

# Cisco Visual Networking Index: Global Mobile Data Traffic Forecast, 2016–2021

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## About the Cisco Visual Networking Index

**Q.** Why did Cisco develop the Cisco Visual Networking Index™ (Cisco VNI™) Forecast?

**A.** Cisco's internal need for reliable Internet traffic growth rates prompted us to develop realistic forecasts based on multiple levels and sources of real data and projections. The VNI projections proved to be useful for Cisco's strategic planning, and we later found that our customers (in all segments) and the industry at large found value and benefited from the predictions and insights as well.

**Q.** What is visual networking?

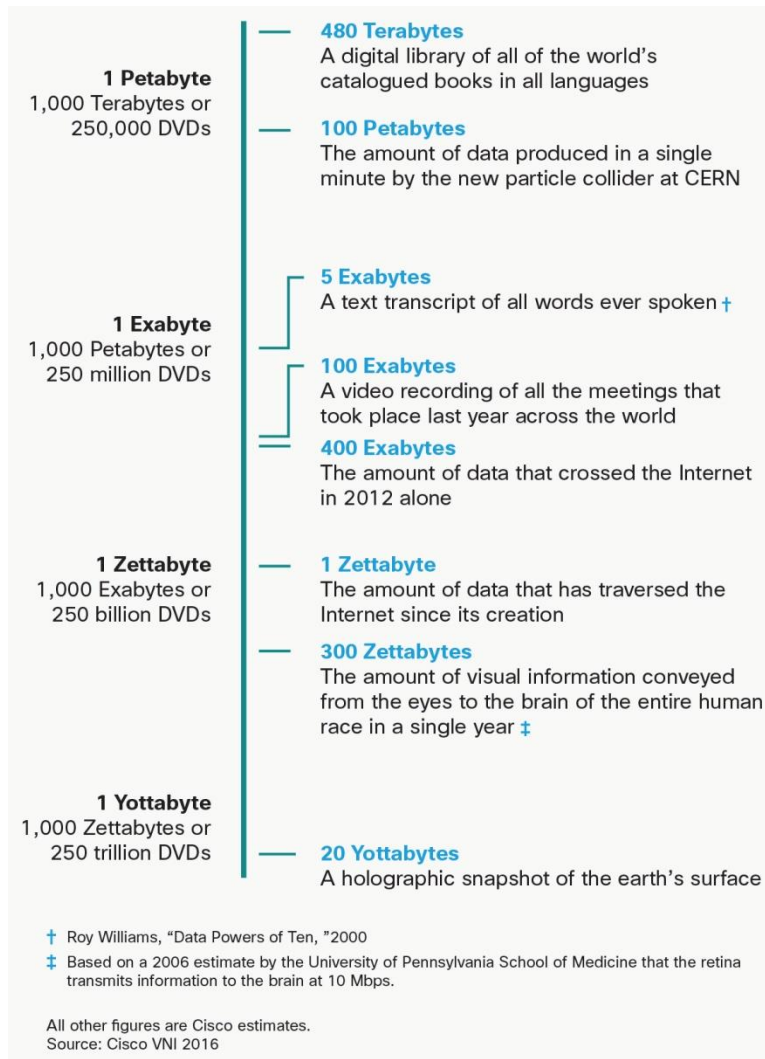
**A.** Consumer and business IP networking trends are significantly shaped by video, social networking, collaboration applications and other multimedia services, the combination of which is termed visual networking. A visual networking experience can range from a person-to-person video call (for example, Skype or Facetime) to a virtual real estate tour (augmented reality) or streaming ultra high definition (UHD) video content to any device a consumer chooses. These choices can include TVs, PCs, tablets, smartphones, or any of the new consumer devices available today, such as phablets, and a variety of wearable devices.

Machine-to-machine (M2M) applications are also creating an entirely new set of requirements and demands for mobile networks, based on Internet of Things (IoT) applications such as utility metering, asset tracking, smart cars, health monitoring, and video surveillance.

**Q.** What is an exabyte? What is a zettabyte?

**A.** An exabyte is 1,000,000,000 gigabytes. A zettabyte is 1,000 exabytes. Figure 1 shows examples of information and network traffic that represent specific data volumes along the byte scale.

**Figure 1.** The Byte Scale and Equivalencies



## About the Cisco VNI Global Mobile Data Traffic Forecast, 2016–2021

- Q.** What is the Cisco® VNI Global Mobile Data Traffic Forecast?
- A.** The Cisco VNI Global Mobile Data Traffic Forecast projects future mobile data traffic over cellular infrastructures: for example, second-, third-, fourth-, and now fifth-generation (2G, 3G, 4G, or 5G) radio networks. The mobile data traffic forecast is part of the comprehensive Cisco VNI study. The Cisco VNI Global Mobile Data Traffic Forecast is published annually in February. The Complete Cisco VNI Forecast is published annually in June, and it includes a fixed IP traffic forecast as well as the updated mobile data traffic forecast of the same year.

- Q.** Why does Cisco develop and maintain the Cisco VNI Global Mobile Data Traffic Forecast?
- A.** Although mobile data traffic had historically been a small percentage of overall global IP traffic, mobile data traffic is expected to grow at a 47 percent compound annual growth rate (CAGR) from 2016 to 2021, two times faster than the growth of global IP fixed traffic during the same period. By 2021, mobile data traffic will represent 20 percent of global IP traffic. Given the rapid traffic growth, changing market dynamics, and global reliance on mobile networks and services, we believe an annual forecast can be a valuable resource for Cisco, our customers, and other interested parties.
- Q.** Does the Cisco VNI Global Mobile Data Traffic Forecast include Wi-Fi?
- A.** Wi-Fi is not included, except in the calculation of traffic offloaded from the mobile network (along with femtocell). Wi-Fi is included as a fixed network component in the comprehensive Cisco VNI Traffic Forecast. For the purposes of this study, offload pertains to traffic from dual-mode devices (that is, devices, excluding laptops, that support cellular and Wi-Fi connectivity) over Wi-Fi and small cell networks. Offloading occurs at the user or device level when one switches from a cellular connection to Wi-Fi or small cell access. Our mobile offload projections include traffic from both public hotspots and residential Wi-Fi networks.
- Q.** What does the public Wi-Fi hotspots forecast include?
- A.** Our Wi-Fi hotspots analysis and projections include public Wi-Fi commercial hotspots and homespots. Commercial hotspots include fixed and mobile network operators (MNO) hotspots that are purchased or installed for a monthly fee or commission. Commercial hotspots can be set up to offer both fee-based and free internet Wi-Fi access. Hotspots are installed to offer public Wi-Fi at cafés and restaurants, retail chains, hotels, airports, planes and trains for customers and guests. A growing variety of private businesses and public venues provide a free Wi-Fi service set identifier (SSID) for their guests and visitors. Homespots or community hotspots have emerged 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. Homespots have dual SSIDs and operators download software to a subscriber's home gateway, which allows outside users to connect to one of the SSIDs like a hotspot. This solution facilitates guest Wi-Fi access and mobile offload, as well as other emerging models of community Wi-Fi services.
- Q.** What was the global mobile data traffic growth rate in 2016?
- A.** In 2016, global mobile data traffic grew more than 63 percent year over year to 7.2 exabytes per month. Year-over-year mobile data traffic growth varied by region: Middle East and Africa (96 percent), Asia Pacific (71 percent), Latin America (66 percent), Central and Eastern Europe (64 percent), Western Europe (52 percent), and North America (44 percent).
- Q.** What is the future outlook for mobile data traffic growth based on the updated forecast?
- A.** Major findings of the Cisco VNI Global Mobile Data Forecast, 2016–2021 include the following points:
- By 2021, global mobile data traffic will reach 49 exabytes per month, or a run rate of 587 exabytes annually.
  - By 2021, smartphones will represent 86 percent of total mobile data traffic, compared to 81 percent in 2016.
  - By 2021, 4G connections will be 53 percent of total mobile connections and will account for 79 percent of mobile data traffic.
  - By 2021, 5G connections will be less than 1 percent of total mobile connections and will account for 1.5 percent of mobile data traffic (**initial growth projections for this nascent technology**).
  - Globally, the average mobile network connection speed will increase 3-fold from 2016 (6.8 Mbps) to 2021 (20.3 Mbps).

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- By 2021, 63 percent of global mobile data traffic (cellular) will be offloaded to Wi-Fi or small cell networks, up from 60 percent in 2016.
  - By 2021, 78 percent of the world's mobile data traffic will be video, up from 60 percent in 2016.
  - By 2021, 93 percent of global smartphones and tablets will be IPv6-capable, up from 68 percent in 2016.
  - The Middle East and Africa will have the strongest mobile data traffic growth of any region over the forecast period, with a 65 percent CAGR, followed by Asia Pacific at 49 percent and Central and Eastern Europe and Western Europe both at 42 percent.
- Q.** In the 2016 Cisco VNI Global Mobile Data Forecast, you predicted a 2015–2020 global CAGR of 53 percent. In this update, you predict a 2016–2021 global CAGR of 47 percent. Why is the projected global growth rate tapering?
- A.** The slight slowing in the growth rate is a typical example of S-curve growth, but the actual amount of traffic continues to represent significant growth. Although the growth in 2021 is projected to be less than 50 percent year over year, down from 63 percent in 2016, the annual run rate of mobile data traffic by 2021 (587 exabytes) will be 122 times larger than global mobile traffic 10 years ago (4.6 exabytes in 2011).
- Q.** Have there been any methodological changes since the last forecast update?
- A.** In the February 2016 update of the Cisco VNI Global Mobile Data Forecast, we have added "phablets" (a new device that blends smartphone and tablet features and functionality) as a subset of our smartphone device category. Within our M2M category, we have updated the low-power wide area (LPWA) network connections in our forecast. LPWA is an emerging ultranarrowband M2M connectivity alternative for a variety of IoT applications. We currently view this technology as a "wild card" in our forecast with significant potential for growth, but it also faces possible regulatory and performance issues that could affect broad and long-term adoption.
- Q.** What is 5G and when will it begin to have an impact on global mobile data traffic and trends?
- A.** 5G, or 5th generation mobile networks, is the next phase of mobile technology ([click here](#) to learn more). 5G's primary improvements over 4G include higher bandwidth (greater than 1 Gbps), broader coverage, and ultra-low latency. While 4G has been driven by device proliferation and dynamic information access, 5G will be driven largely by IoT applications (sensors, meters, et al). With 5G, resources (channels) will be allocated based on awareness of content, user and location. This technology is expected to solve frequency licensing and spectrum management issues. Significant 5G deployments are not expected until 2020. There are several gating factors for 5G adoption.
- Approval of regulatory standards
  - Spectrum availability/auctioning
  - Ratification of air-interface
  - Return on investment (ROI) strategies that mobile carriers will need to offset the expenditures associated with new infrastructure transitions and deployments (monetization).
- The 2017 Mobile VNI Forecast includes our initial projections for 5G adoption and growth. By 2021, 5G connections will represent less than 1 percent of total mobile connections (more than 25 million global 5G devices and M2M connections) and will account for 1.5 percent of mobile data traffic.

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- Q.** How are mobile devices/connections categorized and defined in the Cisco VNI Global Mobile Data Forecast?
- A.** The current Cisco VNI Global Mobile Data Forecast includes the following mobile device categories:
- **Nonsmartphones:** Handheld phones with a closed operating system.
  - **Smartphones:** Mobile phones offering advanced capabilities such as the ability to run applications, often with functionality like that of a PC. Smartphones run complete operating system software and provide a standardized interface and platform for application developers. This category also includes “phablets,” a new device that blends smartphone and tablet features and functionality.
  - **Laptops:** This category includes laptop computers, netbooks, and ultramobile PCs connected to the mobile network through mobile broadband data cards, dongles, embedded modems, or mobile hotspots.
  - **Tablets:** This category includes mobile-connected tablets (average screen size of 7 inches) and what are usually referred to as mobile Internet devices (average screen size of 4 to 6 inches).
  - **Other portables:** This category includes e-readers, handheld gaming consoles, digital cameras and camcorders, digital photo frames, and in-car entertainment systems. E-readers are handheld consumer electronics devices that can access and store a wide range of digitized books for portable use. Newer generations of e-readers are also taking on tablet-type functionality. Photo frames can read, store, and display digital photos in slideshow mode (the most popular screen sizes fall in the 7-inch to 8-inch range). Cellular-enabled digital photo frames can download photos from online photo sites through an embedded cellular modem card. In some cases, the digital photo frame is assigned a phone number or email address so that pictures can be sent directly from a mobile phone to the frame.
  - **M2M modules:** Machine-to-machine technologies that allow systems to communicate with other devices of the same capability, such as utility metering, security and surveillance, fleet management, GPS and navigation, asset tracking, and healthcare record devices.
  - **Wearable devices:** Devices that people wear, which are capable of connecting to and communicating with the network, either directly through embedded cellular connectivity or through another device (primarily a smartphone) over Wi-Fi, Bluetooth, and so forth. These devices support a variety of applications such as virtual reality (VR) and augmented reality (AR) and come in various shapes and forms, ranging from smart watches, smart glasses, heads-up displays (HUDs)/VR headsets, health and fitness trackers, health monitors, wearable scanners, navigation devices, smart clothing and more.
- Q.** What are smart devices? What is the effect on mobile data traffic from smart devices?
- A.** We define smart devices and connections as those having advanced multimedia capabilities with a minimum of 3G connectivity. Throughout the forecast period, we see that the device mix is getting smarter. The share of smart devices and connections as a percentage of the total will increase from 46 percent in 2016 to 75 percent, by 2021. Globally, the traffic from these smart devices, smart traffic, is going to grow from 92 percent of the total global mobile traffic in 2016 to 99 percent by 2021. This is significantly higher than the ratio of smart devices and connections (75 percent by 2021), because on an average, smart devices generate much more traffic than nonsmart devices.

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**Q.** What mobile applications are covered in the current Cisco VNI Global Mobile Data Forecast?

**A.** The updated forecast covers a variety of applications, some of which are not included in the formal study. The following applications are included in the forecast:

- Email and instant messaging
- Gaming and game downloads
- Enterprise mobile applications
- Web browsing and other data
- Music streaming and downloads
- Picture messaging and downloads
- Text messaging
- Social networking
- Application downloads
- Video downloads
- Video messaging and calling
- Video streaming
- File sharing (peer-to-peer [P2P] and web-based)
- Voice over IP (VoIP) (including VoWi-Fi)
- Virtual and augmented reality (VR and AR)
- IoT applications (including in-vehicle apps, drones and more)

Detailed definitions, assumptions, methodology, and analysis are available in the [Cisco VNI Global Mobile Data Forecast, 2016–2021 white paper](#).

**Q.** Can you define the relationship between subscriber, user, device, and connection?

**A.** Within the mobile data forecast, the terms subscriber and user are used interchangeably to identify the end user generating the mobile data traffic. The device is the endpoint (for example, nonsmartphone, smartphone, tablet, or M2M module). The connection is per device to the cellular network.

**Q.** How do you distinguish between business and consumer traffic?

**A.** We (and our relevant data sources) differentiate between business and consumer mobile data traffic by billing practices or records. Therefore, if a mobile subscription is paid by a business, it is applied to our business traffic segment. All other subscriptions are considered to be consumer subscriptions.

**Q.** What are the top applications promoting the growth of mobile data traffic?

**A.** Video continues to be the major application generator for mobile data traffic growth. Video reached a milestone in 2012, accounting for 51 percent of global mobile data traffic, and it will account for 78 percent of global mobile data traffic by 2021.

**Q.** What is the effect of tiered pricing models on mobile usage? Are there any new insights on the top 1 percent of mobile users?

**A.** The top 1 percent of mobile users generated 6 percent of mobile data traffic in 2016, down from 52 percent at the beginning of 2010. The top 20 percent of mobile users generate more than half (56 percent) of global mobile data traffic. Average consumption per user in an unlimited-pricing plan continues to be higher than that of a tiered-pricing plan user.

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- Q.** Why does this forecast include a section on IPv6-capable mobile devices?
- A.** With increasing industry awareness about the depletion of IPv4 addresses and transition to IPv6-capable networks, the Cisco VNI Global Mobile Data Forecast now includes a projection of the number of mobile devices potentially capable of connecting to an IPv6-capable mobile network. In 2016, 43 percent of all mobile-connected devices/connections (3.4 billion) were IPv6-capable. By 2021, 73 percent of all mobile-connected devices/connections (8.4 billion) will be IPv6-capable. A projection of the number of fixed devices potentially capable of connecting to an IPv6-capable fixed network is published as part of the comprehensive VNI report in June.
- Q.** Where can I get historical VNI data?
- A.** Historical IP traffic numbers attributed to the Cisco VNI are listed in Wikipedia at [http://en.wikipedia.org/wiki/Internet\\_traffic](http://en.wikipedia.org/wiki/Internet_traffic).
- Q.** Can I or my organization use or publish Cisco VNI Forecast data?
- A.** Yes. Cisco welcomes and encourages press, analysts, service providers, regulators, and other interested parties (business or academic) to use and cite our research. We do require that proper Cisco attribution be given for any and all Cisco VNI data that is published or shared in private or public print and electronic forms (for example, Source: Cisco Visual Networking Index [or VNI] Global Mobile Data Forecast, 2016–2021).
- Q.** How can I ask questions about the Cisco VNI Global Mobile Data Forecast data?
- A.** You may submit questions or comments via our [public Cisco VNI community page](#). This page also includes answers to frequently-asked questions and discussions moderated by Cisco VNI analyst team.



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