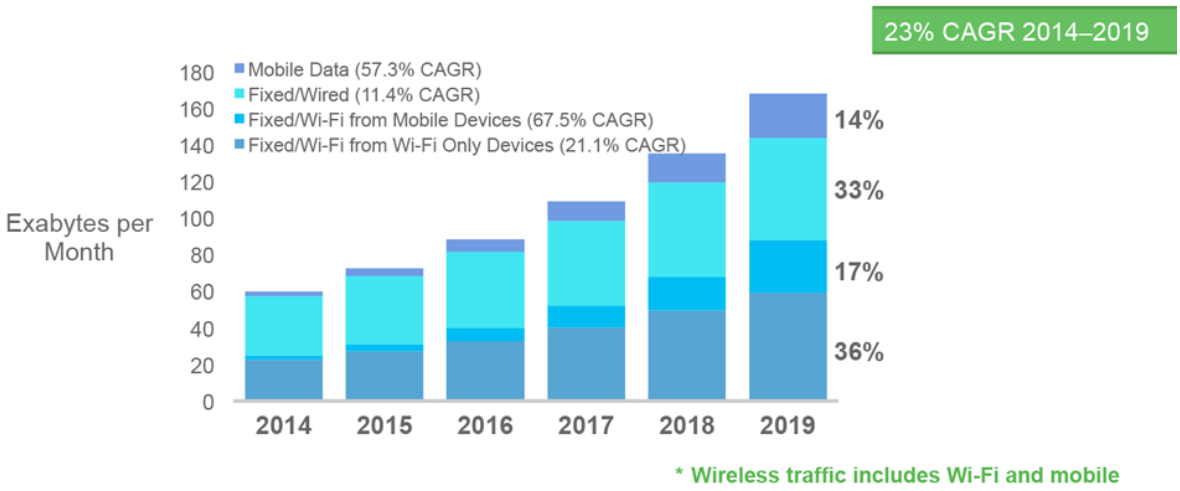
Figure 21. Future of Wi-Fi as Wired Complement



The rapid growth of mobile data traffic has been widely recognized and reported. The trend toward mobility carries over into the realm of fixed networks as well, in that an increasing portion of traffic will originate from portable or mobile devices. Figure 22 shows the growth in Wi-Fi and mobile traffic in relation to traffic from wired devices. By 2019, wired networks will account for 33 percent of IP traffic, and Wi-Fi and mobile networks will account for 67 percent of IP traffic. In 2014, wired networks accounted for the majority of IP traffic, at 54 percent; Wi-Fi accounted for 42 percent; and mobile or cellular networks accounted for 4 percent of total global IP traffic.

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

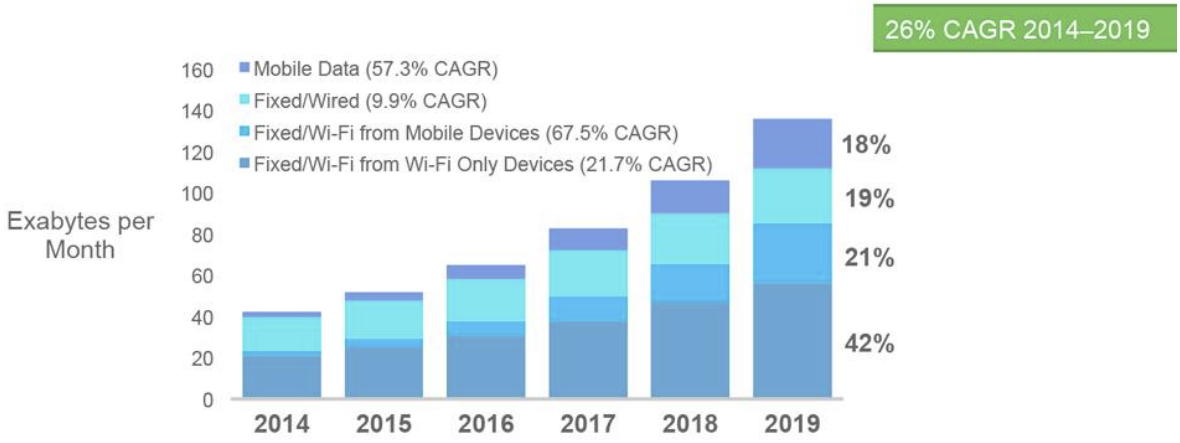
Figure 22. Global IP Traffic, Wired and Wireless



Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

Narrowing the focus to Internet traffic and excluding managed IP traffic yields a more pronounced trend. By 2019, wired devices will account for 19 percent of Internet traffic, and Wi-Fi and mobile devices will account for 81 percent of Internet traffic (Figure 23). In 2014, wired devices accounted for less than half of Internet traffic, at 39 percent.

Figure 23. Global Internet Traffic, Wired and Wireless



Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

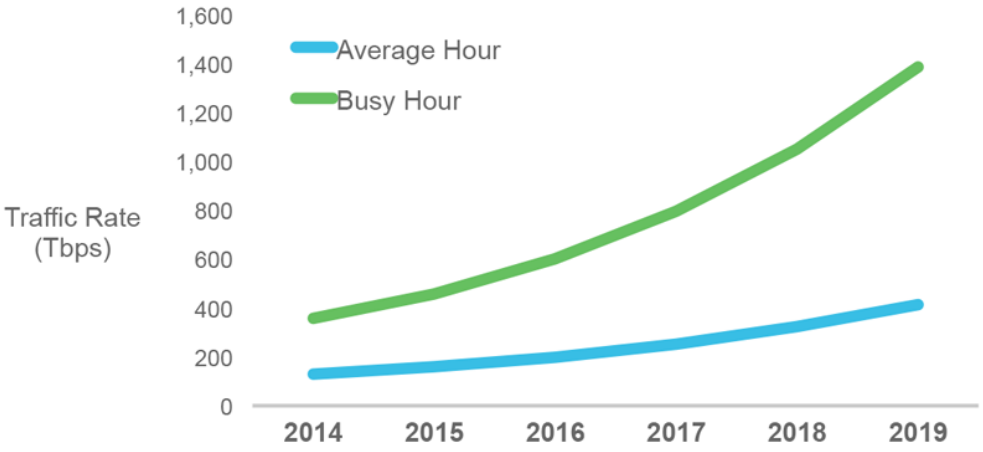
© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

Trend 9: Traffic Pattern Analysis (Peak Compared to Average and CDN Compared to Metro)

While average Internet traffic has settled into a steady growth pattern, busy-hour traffic (or traffic in the busiest 60-minute period of the day) continues to grow more rapidly than average traffic. Service providers plan network capacity according to peak rates, rather than average rates. In 2014, busy-hour Internet traffic grew 37 percent, and average traffic grew at 29 percent.. Between 2014 and 2019, global busy-hour Internet use will grow at a CAGR of 31 percent, compared with 26 percent for average Internet traffic (Figure 24).

Video is the underlying reason for accelerated busy-hour traffic growth. Unlike other forms of traffic, which are spread evenly throughout the day (such as web browsing and file sharing), video tends to have a "prime time." Because of video consumption patterns, the Internet now has a much busier busy hour. Because video has a higher peak-to-average ratio than data or file sharing, and because video is gaining traffic share, peak Internet traffic will grow faster than average traffic. The growing gap between peak and average traffic is amplified further by the changing composition of Internet video. Real-time video such as live video, ambient video, and video calling has a peak-to-average ratio that is higher than on-demand video.

Figure 24. Busy-Hour Compared with Average Internet Traffic Growth

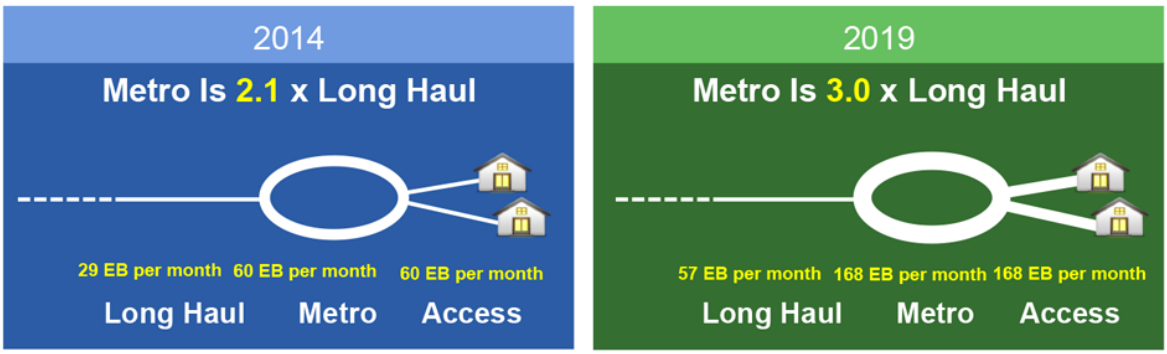


Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

Metro-only traffic (traffic that traverses only the metro network and bypasses long-haul traffic links) surpassed long-haul traffic in 2014, and will account for 66 percent of total IP traffic by 2019. Metro-only traffic will grow twice as fast as long-haul traffic from 2014 to 2019. Long-haul traffic is also deposited onto metro networks so that total metro traffic already exceeds long-haul traffic. In 2014, total metro traffic was 2.1 times greater than long-haul traffic, and by 2019, metro traffic will be 3.1 times greater than long-haul traffic (Figure 25).

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

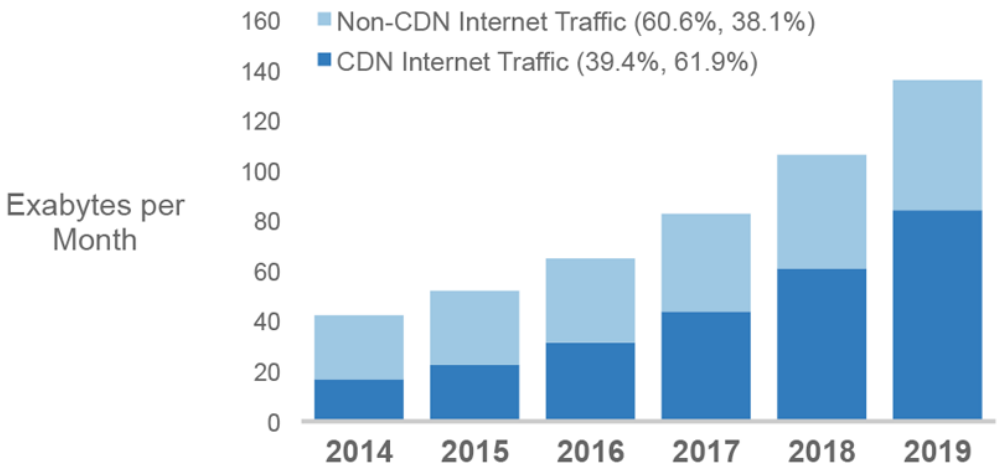
Figure 25. Global Metro Traffic Compared to Long-Haul Traffic, 2014 and 2019



Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

The faster growth of metro traffic compared with long-haul is due in part to CDNs, which will carry 62 percent of total Internet traffic by 2019 (Figure 26). Although network performance is usually attributed to the speeds and latencies offered by the service provider, the delivery algorithms used by CDNs have an equal if not more significant bearing on video quality.

Figure 26. Global Content Delivery Network Internet Traffic, 2014 and 2019



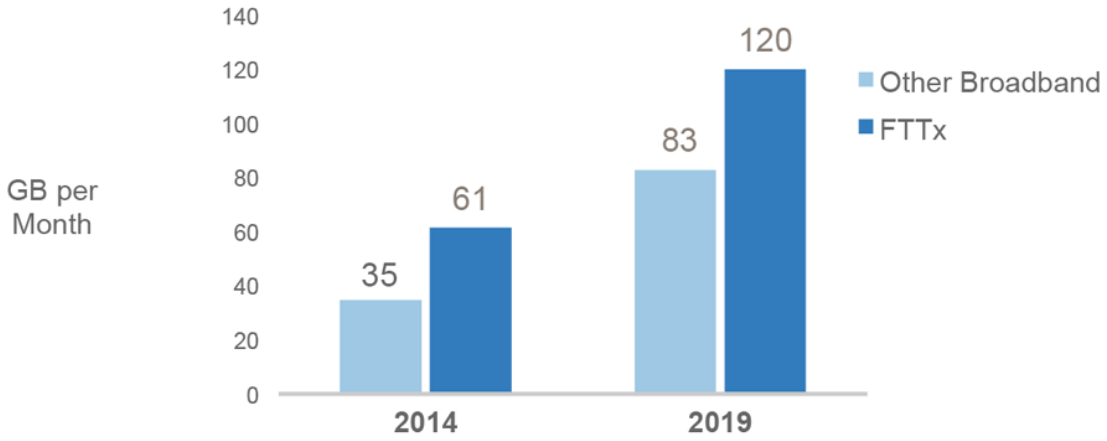
Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

Trend 10: Network Performance Promotes User Behaviors (Data Plans and Caps)

Speed is a critical factor in Internet traffic. When speed increases, users stream and download greater volumes of content, and adaptive bit-rate streaming increases bit rates automatically according to available bandwidth. Service providers find that users with greater bandwidth generate more traffic. In 2014, households with high-speed fiber connectivity generated 77 percent more traffic than households connected by DSL or cable broadband, globally (Figure 27). The average FTTH household generated 61 GB per month in 2014 and will generate 120 GB per month in 2019.

Figure 27. Fiber-Connected Households Generate More Traffic Than Household with Other Broadband



Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

To limit the volume of traffic, service providers can institute use-based tiered pricing and data caps.

On mobile networks, by looking at the use of more than 33,000 lines from Tier 1 mobile operators from 2010 to 2014, we found that monthly traffic from the top 1 percent of users is down to 18 percent of overall use compared to 52 percent in 2010, showing the effects of tiered pricing. With mobile penetration reaching a saturation point in many countries across all regions, the trend has been toward tiered plans as a way to monetize data and effectively manage or throttle the top users of traffic. On the fixed networks, data caps continue to increase to match subscribers' growing appetite for video. In the United States, Tier 1 carriers are considering 500 GB as a possible monthly limit by the 2019 time frame, from a variety of offerings today. A large provider in Japan has a 30-GB per day upload cap. In several countries, Netflix has a sizeable percentage of the Internet video minutes and traffic. Wildcard traffic generators such as Twitch.TV, a live streaming service in which video gamers watch each other play, has established itself on many fixed networks around the world.

Data caps affect a larger percentage of mobile users than fixed users. With Tier 1 carriers, approximately 8 percent of mobile users consume more than 2 GB per month (a common mobile data cap), whereas only 1 percent of fixed users consume more than 500 GB per month (a common fixed data cap).

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

Other Trends to Watch

Cisco's approach to forecasting IP traffic is conservative, and certain emerging trends have the potential to increase the traffic outlook significantly. The most rapid upswings in traffic occur when consumer media consumption migrates from offline to online or from broadcast to unicast:

- **Applications that might migrate from offline to online (cloud)**: The crucial application to watch in this category is gaming. Gaming on demand and streaming gaming platforms have been in development for several years, with many newly released in 2013 or 2014. With traditional gaming, graphical processing is performed locally on the gamer's computer or console. With cloud gaming, game graphics are produced on a remote server and transmitted over the network to the gamer. Currently, online gaming traffic represents only 0.04 percent of the total information content associated with online and offline game play[1]. If cloud gaming takes hold, gaming could quickly become one of the largest Internet traffic categories.
- **Behavior that might migrate from broadcast to unicast**: Live TV is currently distributed by means of a broadcast network, which is highly efficient in that it carries one stream to many viewers. Live TV over the Internet would carry a separate stream for each viewer. AT&T in the past estimated that a shift from multicast or broadcast to over-the-top unicast "would multiply the IP backbone traffic by more than an order of magnitude".[2]
- **New consumer behavior**: The adoption of UHD TV would fall into the category of new consumer behavior. UHD is already growing in terms of supporting devices, and content video providers are preparing to broadcast and stream UHD. Higher resolution and network requirements to stream UHD will create traffic multiplier effects. This nascent traffic type can cause surprises that have network design implications. Another high-bandwidth application on the horizon that could consume a lot of bandwidth is spherical video. Spherical, or immersive, video integrates multiple camera angles to form a single video stream and can be watched from the viewer's preferred perspective. It can generate bit rates 3 to 10 times greater than nonimmersive HD bit rates.

For More Information

For more information about Cisco's IP traffic forecast, refer to "Cisco VNI: Forecast and Methodology, 2014–2019" and visit the other resources and updates at www.cisco.com/go/vni. Several interactive tools allow you to create custom highlights and forecast charts by region, by country, by application, and by end-user segment. Refer to the Cisco VNI Highlights tool and the Cisco VNI Forecast Widget tool. Inquiries can be directed to traffic-inquiries@cisco.com.

[1] Total game play (online and offline) in the United States represents an estimated 166 exabytes per month, according to the University of California, San Diego, study, "How Much Information?"
[2] Alexandre Gerber and Robert Doverspike, "Traffic Types and Growth in Backbone Networks."

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

Appendix A: Cisco Global IP Traffic Forecast

Table 8 shows a summary of Cisco's global IP traffic forecast. For more information and additional tables, refer to "Cisco VNI: Forecast and Methodology, 2014–2019."

Table 8. Global IP Traffic, 2014–2019

IP Traffic, 2014–2019							
	2014	**2015**	**2016**	**2017**	**2018**	**2019**	**CAGR (2014–2019)**
By Type (Petabytes [PB] per Month)							
Fixed Internet	39,909	47,803	58,304	72,251	90,085	111,899	23%
Managed IP	17,424	20,460	23,371	26,087	29,274	31,858	13%
Mobile data	2,514	4,163	6,751	10,650	16,124	24,221	57%
By Segment (PB per Month)							
Consumer	47,740	58,137	71,453	88,730	111,015	138,415	24%
Business	12,108	14,289	16,973	20,258	24,469	29,563	20%
By Geography (PB per Month)							
Asia Pacific	20,729	24,819	29,965	36,608	44,223	54,434	21%
North America	19,628	23,552	28,219	33,641	41,458	49,720	20%
Western Europe	9,601	11,231	13,506	16,396	20,046	24,680	21%
Central and Eastern Europe	4,087	5,270	6,896	9,385	12,601	16,863	33%
Latin America	4,297	5,373	6,663	8,299	10,356	12,870	25%
Middle East and Africa	1,505	2,180	3,178	4,659	6,800	9,412	44%
Total (PB per Month)							
Total IP traffic	59,848	72,426	88,427	108,988	135,484	167,978	23%

Source: Cisco VNI, 2015

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
- **Mobile**: Includes Internet traffic that travels over 2G, 3G, or 4G mobile access technology
- **Internet**: Denotes all IP traffic that crosses an Internet backbone
- **Non-Internet IP**: Includes corporate IP WAN traffic, IP transport of TV and VoD, and mobile "walled-garden" traffic

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.

Americas Headquarters
Cisco Systems, Inc.
San Jose, CA

Asia Pacific Headquarters
Cisco Systems (USA) Pte. Ltd.
Singapore

Europe Headquarters
Cisco Systems International BV Amsterdam,
The Netherlands

Cisco has more than 200 offices worldwide. Addresses, phone numbers, and fax numbers are listed on the Cisco Website at **www.cisco.com/go/offices.**

Cisco and the Cisco logo are trademarks or registered trademarks of Cisco and/or its affiliates in the U.S. and other countries. To view a list of Cisco trademarks, go to this URL: www.cisco.com/go/trademarks. Third party trademarks mentioned are the property of their respective owners. The use of the word partner does not imply a partnership relationship between Cisco and any other company. (1110R)

Printed in USA

FLGD 12352 05/15

© 2015 Cisco and/or its affiliates. All rights reserved. This document is Cisco Public.