White Paper

The Zettabyte Era: Trends and Analysis

This document is part of the Cisco® Visual Networking Index™ (Cisco 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, 2015–2020.

Executive Summary

Annual global IP traffic will pass the zettabyte ([ZB]; 1000 exabytes [EB]) threshold by the end of 2016, and will reach 2.3 ZB per year by 2020. By the end of 2016, global IP traffic will reach 1.1 ZB per year, or 88.7 EB per month, and by 2020 global IP traffic will reach 2.3 ZB per year, or 194 EB per month.

Global IP traffic will increase nearly threefold over the next 5 years. Overall, IP traffic will grow at a compound annual growth rate (CAGR) of 22 percent from 2015 to 2020. Monthly IP traffic will reach 25 GB per capita by 2020, up from 10 GB per capita in 2015.

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 51 percent in 2015, compared with 29-percent growth in average traffic. Busy-hour Internet traffic will increase by a factor of 4.6 between 2015 and 2020, and average Internet traffic will increase by a factor of 2.0.

Smartphone traffic will exceed PC traffic by 2020. In 2015, PCs accounted for 53 percent of total IP traffic, but by 2020 PCs will account for only 29 percent of traffic. Smartphones will account for 30 percent of total IP traffic in 2020, up from 8 percent in 2015. PC-originated traffic will grow at a CAGR of 8 percent, and TVs, tablets, smartphones, and machine-to-machine (M2M) modules will have traffic growth rates of 17 percent, 39 percent, 58 percent, and 44 percent, respectively.

Traffic from wireless and mobile devices will account for two-thirds of total IP traffic by 2020. By 2020, wired devices will account for 34 percent of IP traffic, and Wi-Fi and mobile devices will account for 66 percent of IP traffic. In 2015, wired devices accounted for the majority of IP traffic, at 52 percent.

Content delivery networks (CDNs) will carry nearly two-thirds of Internet traffic by 2020. Sixty-four percent of all Internet traffic will cross CDNs by 2020 globally, up from 45 percent in 2015.

The number of devices connected to IP networks will be more than three times the global population by 2020. There will be 3.4 networked devices per capita by 2020, up from 2.2 networked devices per capita in 2015. There will be 26.3 billion networked devices in 2020, up from 16.3 billion in 2015.

Broadband speeds will nearly double by 2020. By 2020, global fixed broadband speeds will reach 47.7 Mbps, up from 24.7 Mbps in 2015.

By the year 2020

2.3
zettabytes will be the amount of annual global IP traffic.

47.7
Mbps of global fixed broadband speeds up from 24.7 Mbps in 2015.

30%
of total IP traffic will be from smartphones (exceeding PC traffic).

2/3
Traffic from wireless devices will account for two-thirds of total IP traffic by 2020.

3.4
devices per capita will be connected to IP networks (3X the global population).

Global Internet Video and Gaming Highlights

- It would take more than 5 million years to watch the amount of video that will cross global IP networks each month in 2020. Every second, a million minutes of video content will cross the network by 2020.
- Globally, IP video traffic will be 82 percent of all IP traffic (both business and consumer) by 2020, up from 70 percent in 2015. Global IP video traffic will grow threefold from 2015 to 2020, a CAGR of 26 percent. Internet video traffic will grow fourfold from 2015 to 2020, a CAGR of 31 percent.
- Internet video surveillance traffic nearly doubled in 2015, from 272 petabytes (PB) per month at the end of 2014 to 516 PB per month in 2015. Internet video surveillance traffic will increase tenfold between 2015 and 2020. Globally, 3.9 percent of all Internet video traffic will be due to video surveillance in 2020, up from 1.5 percent in 2015.
- Virtual reality traffic quadrupled in 2015, from 4.2 PB per month in 2014 to 17.9 PB per month in 2015. Globally, virtual reality traffic will increase 61-fold between 2015 and 2020, a CAGR of 127 percent.
- Internet video to TV grew 50 percent in 2015. This traffic will continue to grow at a rapid pace, increasing 3.6-fold by 2020. Internet video to TV will be 26 percent of fixed consumer Internet video traffic in 2020.
- Consumer video-on-demand (VoD) traffic will nearly double by 2020. The amount of VoD traffic in 2020 will be equivalent to 7.2 billion DVDs per month.
- Internet gaming traffic will grow sevenfold from 2015 to 2020, a CAGR of 46 percent. Globally, Internet gaming traffic will be 4 percent of consumer Internet traffic in 2020, up from 2 percent in 2015.

Global Mobile Highlights

- Globally, mobile data traffic will increase eightfold between 2015 and 2020. Mobile data traffic will grow at a CAGR of 53 percent between 2015 and 2020, reaching 30.6 exabytes per month by 2020.
- Global mobile data traffic will grow almost three times as fast as fixed IP traffic from 2015 to 2020. Fixed IP traffic will grow at a CAGR of 19 percent between 2015 and 2020, while mobile traffic grows at a CAGR of 53 percent. Global mobile data traffic was 5 percent of total IP traffic in 2015, and will be 16 percent of total IP traffic by 2020.

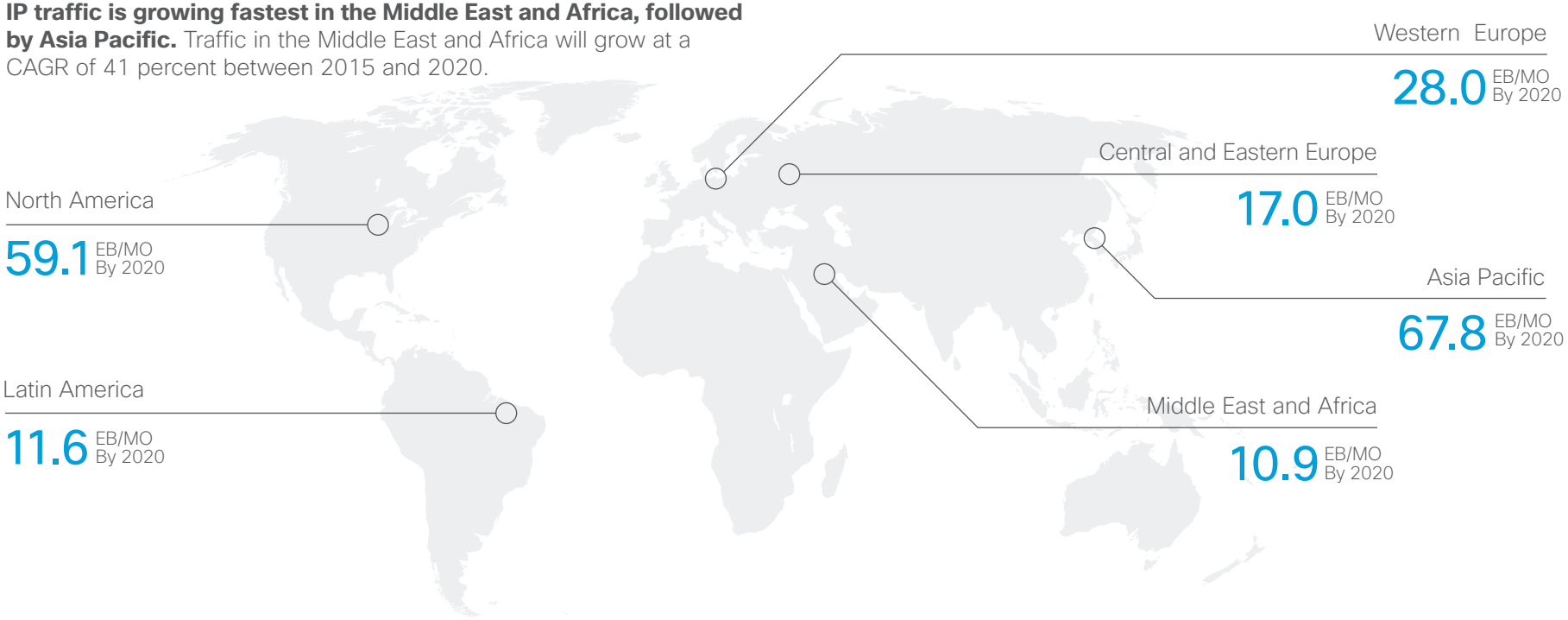
It would take an individual more than

5,000,000 YEARS

to watch the **amount of video** that will cross global IP networks **each month by 2020**.

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 41 percent between 2015 and 2020.



Summary of regional growth rates:

- IP traffic in North America (NA) will reach 59.1 EB per month by 2020, growing at a CAGR of 19 percent.
- IP traffic in the Middle East and Africa (MEA) will reach 10.9 EB per month by 2020, growing at a CAGR of 41 percent.
- IP traffic in Central and Eastern Europe (CEE) will reach 17.0 EB per month by 2020, growing at a CAGR of 27 percent.
- IP traffic in Latin America (LATAM) will reach 11.6 EB per month by 2020, growing at a CAGR of 21 percent.
- IP traffic in Asia Pacific (AP) will reach 67.8 EB per month by 2020, growing at a CAGR of 22 percent.
- IP traffic in Western Europe (WE) will reach 28.0 EB per month by 2020, growing at a CAGR of 20 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 Internet traffic will grow at a faster pace than IP WAN.

CAGR by 2020

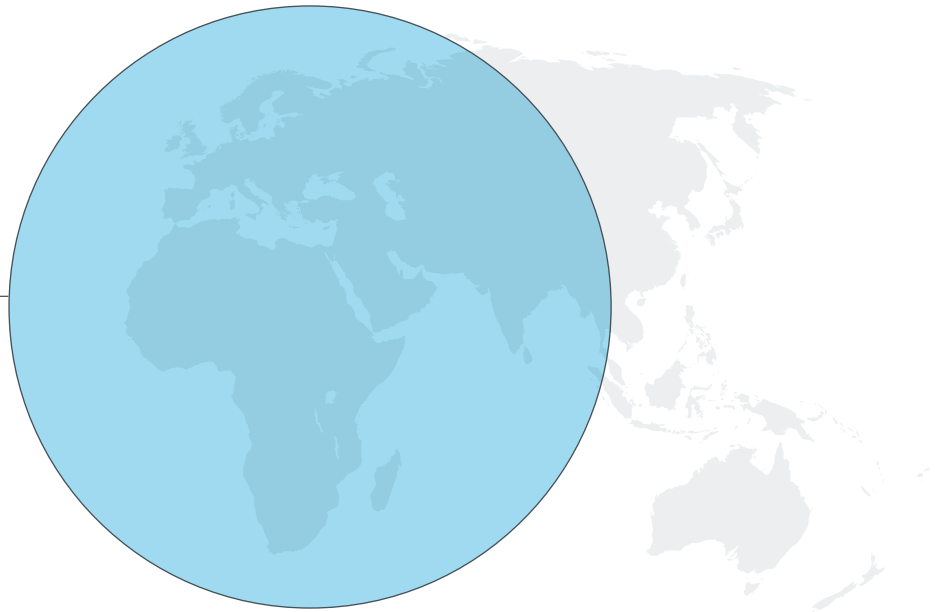
6%	21%	47%
IP WAN	Fixed business Internet	Mobile business Internet

Business IP traffic will grow at a CAGR of

18%

from 2015 to 2020.

Increased adoption of advanced video communications in the enterprise segment will cause business IP traffic to grow by a factor of 2 between 2015 and 2020.



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 21 percent, a faster pace than the global average of 18 percent. In volume, Asia Pacific will have the largest amount of business IP traffic in 2019, at 11.4 EB per month. North America will be second, at 9.1 EB per month.

Forecast Overview

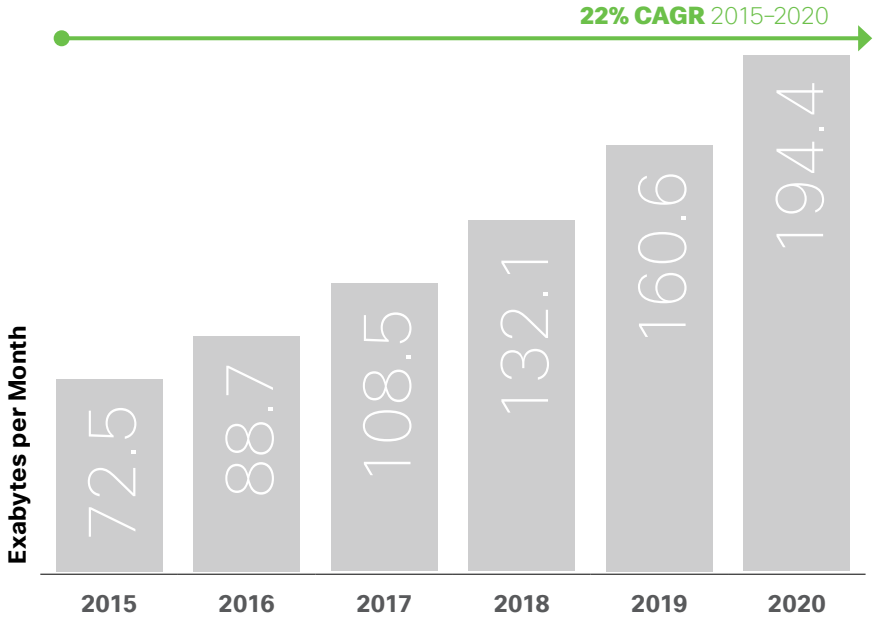
The current Cisco VNI Forecast projects global IP traffic to nearly triple from 2015 to 2020. Appendix A offers a detailed summary. Overall IP traffic is expected to grow to 194 EB per month by 2020, up from 72.5 EB per month in 2015, a CAGR of 22 percent (Figure 1). This growth represents only a slight tapering from last year's projected growth rate for 2014 to 2019, which was 23 percent. It appears that global IP traffic growth is stabilizing in the 20–25 percentage range.

For more details about Cisco's forecasting methodology, refer to the paper *Cisco VNI: Forecast and Methodology, 2015–2020*.

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

- By 2020, the gigabyte (GB) equivalent of all movies ever made will cross the global Internet every 2 minutes.
- Globally, IP traffic will reach 511 terabits per second (Tbps) in 2020, the equivalent of 142 million people streaming Internet high-definition (HD) video simultaneously, all day, every day.
- Global IP traffic in 2020 will be equivalent to 504 billion DVDs per year, 42 billion DVDs per month, or 58 million DVDs per hour.

Figure 1 Cisco VNI Forecasts 194 EB per Month of IP Traffic by 2020



Source: Cisco VNI Global IP Traffic Forecast, 2015–2020

By the year 2020

the gigabyte equivalent of **all movies ever** made will cross the global Internet

EVERY 2 MINUTES.

Total Internet traffic has experienced dramatic growth in the past 2 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 2015, global Internet traffic reached more than 20,000 GBps. Table 1 provides a view of the historical benchmarks for total Internet traffic.

Per capita IP and Internet traffic growth has followed a similarly steep growth curve over the past decade. Globally, monthly IP traffic will reach 25 GB per capita by 2020, up from 10 GB per capita in 2015, and Internet traffic will reach 21 GB per capita by 2020, up from 7 GB per capita in 2015. 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.

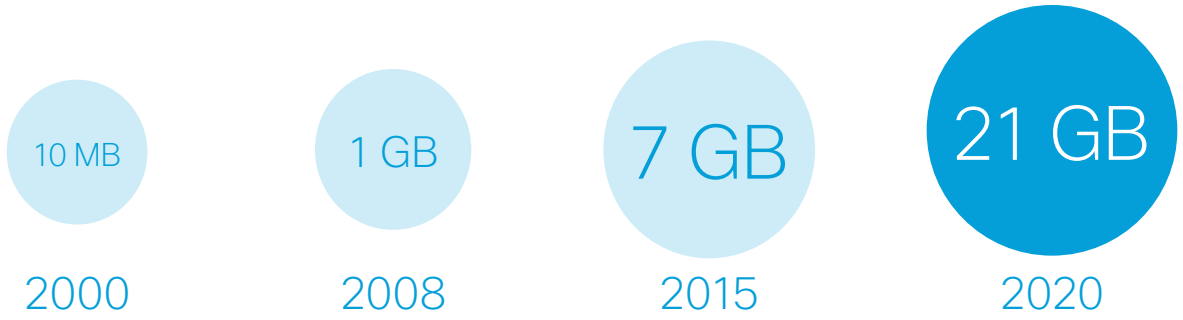
The sections that follow explore the trends contributing to the continued growth of global IP traffic.

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
2015	20,235 GBps
2020	61,386 GBps

Cisco VNI Global IP Traffic Forecast, 2015–2020

Monthly Internet traffic per capita

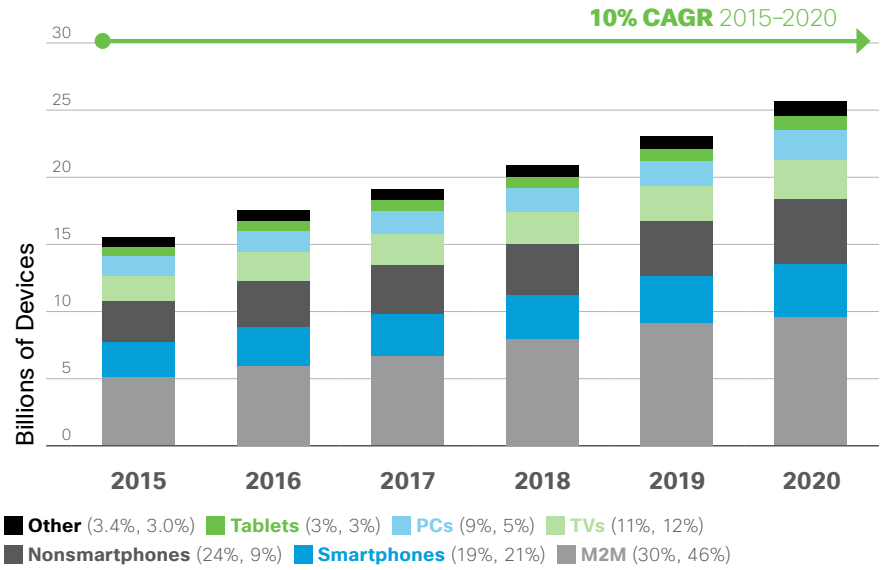


Trend 1: Continued Shifts in Mix of Devices and Connections

Figure 2 shows that globally, devices and connections (10-percent CAGR) are growing faster than both the population (1.1-percent CAGR) and Internet users (6.5-percent CAGR). 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, are contributing in a major way to the growth of devices and connections. By 2020, M2M connections will be 46 percent of the total devices and connections.

M2M connections will be the fastest-growing category, growing nearly 2.5-fold during the forecast period, at 20 percent CAGR, to 12.2 billion connections by 2020. Smartphones will grow the second fastest, at 13-percent CAGR (increasing by a factor of 1.8). Connected TVs (which include flat-panel TVs, set-top boxes [STBs], digital media adapters [DMAs], Blu-ray disc players, and gaming consoles) will grow nearly next fastest at 12-percent CAGR, to 3.1 billion by 2020. PCs will continue to decline (about a 2-percent decline) over the forecast period. However, there will be more PCs than tablets by the end of 2020 (1.35 billion PCs versus 785 million tablets).

Figure 2 Global Devices and Connections Growth



Percentages (n) refer to 2015, 2020 device share.
Source: Cisco VNI Global IP Traffic Forecast, 2015–2020

By 2020 the consumer share of the total devices, including both fixed and mobile devices, will be 74 percent, with business claiming the remaining 26 percent. Consumer share will grow at a slightly slower rate, at 9.5-percent CAGR relative to the business segment, which will grow at 12-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 Highlights tool.

Globally, the average number of devices and connections per capita will grow from 2.2 in 2015 to 3.4 by 2020 (Table 2).

Among the countries that will have the highest average per capita of devices and connections by 2020 are the United States (12.3), South Korea (12.2), and Japan (11.9).

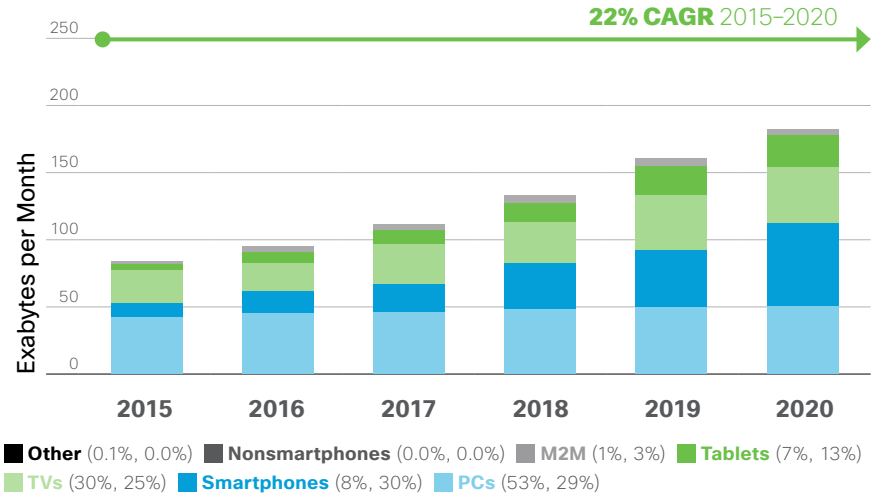
The changing mix of devices and connections and growth in multidevice ownership affects traffic and can be seen in the changing device contribution to total IP traffic. At the end of 2015, 47 percent of IP traffic and 37 percent of consumer Internet traffic originated from non-PC devices. By 2020, 71 percent of IP traffic and 71 percent of consumer Internet traffic will originate from non-PC devices (Figure 3).

Table 2 Average Number of Devices and Connections per Capita

	2015	2020	CAGR
Asia Pacific	1.87	2.82	8.5%
Central and Eastern Europe	2.49	3.96	9.8%
Latin America	2.07	2.95	7.4%
Middle East and Africa	1.09	1.47	6.2%
North America	7.14	12.18	11.3%
Western Europe	5.09	8.87	11.7%
Global	2.21	3.39	8.9%

Source: Cisco VNI Global IP Traffic Forecast, 2015-2020

Figure 3 Global IP Traffic by Devices

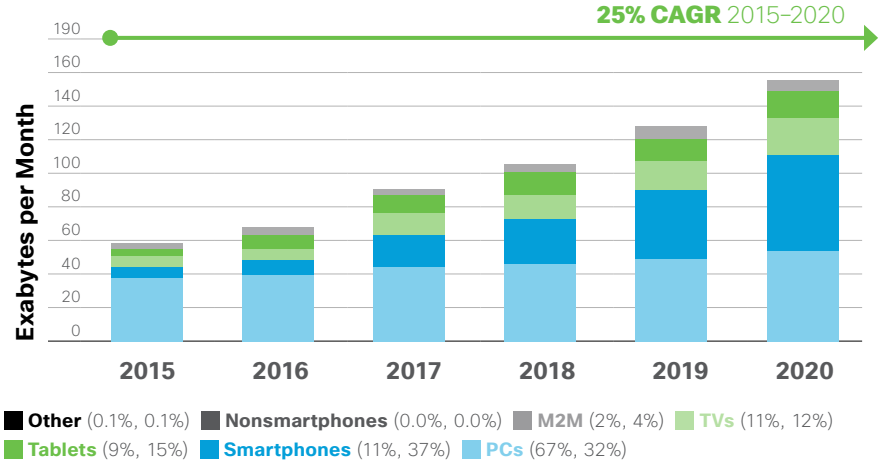


Percentages (n) refer to 2015, 2020 device share.
Source: Cisco VNI Global IP Traffic Forecast, 2015-2020

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 smartphones and tablets, traffic from these devices is growing as a percentage of total Internet traffic. Tablets will account for 15 percent of total global Internet traffic by 2020, up from 9 percent in 2015. Smartphones will account for 37 percent of total global Internet traffic by 2020, up from 11 percent in 2015 (Figure 4).

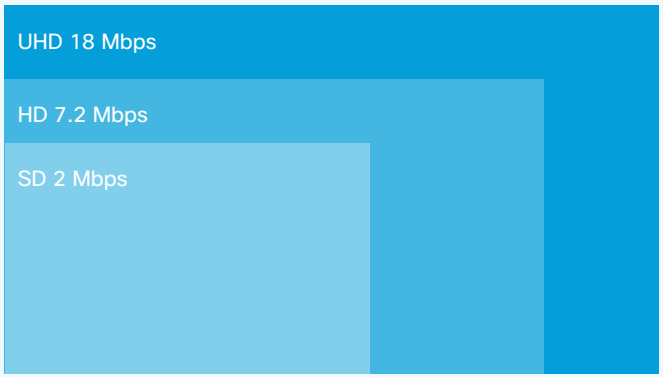
The video impact of the devices on the traffic is more pronounced because of the introduction of ultra-high-definition (UHD), or 4K, video streaming. This technology has such an impact because the bit rate for 4K video at about 18 Mbps is more than double the HD video bit rate and nine times more than standard-definition (SD) video bit rate. We estimate that by 2020, 40 percent of the installed flat-panel TV sets will be UHD, up from 8 percent in 2015 (Figure 5).

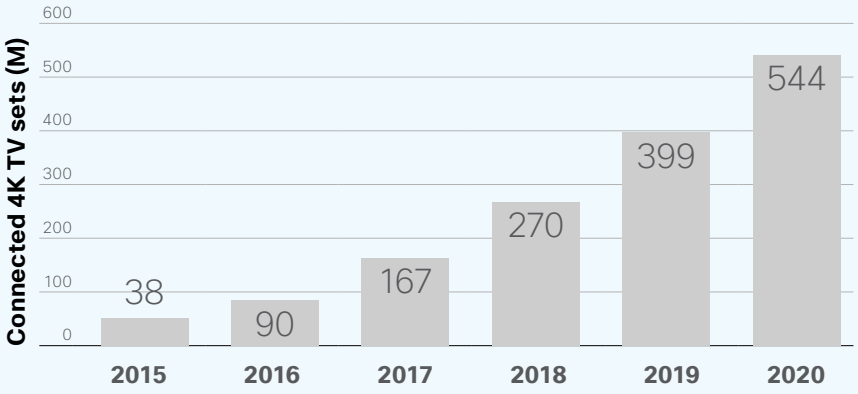
Figure 4 Global Internet Traffic by Device Type



Percentages (n) refer to 2015, 2020 device share.
Source: Cisco VNI Global IP Traffic Forecast, 2015–2020

Figure 5 Increasing Video Definition: By 2020, More Than 40 Percent of Connected Flat-Panel TV Sets Will Be 4K





Source: Cisco VNI Global IP Traffic Forecast, 2015–2020

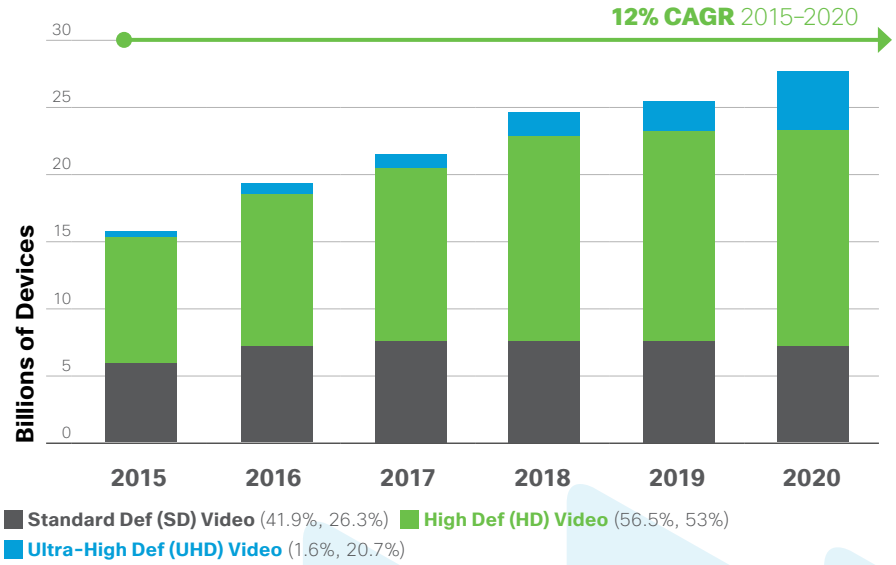
An Internet-enabled **HD television** that delivers

45 MINUTES

of content per day from the Internet would generate as much Internet traffic as **an entire household** today.

UHD (or 4K) IP VoD will account for 21 percent of global VoD traffic in 2020 (Figure 6).

Figure 6 Global 4K Video Traffic



Percentages (n) refer to 2015, 2020 traffic shares.
Source: Cisco VNI Global IP Traffic Forecast, 2015–2020

Trend 2: IPv6 Adoption Enables Internet of Everything (IoE) 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, North America, and Latin America have already exhausted their IPv4 allotments, and Africa is expected to exhaust its allotment by 2018.

Table 3 shows the projected exhaustion dates as of May 2016, according to the Regional Internet Registries (RIR).

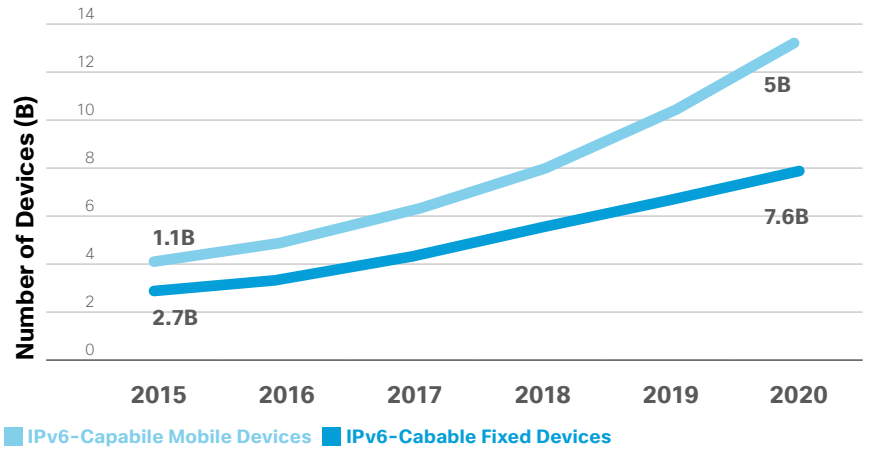
Building on the VNI IPv6-capable devices analysis, the forecast estimates that globally there will be nearly 13 billion IPv6-capable fixed and mobile devices by 2020, up from nearly 4 billion in 2015, a CAGR of 27 percent. In terms of percentages, 48 percent of all fixed and mobile networked devices will be IPv6 capable by 2020, up from 23 percent in 2015 (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 and estimations of the types of mobile network infrastructure to which the device can connect (3.5 generation [3.5G] or later). Fixed-device IPv6 capability is assessed based on device support of IPv6 and 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.

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)	September 24, 2015 (actual)
African Network Information Center (AFRINIC)	April 4, 2018 (projected)

Figure 7 Global IPv6-Capable Devices and Connections Forecast, 2015–2020



Source: Cisco VNI Global IP Traffic Forecast, 2015–2020

Globally, 90 percent of smartphones and tablets will be IPv6 capable by 2020, up from 60 percent in 2015. Globally, there will be 5.8 billion IPv6-capable smartphones and tablets by 2020, up from 2.1 billion in 2015. By 2020, 30 percent of M2M connections will be IPv6 capable, reaching 3.7 billion, a 67-percent CAGR.

According to the World IPv6 Launch Organization in May 2016, fixed and mobile network operators worldwide are deploying IPv6 and starting to report notable IPv6 traffic generation. Romania's RCS & RDS reported nearly 12 percent, France's Free telecom company reported 22 percent, KDDI reported nearly 28 percent, Comcast reported 45 percent, AT&T reported 59 percent, and Verizon Wireless reported 69 percent deployment. According to Google, in May 2016, the percentage of users who accessed Google through IPv6 was about 11 percent.

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

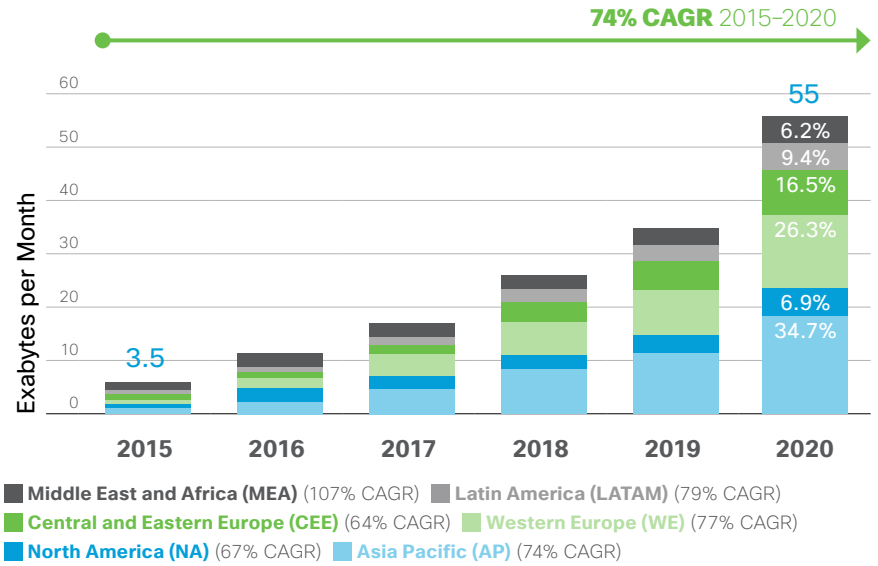
Looking to 2020, if 60 percent of IPv6-capable devices are actively connected to an IPv6 network, the forecast estimates that globally, IPv6 traffic would amount to 55 EB per month, or 34 percent of total Internet traffic (Figure 8).

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.

Content providers are also moving to increase the IPv6 enablement of their sites and services. According to Cisco IPv6 labs, by 2020 the content available over IPv6 will be about 35 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 positively affected 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 IoE.

Figure 8 Projected Global Fixed and Mobile IPv6 Traffic Forecast 2015–2020



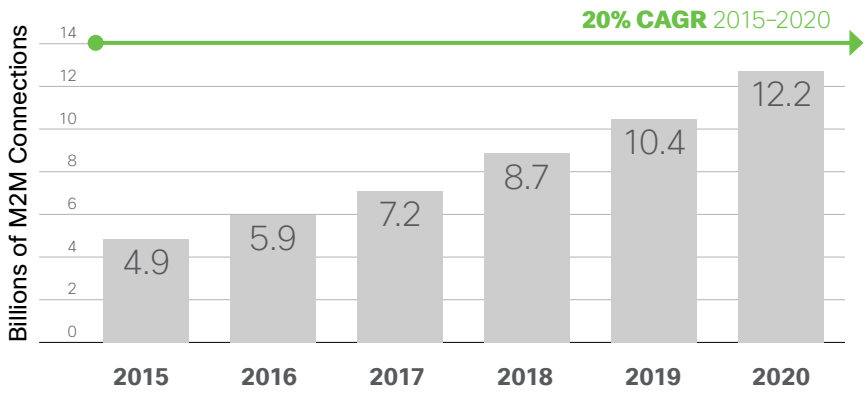
Source: Cisco VNI Global IP Traffic Forecast, 2015–2020

Trend 3: M2M Applications Across Many Industries Accelerate IoE Growth

The IoE phenomenon, in which people, processes, data, and things connect to the Internet and each other, is showing tangible growth. Globally, M2M connections will grow nearly 2.5-fold, from 4.9 billion in 2015 to 12.2 billion by 2020 (Figure 9). There will be 1.6 M2M connections for each member of the global population by 2020.

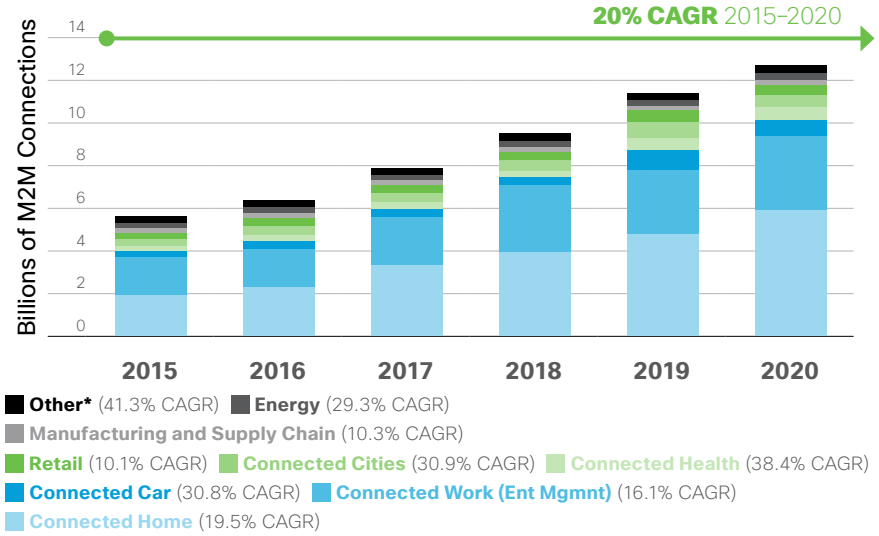
Connected home applications, such as home automation, home security and video surveillance, connected white goods, and tracking applications, will represent 47 percent, or nearly half, of the total M2M connections by 2020, showing the pervasiveness of M2M in our lives (Figure 10). Connected healthcare, 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.

Figure 9 Global M2M Connection Growth



Source: Cisco VNI Global IP Traffic Forecast, 2015–2020

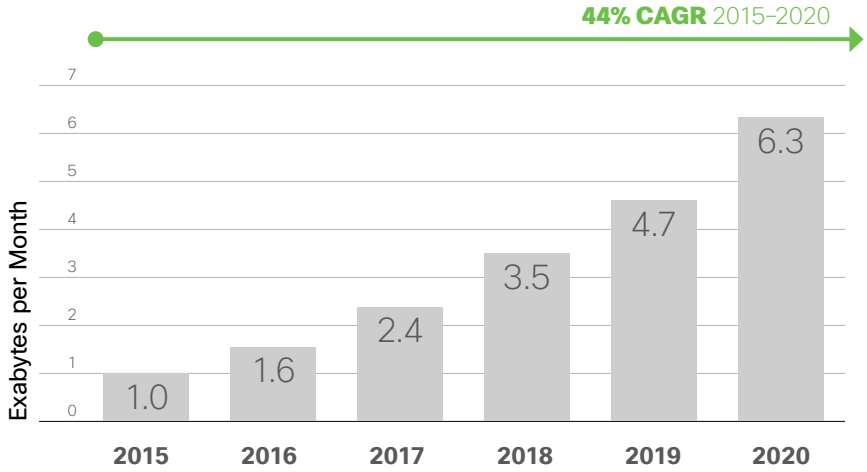
Figure 10 Global M2M Connection Growth by Industries



*"Other" includes Agriculture, Construction, and Emergency Services.
Source: Cisco VNI Global IP Traffic Forecast, 2015–2020

Although the number of connections is growing threefold, global M2M IP traffic will grow sixfold over this same period, from 1 EB per month in 2015 (1.4 percent of global IP traffic) to 6.3 EB by 2020 (3.2 percent of global IP traffic; refer to Figure 11). The amount of traffic is growing faster than the number of connections because of the increase of deployment of video applications on M2M connections and 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: Exabytes per Month



Source: Cisco VNI Global IP Traffic Forecast, 2015–2020

By the year 2020

there will be

1.6 M2M CONNECTIONS

per capita globally.

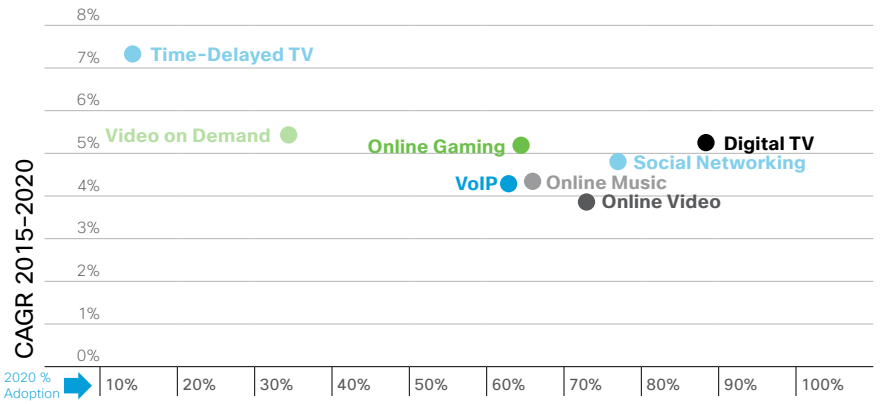
Trend 4: Service Adoption Trends: Residential, Consumer Mobile, and Business Services

Global Residential Services: Video Continues to Grow

Between 2014 and 2015, the highest growth happened on the Internet side in online gaming, with 15-percent year-over-year (YoY) growth. Social networking was the most widely adopted residential Internet service, with YoY growth of 8.5 percent, growing from 1.3 billion users in 2014 to 1.4 billion users in 2015.

By 2020, digital TV and social networking will be the two services with the highest penetration rates, with 87 percent and 76 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 7-percent CAGR. Online gaming (5.3-percent CAGR) will be the fastest-growing residential Internet service. Online-gaming growth is accelerated primarily by technology enhancements in PCs such as graphics, motion sensing, gesture recognition, etc (Figure 12).

Figure 12 Global Residential Services Adoption and Growth



Note: By 2020, the global residential fixed Internet population will be 2.4 billion; the number of global TV households will be 1.8 billion.
Source: Cisco VNI Service Adoption Forecast, 2015–2020

By 2020, **time-delayed TV** and **online gaming** will be the two **fastest-growing residential services** globally, with **7 percent** and **5 percent** CAGRs, respectively.

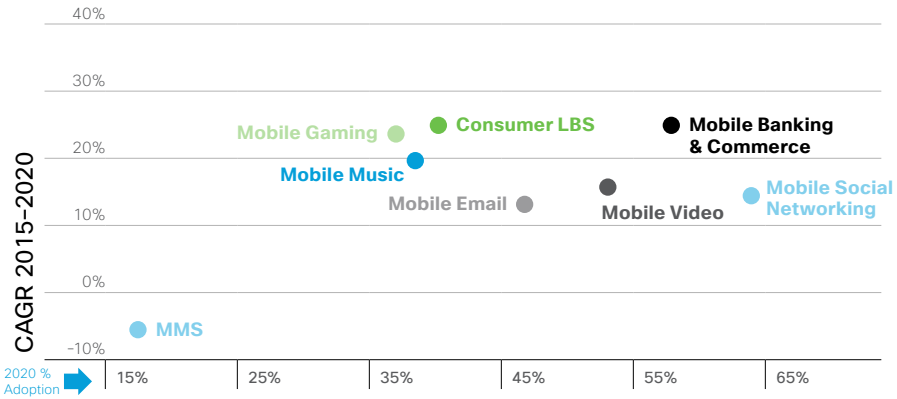
Trend 4: Service Adoption Trends: Residential, Consumer Mobile, and Business Services (Cont.)

Global Consumer Mobile Services

Between 2014 and 2015, all consumer mobile services except one grew at more than 10 percent YoY. The highest growth was in consumer location-based services (LBS), with YoY growth of 38 percent, from a base of 585 million users in 2014 to 807 million in 2015. Other significant YoY growth was in mobile banking and commerce (37 percent), followed by mobile video (35 percent). Regions such as Latin America (62-percent YoY growth) and the Middle East and Africa (52-percent YoY growth) had the fastest growth in consumer mobile LBS. Mobile banking and commerce also grew the fastest in Latin America, at 49-percent YoY growth. Mobile video growth was led by Middle East and Africa, at 43-percent YoY growth.

From 2015 to 2020, 6 out of 8 consumer mobile services will grow at more than 14-percent CAGR, 3 will grow at more than 20-percent CAGR, and 1 will decline. The fastest growth will be in consumer LBS (23.9 percent), followed by mobile commerce (22.7 percent). Regions with especially high rates of growth in mobile commerce services are the Middle East and Africa, Central and Eastern Europe, Latin America, and Asia Pacific, which have historically been underserved (or not reached) by traditional brick and-mortar financial institutions (Figure 13).

Figure 13 Global Consumer Mobile Services



Note: By 2020, the global consumer mobile population will be 5 billion.
Source: Cisco VNI Service Adoption Forecast, 2015–2020

By 2020, **consumer LBS** and **mobile commerce** will be the **two fastest-growing** consumer mobile services globally, with **24 percent** and **23 percent** CAGRs, respectively.

Trend 4: Service Adoption Trends: Residential, Consumer Mobile, and Business Services (Cont.)

Global Business Services

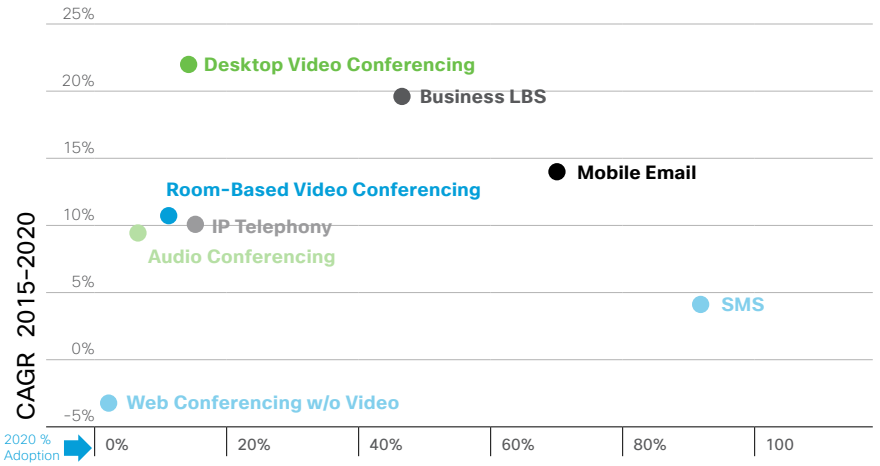
Between 2014 and 2015, the highest YoY growth was in business LBS, with a 32-percent increase, from 92 million users in 2014 to 121 million in 2015. Other significant YoY growth was in desktop video conferencing (25 percent; refer to Figure 14).

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. We see that personal or desktop video conferencing is increasingly replacing room-based conferencing as video becomes simpler and more integrated into unified communications business service offers.

From 2015 to 2020, the fastest-growing business service is expected to be desktop or personal video conferencing. The growth in personal video conferencing, specifically unified communications-based video conferencing, has recently accelerated because of the higher quality and lower price of new services and products. It is also caused by the availability of desktop video conferencing offers, which can be standalone or integrated. In addition, the growth in mobile clients will support video conferencing growth. Conversely, the use of web conferencing without video will show a decline of 4-percent CAGR over the forecast period (Figure 14).

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

Figure 14 Global Business Services Adoption and Growth



Note: By 2020, the global business Internet population will be 2.2 billion; the number of business mobile users will be 577 million.

Source: Cisco VNI Service Adoption Forecast, 2015–2020

By 2020, **desktop video** conferencing and **business mobile LBS** will be the **two fastest-growing** business services globally, with **21 percent** and **18 percent** CAGRs, respectively.

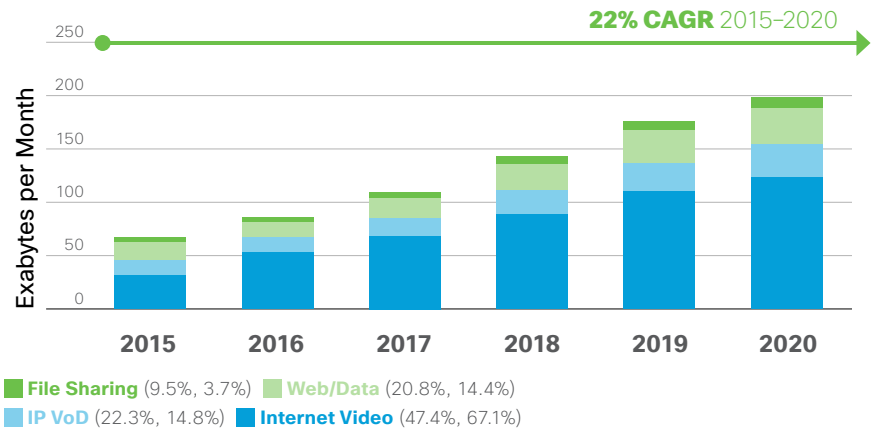
Trend 5: Applications Traffic Growth

The sum of all forms of IP video, which include Internet video, IP VoD, video files exchanged through file sharing, video-streamed gaming, and video conferencing, will continue to be in the range of 80 to 90 percent of total IP traffic. Globally, IP video traffic will account for 82 percent of traffic by 2020 (Figure 15).

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 peer-to-peer [P2P] traffic) 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 onboard 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 4 percent of consumer fixed Internet traffic by 2020. Furthermore, these downloads tend to occur during peak usage periods, with gaming downloads reaching up to 10 percent of busy-hour traffic.

Figure 15 Global IP Traffic by Application Category



Percentages (n) refer to 2015, 2020 traffic shares.
Source: Cisco VNI Global IP Traffic Forecast, 2015–2020

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, a situation that 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 content-delivery system (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 symmetrical.
- High-end video communications could accelerate, requiring symmetrical 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.

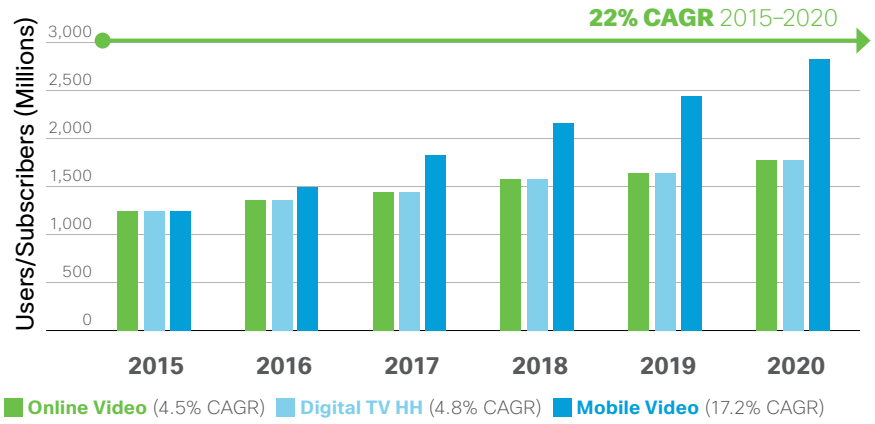
Trend 6: "Cord-Cutting" Analysis

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 more slowly relative to 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. Online video, which we found was growing faster until last year, is now growing almost on par with digital television. Also, in emerging regions, mobile video growth rates are even higher, because these regions are skipping over fixed connectivity.

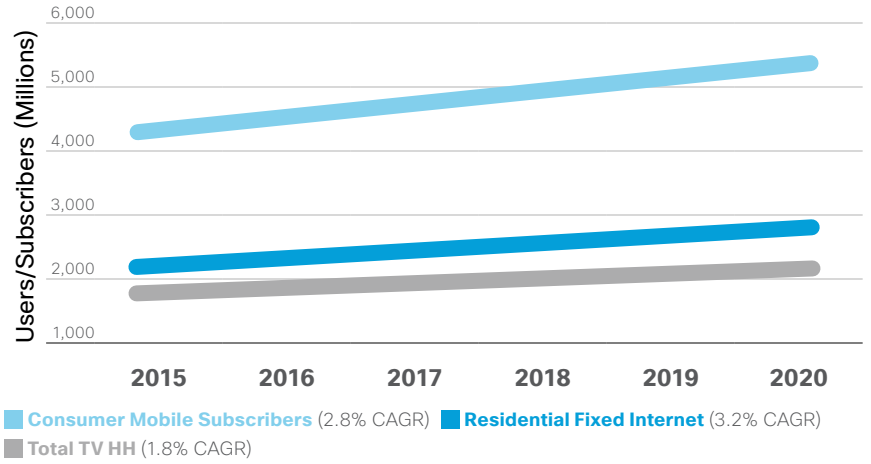
Another factor supporting this trend is that the total addressable markets for these services–residential Internet users, consumer mobile users, and total TV households (for digital-TV households)–show significantly different growth patterns (Figure 17). Residential Internet users are expected to increase at a CAGR of nearly 3.2 percent, and consumer mobile users at 2.8 percent, while at the same time the number of TV households is flattening, with a meager 1.8-percent forecasted CAGR.

Figure 16 Mobile Video Growing Fastest; Online Video and Digital TV Grow Similarly



Source: Cisco VNI Global IP Traffic Forecast, 2015–2020

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

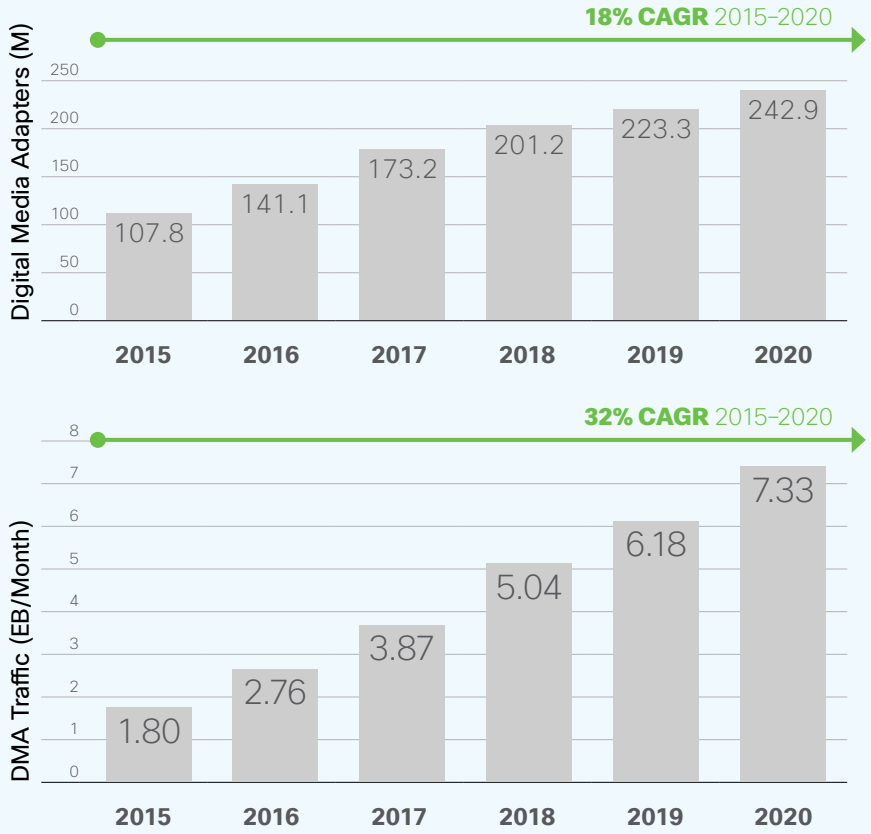


Source: Cisco VNI Global IP Traffic Forecast, 2015–2020

Also, if we look at Internet devices such as digital media adapters (DMAs), we find that although they represent only 9 percent of all Internet-connected set-top boxes (STBs)—including service provider STBs, gaming consoles, and directly connected Internet TV sets—by 2020 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).

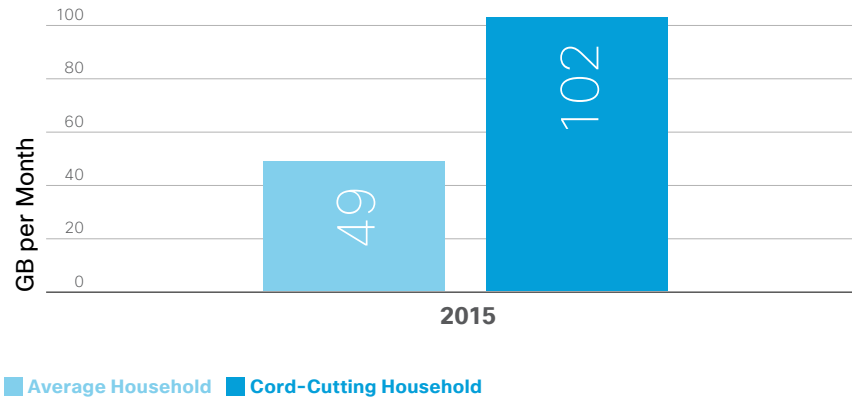
From a traffic perspective, we expect that on average a household that is still on linear TV will generate much less traffic than a household that has "cut the cord" and is relying on Internet video (Figure 19). A cord-cutting household will generate 102 GB per month in 2016, compared to 49 GB per month for an average household. This difference occurs because linear television generates much less traffic (one stream of video shared across numerous linear-TV households) than Internet video, which is unicast to each Internet video device.

Figure 18 Growth in Global Digital Media Adapters



*DMAs include devices such as Roku, Apple TV, Chromecast, etc.
Source: Cisco VNI Global IP Traffic Forecast, 2015–2020

Figure 19 Global Cord Cutting Generates Double the Traffic



Source: Cisco VNI Global IP Traffic Forecast, 2015–2020

Trend 7: Security Analysis

Users expect their online experience to be always available and always secure—and for their personal and business assets to be safe. Annual security reports for 2016 from industry giants in the security space highlight the need for increased focus on cybercrime, data breaches and espionage, and mitigation strategies (Figure 20).

The last several years have been easily the most eventful period from a security threat perspective, with many serious data breaches that have been discussed widely in the media. There were a total of 780 breaches with a total of nearly 178 million records stolen in 2015. The number of records stolen per data breach averaged 228 thousand in 2015, according to 2015 data breach statistics from IDT911. The average cost paid for each sensitive lost or stolen record increased 6 percent from 2015 to 2016, according to a joint study by IBM and the Ponemon Institute.

More secure Internet servers leads to a large footprint of security and authentication, better serving end users with secure transactions and communication. The percentage of secure Internet servers that conduct encrypted transactions over the Internet using Secure Sockets Layer (SSL) compared to the total number of web-facing servers depicts the nature of the secure footprint. Western Europe led with the number of secure Internet servers per 1 million people with 50 percent, followed by Central and Eastern Europe with 29 percent, North America with 27 percent, and Asia Pacific with around 23 percent. The average number of breaches was highest in Asia Pacific organizations and lowest in U.K. and U.S. enterprises in 2015, according to a recent study published by McAfee.

Figure 20 Security—Industry Top of Mind

*Frequency of **DDoS attacks** has increased more than **2.5 times** over the last 3 years.*

— Arbor Networks

***458% increase** in the number of times hackers searched **IoT connections** for vulnerabilities.*

— AT&T

***Spear-phishing** campaigns targeting employees **increased 55%** last year.*

— Symantec

***Malware** attacks nearly doubled to **8.19 billion**, with Android ecosystem being the prime target.*

— Dell

*There's a **221% increase** in compromised **WordPress sites**.*

— Cisco

***89%** of all cyber attacks involved **financial or espionage** motivations.*

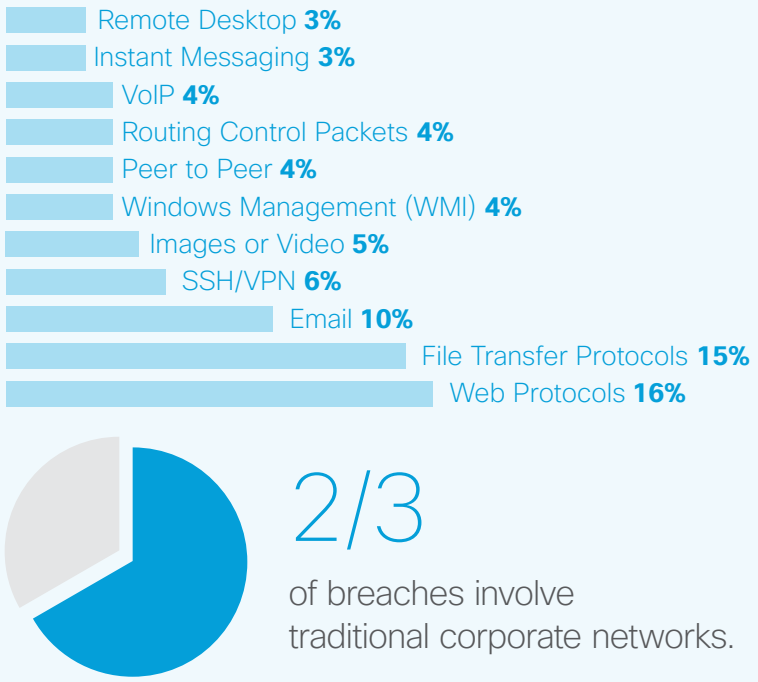
— Verizon

Sixty percent of data stolen was through web protocols, file transfer and tunneling protocols, or email. Two-thirds of breaches involved traditional corporate networks, and cloud break-ins accounted for the remaining one-third, according to McAfee and LemonFish (Figure 21).

Frequency of distributed-denial-of-service (DDoS) attacks has increased more than 2.5 times over the last 3 years, according to Arbor Networks. DDoS attacks are increasing at roughly the same rate as traffic. Peak DDoS attack size (Gbps) is increasing in a linear trajectory, with peak attacks reaching 300, 400, and 500 Gbps, in 2013, 2014, and 2015 respectively, at about 10 to 15 percent per year. DDoS attacks can represent up to 10 percent of a country's total Internet traffic while they are occurring. The average size of DDoS attacks is increasing steadily and approaching 1 Gbps, enough to take most organizations completely offline. In 2015, the top motivation behind DDoS attacks was criminals demonstrating attack capabilities, with gaming and criminal extortion attempts in second and third place, respectively. DDoS attacks account for more than 5 percent of all monthly gaming-related traffic and more than 30 percent of gaming traffic while they are occurring.

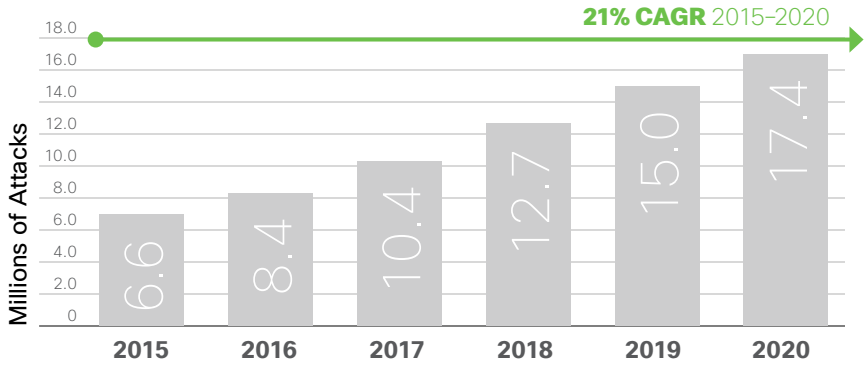
The events from 2015 and the first quarter of 2016 once again demonstrated that the attackers are increasing their computing resources to perform DDoS attacks. Amplification attackers, who have tools for carrying out a DDoS attack, exploit vulnerabilities in the network and compute resources. With the growth of the IoE and spread of vulnerable devices and traditional PCs, the abundance of configuration drawbacks with applications can be targeted. Security vendors continue to ensure these attacks are financially unviable for the cybercriminals. Globally, the number of DDoS attacks grew 25 percent in 2015 and will increase 2.6-fold to 17 million by 2020 (Figure 22).

Figure 21 How is Data Being Breached?



Source: McAfee, Lemonfish, Cisco VNI 2016

Figure 22 Global DDoS Attacks Forecast, 2015–2020



Source: Cisco VNI Global IP Traffic Forecast, 2015-2020

Trend 8: 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 nearly double from 2015 to 2020, from 24.7 Mbps to 47.7 Mbps. Table 4 shows the projected broadband speeds from 2015 to 2020. 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 within the VNI countries in terms of broadband speed largely because of their wide deployment of FTTH.

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.

There is a strong correlation between experienced speeds and number of video minutes viewed per viewer (Figure 23). As speeds increase in each country covered in the study, the number of video minutes per viewer also increases.

Table 4 Fixed Broadband Speeds (in Mbps), 2015–2020

Region	2015	2016	2017	2018	2019	2020	CAGR 2015-2020
Global	24.7	29.5	32.8	38.5	43.5	47.7	14%
Asia Pacific	28.1	33.9	37.4	41.5	46.8	51.3	13%
Latin America	7.6	9.3	11.3	13.6	16.2	17.8	18%
North America	25.4	32.9	37.6	42.7	47.4	51.4	15%
Western Europe	22.8	30.2	35.5	41.2	46.0	50.1	17%
Central and Eastern Europe	25.3	29.2	32.8	36.6	41.2	46.3	13%
Middle East and Africa	7.0	7.8	9.2	12.8	14.8	16.5	19%

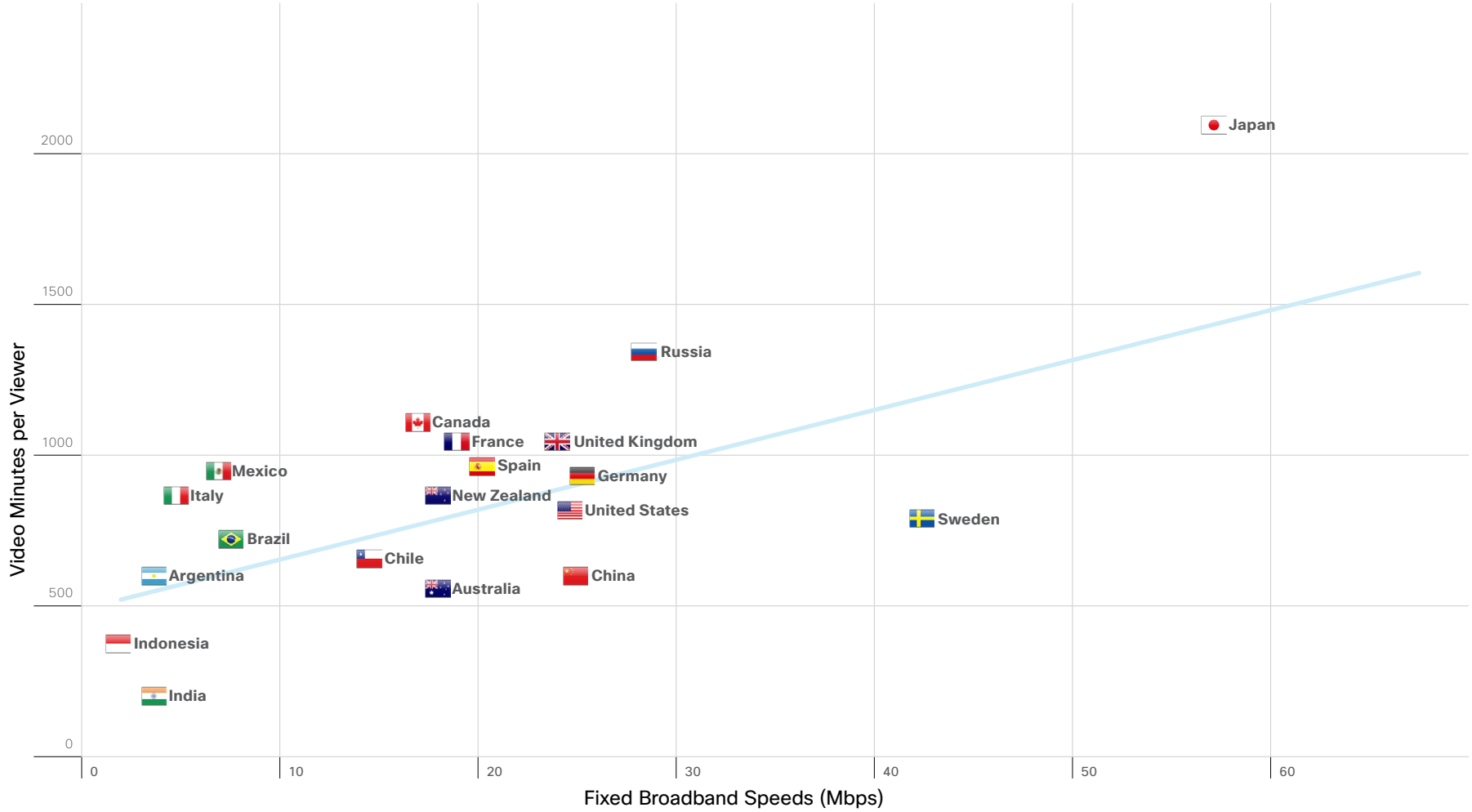
Source: Cisco VNI Global IP Traffic Forecast, 2015-2020

Table 5 Broadband Speed Greater than 10 Mbps, 2015–2020

Region	Greater than 10 Mbps		Greater than 25 Mbps		Greater than 100 Mbps	
	2015	2020	2015	2020	2015	2020
Global	53%	77%	30%	38%	4%	8%
Asia Pacific	53%	83%	30%	52%	4%	8%
Latin America	27%	39%	10%	15%	1%	2%
North America	64%	88%	38%	52%	5%	9%
Western Europe	54%	74%	32%	43%	5%	11%
Central and Eastern Europe	58%	83%	33%	41%	3%	6%
Middle East and Africa	17%	20%	7%	8%	0.3%	1%

Source: Cisco VNI Global IP Traffic Forecast, 2015-2020

Figure 23 Increase in Experienced Speeds (Mbps) Increases Internet Video Viewership (Minutes)–2016



Source: Cisco VNI Global IP Traffic Forecast, 2015–2020

Mobile Speeds

Globally, the average mobile network connection speed in 2015 was 2.0 Mbps. The average speed will more than double and will be 6.5 Mbps by 2020. Smartphone speeds, generally third-generation (3G) and later, are currently nearly 3 times higher than the overall average. Smartphone speeds will nearly double by 2020, reaching 12.5 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 can support. 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).

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 2020.

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.

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

	2015	2016	2017	2018	2019	2020	CAGR 2015–2020
Global							
Global speed: All handsets	2.0	2.4	3.1	3.9	5.1	6.5	26%
Global speed: Smartphones	7.5	8.3	9.2	9.9	11.1	12.5	11%
Global speed: Tablets	11.6	12.8	13.9	15.0	15.6	16.2	7%
By Region							
Asia Pacific	2.4	3.6	4.6	5.7	7.0	8.6	29%
Latin America	1.5	1.9	2.5	3.1	3.9	4.9	27%
North America	5.9	7.9	9.9	12.1	13.7	15.3	21%
Western Europe	4.1	6.1	8.3	10.5	12.2	14.1	28%
Central and Eastern Europe	2.3	3.4	5.6	7.8	9.1	10.6	36%
Middle East and Africa	0.8	1.3	1.9	2.6	3.6	4.8	45%

Source: Cisco VNI Global IP Traffic Forecast, 2015–2020

Wi-Fi Speeds from Mobile Devices

Globally, Wi-Fi connection speeds originating from dual-mode mobile devices will nearly double by 2020. The average Wi-Fi network connection speed (10.6 Mbps in 2015) will exceed 18.5 Mbps in 2020. North America will experience the highest Wi-Fi speeds, 29 Mbps, by 2020 (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	2015	2016	2017	2018	2019	2020	CAGR 2015-2020
Global	12.5	18.2	19.5	21.8	23.1	24.4	14%
Asia Pacific	11.4	19.5	20.9	22.3	23.5	24.7	17%
Latin America	5.9	7.7	8.4	9.2	9.9	10.6	12%
North America	17.4	27.4	29.2	31.5	33.6	35.5	15%
Western Europe	13.9	20.3	22.4	23.2	24.0	24.8	12%
Central and Eastern Europe	13.4	16.7	19.0	21.6	23.3	25.3	13%
Middle East and Africa	4.4	4.9	5.5	6.1	6.7	7.0	10%

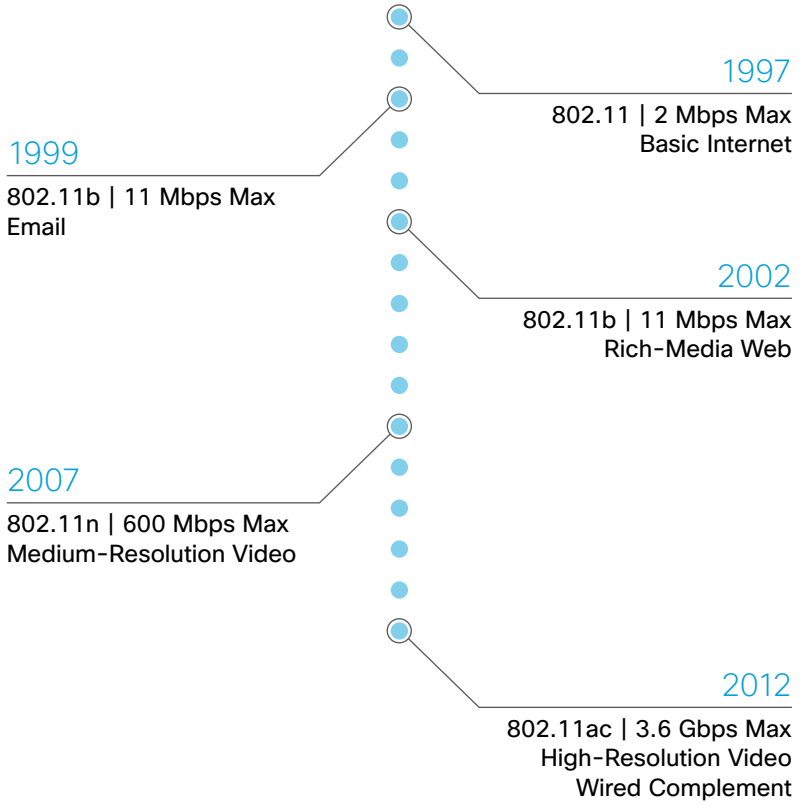
Source: Cisco VNI Global IP Traffic Forecast, 2015-2020

Trend 9: Mobility (Wi-Fi) Continues to Gain Momentum

Globally, there will be nearly 433 million public Wi-Fi hotspots by 2020, up from 64 million hotspots in 2015, a sevenfold increase. By 2020, China will lead in total number of hotspots, followed by the United States and France. Western Europe had 45 percent of the world's Wi-Fi hotspots share in 2015. By 2020, public Wi-Fi along with community hotspots are accounted for 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. Asia Pacific will lead in adoption of homespots. By 2020, China will lead in total number of homespots, followed by France and Japan. Adoption of homespots has been led by Western Europe and then North America in 2015, but Asia Pacific will lead by 2020.

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 2015 through 2020. In 2015, 59.5 percent of all home Wi-Fi routers shipped globally were 802.11ac enabled. By 2020, 96.6 percent of all home Wi-Fi routers will be equipped with 802.11ac. IEEE 802.11n, which was ratified in 2007, provides a range of speeds that allow users to view medium-resolution video streaming because of the 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 24).

Figure 24 Future of Wi-Fi as Wired Complement



In 2015, 802.11ac was 59.5% of BB CPE shipped. By 2020,

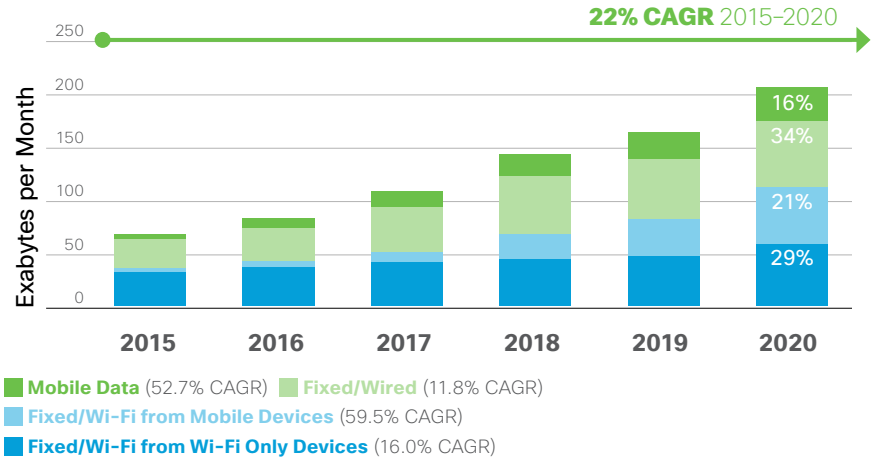
96.6%

of BB CPE will be equipped with 802.11ac.

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 25 shows the growth in Wi-Fi and mobile traffic in relation to traffic from wired devices. By 2020, wired networks will account for 34 percent of IP traffic, and Wi-Fi and mobile networks will account for 66 percent of IP traffic. In 2015, wired networks accounted for the majority of IP traffic at 52 percent, Wi-Fi accounted for 43 percent, and mobile or cellular networks accounted for 5 percent of total global IP traffic.

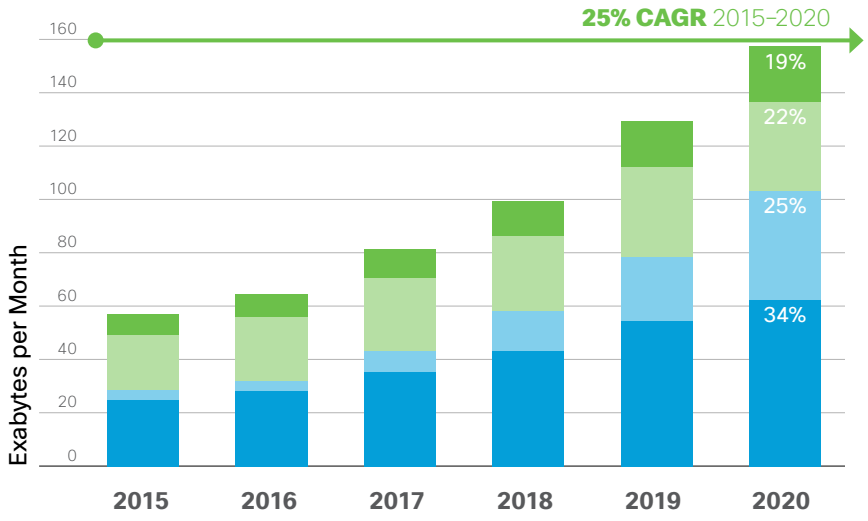
Narrowing the focus to Internet traffic and excluding managed IP traffic yields a more pronounced trend. By 2020, wired devices will account for 22 percent of Internet traffic, and Wi-Fi and mobile devices will account for 78 percent of Internet traffic (Figure 26). In 2015, wired devices accounted for less than half of Internet traffic, at 38 percent.

Figure 25 Global IP Traffic, Wired and Wireless*



*Wireless traffic includes Wi-Fi and mobile.
Source: Cisco VNI Global IP Traffic Forecast, 2015–2020

Figure 26 Global Internet Traffic, Wired and Wireless



Source: Cisco VNI Global IP Traffic Forecast, 2015–2020

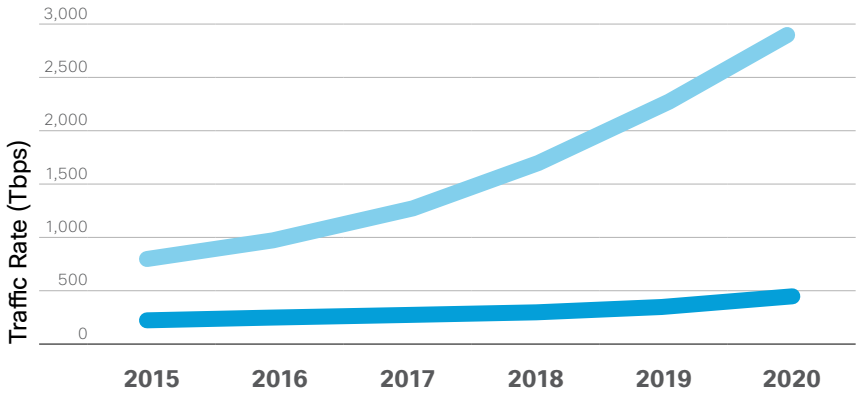
Trend 10: Traffic-Pattern Analysis (Peak Compared to Average and CDN Uptake)

Although 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. Service providers plan network capacity according to peak rates rather than average rates. In 2015, busy-hour Internet traffic grew 51 percent, and average traffic grew at 29 percent. Between 2015 and 2020, global busy-hour Internet use will grow at a CAGR of 36 percent, compared with 25 percent for average Internet traffic (Figure 27).

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.

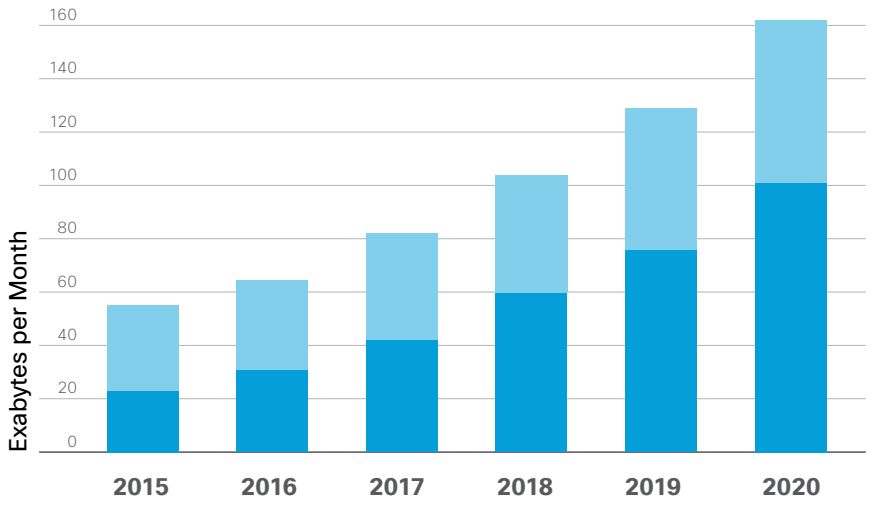
Changes in traffic topology are being brought about by the increasing role of content-delivery networks (CDNs) in data delivery. CDNs will carry 64.5 percent of total Internet traffic by 2020 (Figure 28). Although network performance is usually attributed to the speeds and latencies offered by the service provider, the delivery algorithms used by CDNs have an equal if not more significant bearing on video quality.

Figure 27 Busy Hour Compared with Average Internet Traffic Growth



Source: Cisco VNI Global IP Traffic Forecast, 2015–2020

Figure 28 Global Content Delivery Network Internet Traffic, 2015 and 2020



Percentages (n) refer to 2015, 2020 traffic shares.
Source: Cisco VNI Global IP Traffic Forecast, 2015–2020

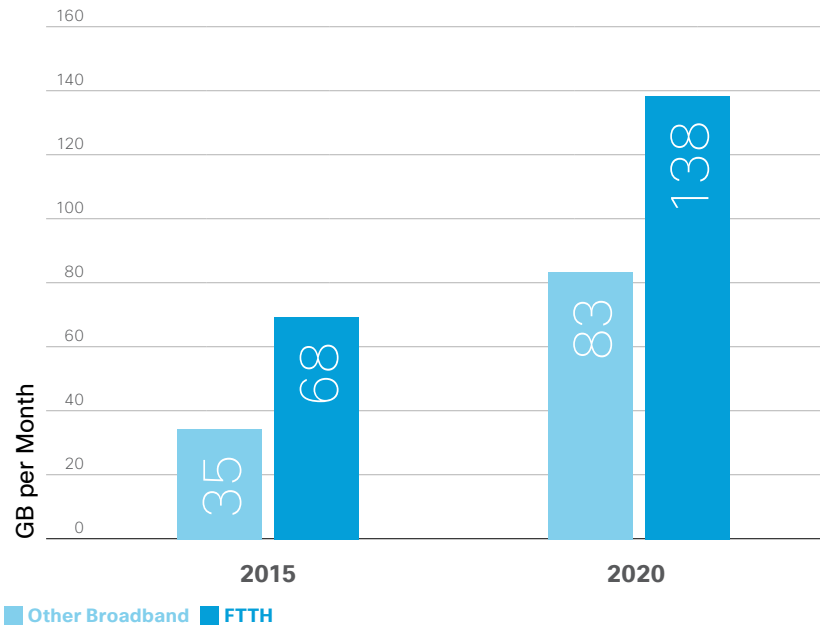
Speed is a critical factor in Internet traffic. When speed increases, users stream and download greater volumes of content, and adaptive bit-rate streaming increases bit rates automatically according to available bandwidth. Service providers find that users with greater bandwidth generate more traffic. In 2015, households with high-speed fiber connectivity generated 58 percent more traffic than households connected by DSL or cable broadband, globally (Figure 29). The average FTTH household generated 68 GB per month in 2015 and will generate 138 GB per month in 2020.

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 2015, 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 offering a variety of fair usage limits today, as high as 1 TB per month. A large provider in Japan has a 30-GB-per-day upload cap. In several countries, Netflix has a sizable 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 12 percent of mobile users consume more than 2 GB per month (a common mobile data cap), whereas only 1.4 percent of fixed users consume more than 500 GB per month (a common fixed data cap).

Figure 29 Fiber-Connected Households Generate More Traffic Than Households with Other Sources of Broadband



Source: Cisco VNI Global IP Traffic Forecast, 2015-2020

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.

- **Growth of smartphones** as the "communications hub" for social media, video consumption, tracking IoE/digitization applications (et al.), as well as traditional voice. This trend demonstrates the impact that smartphones have on how consumers and businesses access and use the Internet and IP networks.
- **Internet gaming** is seeing a resurgence—the traffic nearly doubled in 2015 and will grow sevenfold by 2020. Gaming on demand and streaming gaming platforms have been in development for several years, with many newly released in 2014 and 2015. 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. If cloud gaming becomes popular, gaming could quickly become one of the largest Internet traffic categories.
- **Virtual reality** – With new hardware available to individuals, and a growing body of content to consume, virtual reality has experienced high growth in recent years. Traffic associated with virtual- and augmented-reality applications quadrupled in 2015 and is poised to grow 61-fold by 2020. This growth stems mainly from the download of large virtual-reality content files and applications, but a significant wild card is the potential adoption of virtual-reality streaming, which could raise our prediction of high growth even higher.
- **Immersive video** – This emerging traffic type can cause significant new network design implications, as it is a high-bandwidth-consuming application. Social media platforms such as Facebook have launched support for spherical, or immersive, video that 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.
- **Video surveillance** – New Internet-connected video-surveillance cameras upload a constant video stream to the cloud for remote viewing. With a steady flow of video traffic from each camera, video surveillance is already having an impact on overall Internet traffic and accounts for 1.5 percent of total Internet traffic today, growing to nearly 4 percent by 2020. If such devices become mass marketed in the next 5 years, we could see video cameras generating a significantly higher volume of traffic, since Internet-enabled cameras can produce up to 300 GB per camera per month for full-HD-resolution monitoring of high-activity areas.

Appendix A: Cisco Global IP Traffic Forecast

Global IP Traffic, 2015–2020

Table 8 shows a summary of the Cisco global IP traffic forecast. For more information and additional tables, refer to *Cisco VNI: Forecast and Methodology, 2015–2020*.

Table 8 Global IP Traffic, 2015–2020

IP Traffic, 2015–2020							
	2015	2016	2017	2018	2019	2020	CAGR 2015–2020
By Type (PB per Month)							
Fixed Internet	49,494	60,160	73,300	89,012	108,102	130,758	21%
Managed IP	19,342	22,378	25,303	28,155	30,750	33,052	11%
Mobile data	3685	6180	9931	14,934	21,708	30,564	53%
By Segment (PB per Month)							
Consumer	58,539	72,320	89,306	109,371	133,521	162,209	23%
Business	13,982	16,399	19,227	22,729	27,040	32,165	18%
By Geography (PB per Month)							
Asia Pacific	24,827	30,147	36,957	45,357	55,523	67,850	22%
North America	24,759	30,317	36,526	43,482	50,838	59,088	19%
Western Europe	11,299	13,631	16,408	19,535	23,536	27,960	20%
Central and Eastern Europe	5205	6434	8116	10,298	13,375	17,020	27%
Latin America	4500	5491	6705	8050	9625	11,591	21%
Middle East and Africa	1930	2698	3822	5380	7663	10,865	41%
Total (PB per Month)							
Total IP traffic	72,521	88,719	108,533	132,101	160,561	194,374	22%

Source: Cisco VNI Global IP Traffic Forecast, 2015–2020

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

For More Information

For more information about the Cisco IP traffic forecast, refer to *Cisco VNI: Forecast and Methodology, 2015–2020* 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, country, application, and end-user segment. Refer to the Cisco VNI Highlights tool and the Cisco VNI Forecast Widget tool. For regional details about the VNI service adoption forecast, please visit the Cisco VNI SA highlights tool and Cisco VNI SA Graphing tool. Inquiries can be directed to traffic-inquiries@cisco.com.

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