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ERICSSON MOBILITY REPORT

NOVEMBER 2017

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Welcome to this edition of the Ericsson Mobility Report, where we, among other things, forecast 1 billion 5G subscriptions for enhanced mobile broadband by 2023. The evolution to 5G will enable a range of new use cases. One example we describe is the use of augmented reality-assisted maintenance and repair in the manufacturing industry.

Between Q3 2016 and Q3 2017, the total data traffic in mobile networks increased by 65 percent. The number of LTE subscriptions is growing rapidly, and LTE is anticipated to become the dominant mobile access technology by the end of this year. Operators are increasingly deploying networks that are capable of Gigabit speeds.

In addition to the forecast figures, we have included three feature articles in this report. One article looks into the subject of mobile data plans, exploring operators' need for a variety of offerings. The other two articles cover different aspects of 5G, the first focusing on enhancing the event experience through digitalized services and the second on consumer expectations.

I hope you find this report valuable and engaging. You can find all our content, including regional versions of the report, at **www.ericsson.com/mobility-report**

PUBLISHER

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2017 **7.8B**
2023 **9.1B**

CAGR 3%

WORLDWIDE MOBILE SUBSCRIPTIONS

WORLDWIDE TOTAL MONTHLY MOBILE DATA TRAFFIC

2017 **14EB**
2023 **110EB**

CAGR 42%

WORLDWIDE MONTHLY DATA TRAFFIC PER ACTIVE SMARTPHONE

2017 **2.9GB**
2023 **17GB**

CAGR 34%

CONTENTS

2017 4.4B
2023 7.3B

WORLDWIDE SMARTPHONE SUBSCRIPTIONS

CAGR 9%

WORLDWIDE MOBILE BROADBAND SUBSCRIPTIONS

2017 5.2B
2023 8.5B

CAGR 9%

WORLDWIDE LTE SUBSCRIPTIONS

2017 2.6B
2023 5.5B

CAGR 13%

Forecast

Articles

MOBILE SUBSCRIPTIONS Q3 2017

In Q3, 95 million new mobile subscriptions were added, resulting in a total of 7.8 billion

The number of mobile subscriptions is growing at almost 6 percent year-on-year, reaching 7.8 billion in Q3. China had the most net additions during the quarter (+30 million), followed by Indonesia (+7 million), the US (+4 million), Angola (+4 million) and Pakistan (+3 million).

The number of mobile broadband subscriptions[1] is growing at around 20 percent year-on-year, increasing by 210 million in Q3 2017 alone. The total number is now 5 billion.

During Q3 2017, 170 million LTE subscriptions were added to reach a total of 2.5 billion. The net additions for WCDMA/HSPA were around 60 million subscriptions during the quarter. The majority of 3G/4G subscriptions can use GSM/EDGE as a fallback.

There are now 5 billion mobile broadband subscriptions

Over the same period, GSM/EDGE-only subscriptions declined by 130 million. Other technologies declined by around 5 million.

Subscriptions associated with smartphones now account for 57 percent of all mobile phone subscriptions. Around 400 million smartphones were sold in Q3, which equates to 83 percent of all mobile phones sold in the quarter.

Mobile subscriptions Q3 2017 (million)

- North America: 380
- Latin America: 700
- Western Europe: 520
- Central and Eastern Europe: 585
- Middle East: 425
- Africa: 1,015
- APAC (excluding China and India): 1,560
- China: 1,395
- India: 1,185

[1] Mobile broadband includes radio access technologies HSPA (3G), LTE (4G), 5G, CDMA2000 EV-DO, TD-SCDMA and Mobile WiMAX
Note: WCDMA without HSPA and GPRS/EDGE (2G) are not included

New mobile subscriptions Q3 2017

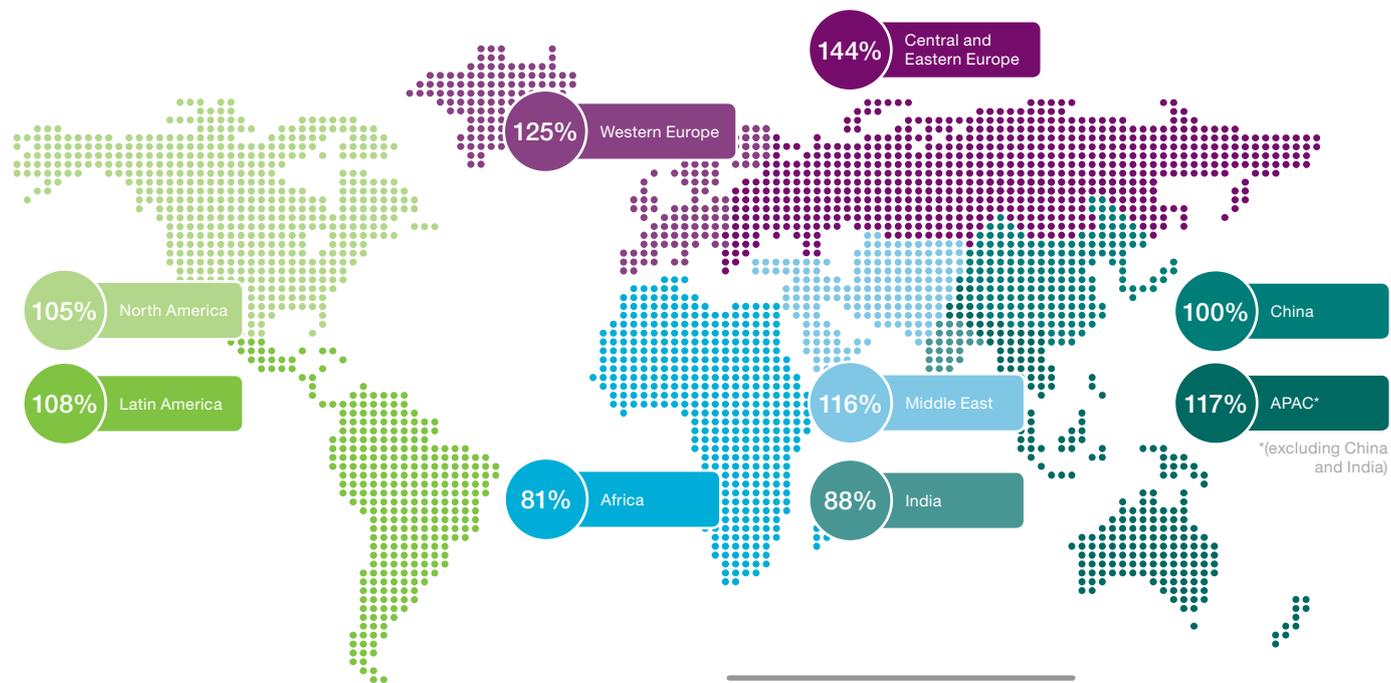**95 million new mobile subscriptions globally in Q3 2017**

Bar chart values:
- North America: 4 million
- Latin America: 10 million
- Western Europe: 5 million
- Central and Eastern Europe: 6 million
- Middle East: 7 million
- Africa: 14 million
- APAC (excluding China and India): 22 million
- China: 30 million
- India: -3 million

Top 5 countries by net additions Q3 2017

1. China — +30 million
2. Indonesia — +7 million
3. US — +4 million
4. Angola — +4 million
5. Pakistan — +3 million

The number of mobile subscriptions exceeds the population in many countries, which is largely due to inactive subscriptions, multiple device ownership or optimization of subscriptions for different types of calls.

As a result, the number of subscribers is lower than the number of subscriptions. Today, there are around 5.3 billion subscribers globally compared to 7.8 billion subscriptions.

5.3 BILLION
subscribers

Subscription penetration percentages:
- North America: 105%
- Latin America: 108%
- Western Europe: 125%
- Central and Eastern Europe: 144%
- Middle East: 116%
- Africa: 81%
- India: 88%
- China: 100%
- APAC*: 117%

*(excluding China and India)

103% global subscription penetration in Q3 2017

Subscription penetration Q3 2017 (percent of population)

MOBILE SUBSCRIPTIONS OUTLOOK

Preparations for 5G are gaining momentum and operators are gearing up for commercial launches. The number of 5G subscriptions is forecast to reach 1 billion by the end of 2023

The standardization work plan for 5G has been accelerated. The standard as specified in 3GPP Release 15 is planned to be finalized by the end of 2017 for Non-Standalone 5G New Radio (NR),[1] and by mid-2018 for Standalone 5G NR. Early 5G deployments are anticipated in several markets, including the US, South Korea, Japan and China. The first commercial networks based on Standalone 5G NR are expected to go live in 2019, with major network deployments from 2020. By the end of 2023, over 1 billion 5G subscriptions are forecast for enhanced mobile broadband.
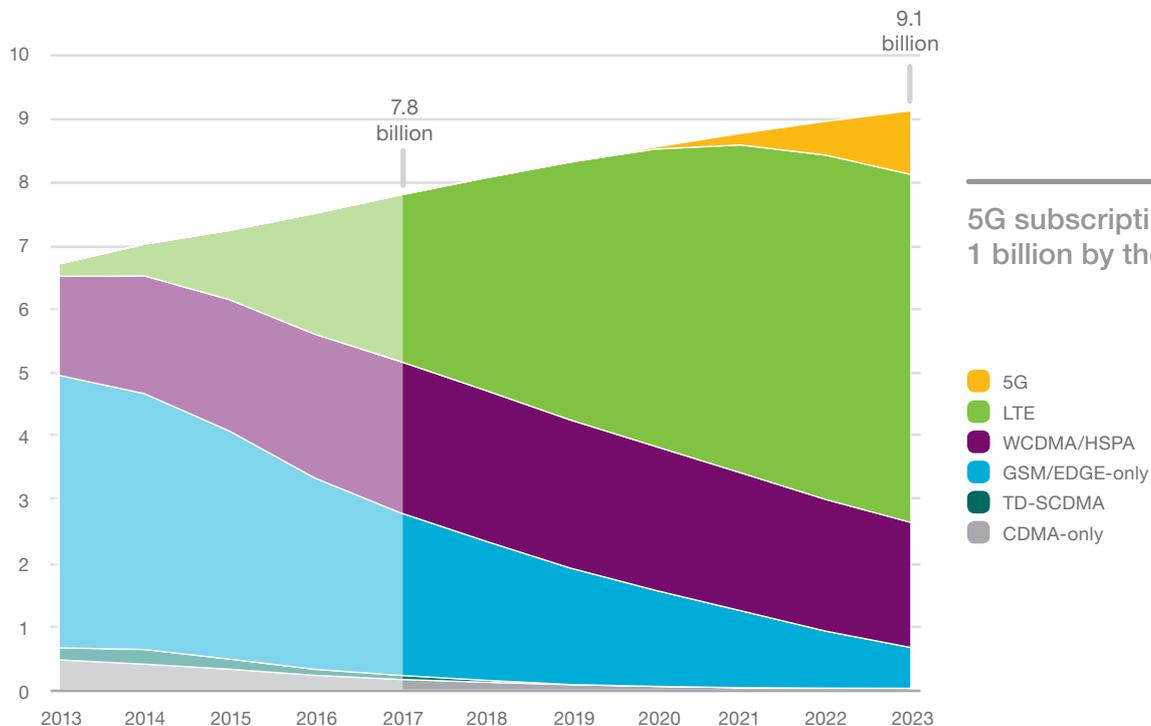
LTE is anticipated to become the dominant mobile access technology by the end of 2017, and is estimated to reach 5.5 billion subscriptions by the end of 2023. At that point, LTE subscriptions will account for more than 60 percent of all mobile subscriptions. In developing markets, GSM/EDGE-only will still account for a significant share of subscriptions.

Smartphone penetration will continue to rise, driven by the increasing affordability of devices. At the end of 2023, 7.3 billion subscriptions associated with smartphones are anticipated.

A 5G subscription is here counted as such when associated with a device that supports NR as specified in 3GPP Release 15, connected to a 5G-enabled network.
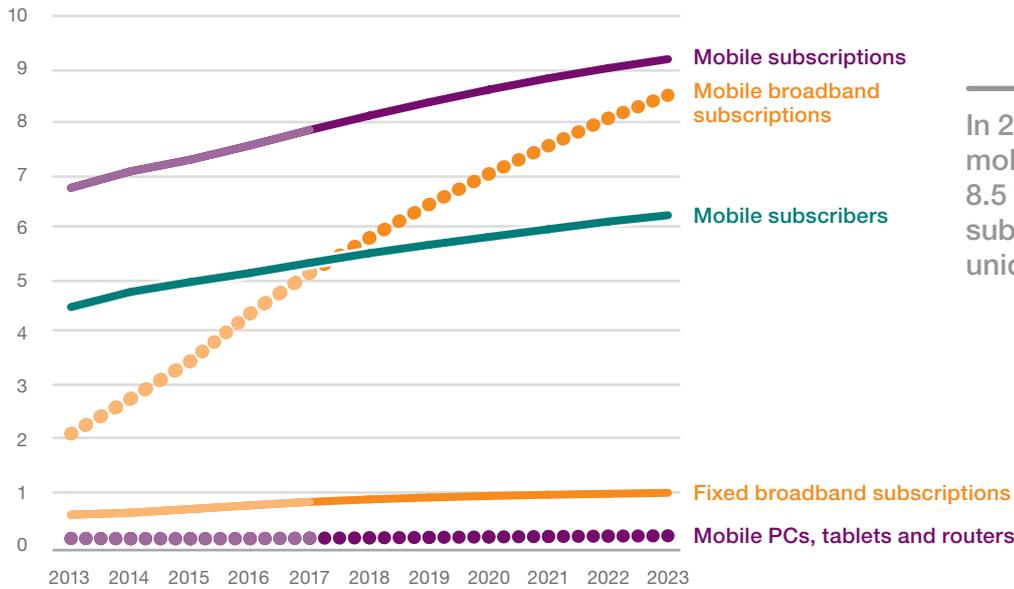
Mobile subscriptions by technology (billion)

5G subscriptions will reach 1 billion by the end of 2023

- 🟠 5G
- 🟢 LTE
- 🟣 WCDMA/HSPA
- 🔵 GSM/EDGE-only
- 🟢 TD-SCDMA
- ⚪ CDMA-only

[1] Non-Standalone 5G NR will utilize the existing LTE radio and Evolved Packet Core network as an anchor for mobility management and coverage, while adding a new 5G radio access carrier to enable certain 5G use cases
Figure note: IoT connections and Fixed Wireless Access (FWA) subscriptions are not included in the above graph

Subscriptions/lines, subscribers (billion)

In 2023, there will be 9.1 billion mobile subscriptions, 8.5 billion mobile broadband subscriptions and 6.2 billion unique mobile subscribers

Subscriptions for mobile broadband are expected to approach 95 percent of all subscriptions by the end of 2023

It is forecast that there will be 9.1 billion mobile subscriptions by the end of 2023. Mobile broadband subscriptions will reach 8.5 billion, accounting for close to 95 percent of all mobile subscriptions. The number of unique mobile subscribers is estimated to reach 6.2 billion by the end of the forecast period.

Mobile broadband will complement fixed broadband in some segments, and will be the dominant mode of access in others.[2] Subscriptions for PCs and tablets with mobile capabilities are expected to show moderate growth, reaching 330 million in 2023.

5G will be introduced in higher spectrum bands to meet new traffic demands

Mobile broadband traffic is expected to increase by eight times over the coming six years, while commercial 5G systems will be introduced from 2019. However, below 3GHz, most of the mobile cellular spectrum bands currently used by service providers are becoming congested during busy hours in highly loaded cells.

In response to increasing demands, the mobile industry is focusing on optimizing the spectral efficiency of LTE in existing frequency bands using new advanced functionalities,

such as Multiple Input Multiple Output (MIMO) and carrier aggregation. To solve capacity needs long term, most countries are expected to make additional spectrum available under new national 5G regulatory regimes. This will be achieved by extending the use of spectrum to higher bands, where a large amount of bandwidth could help accommodate the expected mobile data consumption from around 1 billion new 5G subscriptions in 2023.

Several suitable bands are currently being considered to support 5G subscription growth, and to deliver the data rates needed to meet the future demand for broadband services and applications. Currently bandwidth in the 28GHz band (26.5–29.5GHz)
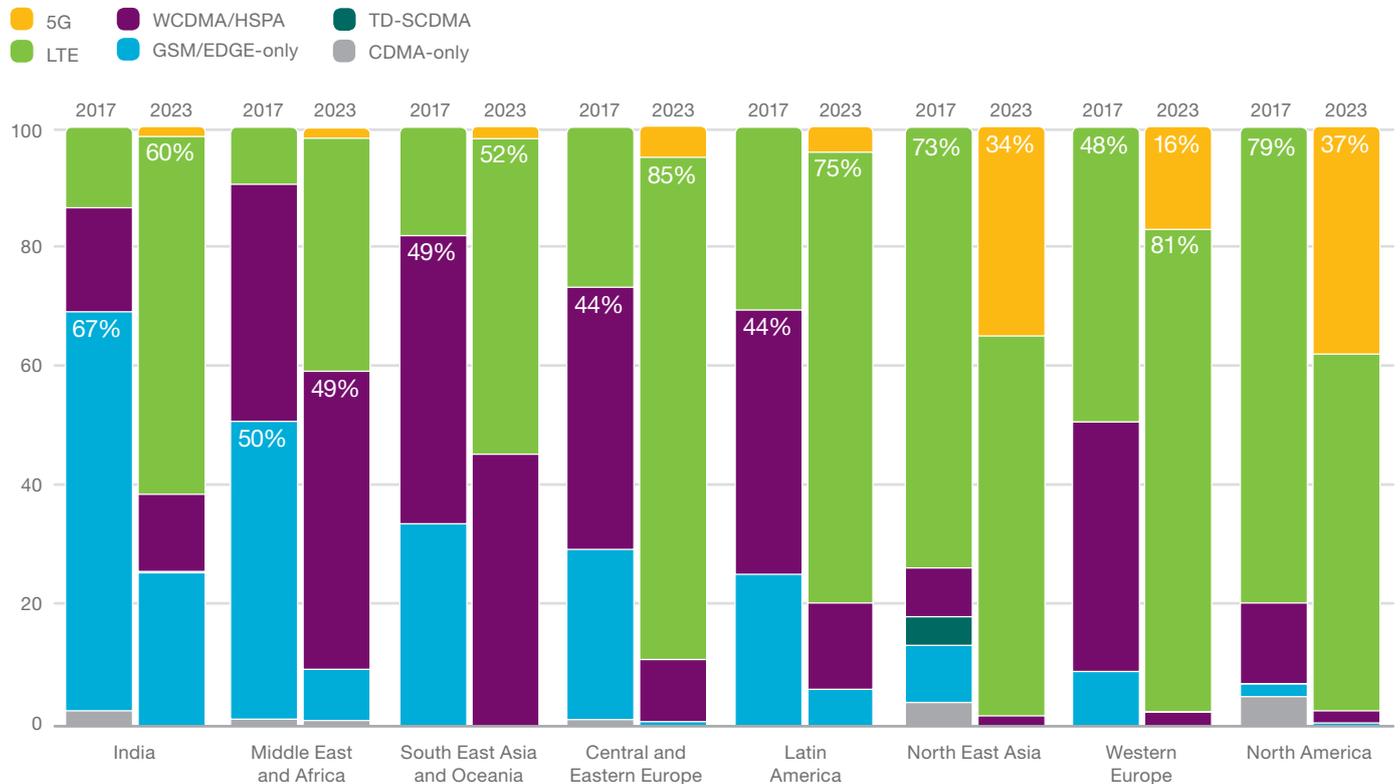
is being allocated in some countries, but bandwidth in the 26GHz band (24.25–27.5GHz) is also being considered. The latter band is part of the International Telecommunication Union's (ITU) World Radiocommunication Conference 2019 (WRC-19) agenda, while the former band is being assigned under an already existing mobile allocation in the ITU Radio Regulations.

The mobile industry considers these two bands to be the most important for terrestrial mobile applications on higher frequencies (above 6GHz). The 38GHz and 42GHz bands are also being considered as complementary resources to support 5G requirements.

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[2] The number of fixed broadband users is at least three times the number of fixed broadband connections, due to shared subscriptions in households, enterprises and public access spots. This is the opposite of the situation for mobile phones, where subscription numbers exceed user numbers

REGIONAL SUBSCRIPTIONS OUTLOOK

Mobile subscriptions by region and technology (percent)

Legend:
- 5G
- LTE
- WCDMA/HSPA
- GSM/EDGE-only
- TD-SCDMA
- CDMA-only

Mobile broadband drives subscription growth across all regions

The number of mobile subscriptions continues to grow across the regions, fueled by a strong uptake in mobile broadband.[1] There are still large variations between regions. However, with the exception of India, subscriptions for mobile broadband now make up 50 percent or more of total subscriptions in all regions. Globally, the most common way to access the internet is over a mobile network.

By the end of 2023, the Middle East and Africa region will transform from a situation where half of all mobile subscriptions are GSM/EDGE-only, to one where 90 percent of subscriptions are for mobile broadband. Driving factors for this growth include a young and growing population with increasing digital skills, as well as more affordable smartphones.

37% of subscriptions in North America are expected to be for 5G in 2023

In North East Asia, 5G is expected to be deployed early in South Korea, Japan and China. For the region as a whole, 5G subscription penetration is expected to reach 34 percent by the end of the forecast period.

North America currently has the highest penetration of LTE subscriptions at close to 80 percent. The region will also lead 5G uptake, with major operators stating their intentions to deploy 5G early. 5G subscriptions are expected to account for 37 percent of all mobile subscriptions in the region by the end of 2023.

Western Europe is expected to evolve more slowly, with 5G making up 16 percent of mobile subscriptions at the end of the period.

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[1] Mobile broadband includes radio access technologies HSPA (3G), LTE (4G), 5G, CDMA2000 EV-DO, TD-SCDMA and Mobile WiMAX
Note: WCDMA without HSPA and GPRS/EDGE (2G) are not included

VOICE OVER LTE OUTLOOK

VoLTE subscriptions[1] are expected to exceed 650 million by the end of 2017, creating a foundation for interoperable consumer and enterprise communication services on different devices

VoLTE has now been launched in more than 125 networks in over 60 countries across all regions. The number of VoLTE subscriptions is projected to reach 5.5 billion by the end of 2023, accounting for more than 80 percent of the combined LTE and 5G subscriptions.

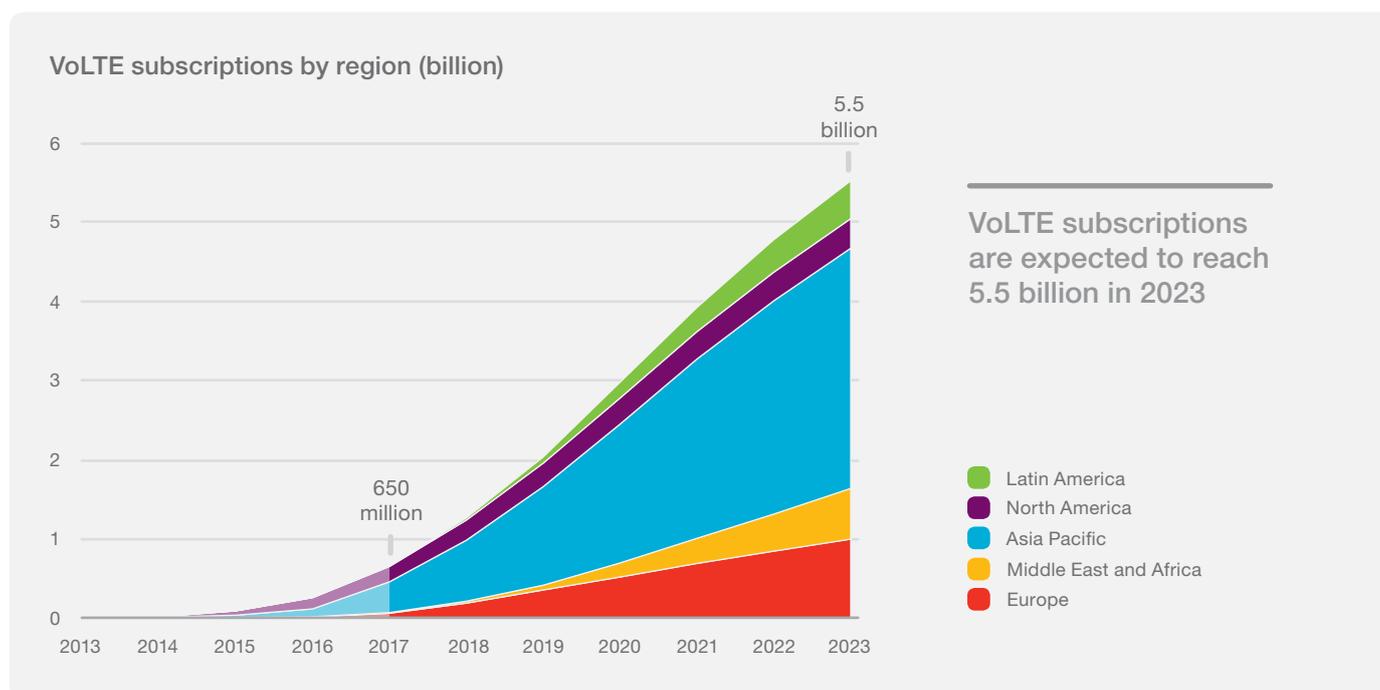### Enabling new consumer and enterprise use cases with VoLTE

VoLTE is delivered via the IP Multimedia Subsystem (IMS) and enables operators to offer high-quality, simultaneous communication and data services on smartphones and other devices. Functionality includes HD voice, HD voice+ and music within calls with the new Enhanced Voice Services (EVS) codec, content sharing within calls, video communication, IP messaging and evolution to chat bots, and allowing several devices to share the same phone number.

Wi-Fi calling is built on the same core network systems as VoLTE, and enables operators to extend their voice service to places with limited cellular coverage. To date, Wi-Fi calling has been implemented on over 55 networks in more than 30 countries.[2]

There are more than 1,300 VoLTE-enabled device models.[3] Cellular smartwatches are one of the latest devices to utilize VoLTE. Users are able to make voice calls directly on their smartwatch, without having a smartphone nearby. Calls can also be transferred between a user's smartphone and watch.

VoLTE support in Cat-M1-capable Internet of Things (IoT) devices and network infrastructure is now being enabled, and new use cases are being explored. Many IoT use cases could benefit by incorporating basic voice calling functionality. One example is in assistance situations, such as using an alarm panel in an elevator, or calling the owner of a lost dog via its IoT-connected collar. The technology could also be used to improve business performance, for example, enabling faster repair of vending machines by providing a button to call a service center easily.

VoLTE technology will be the foundation for enabling voice calls over 5G access. New communication service use cases in a 5G context are being explored, such as combining them with augmented reality and virtual reality.

VoLTE subscriptions by region (billion)

VoLTE subscriptions are expected to reach 5.5 billion in 2023

- Latin America
- North America
- Asia Pacific
- Middle East and Africa
- Europe

[1] A subscriber is counted as having a VoLTE subscription if making at least one VoLTE call per month
[2] GSMA (November 2017)
[3] GSA (July 2017), supporting different regions and frequencies
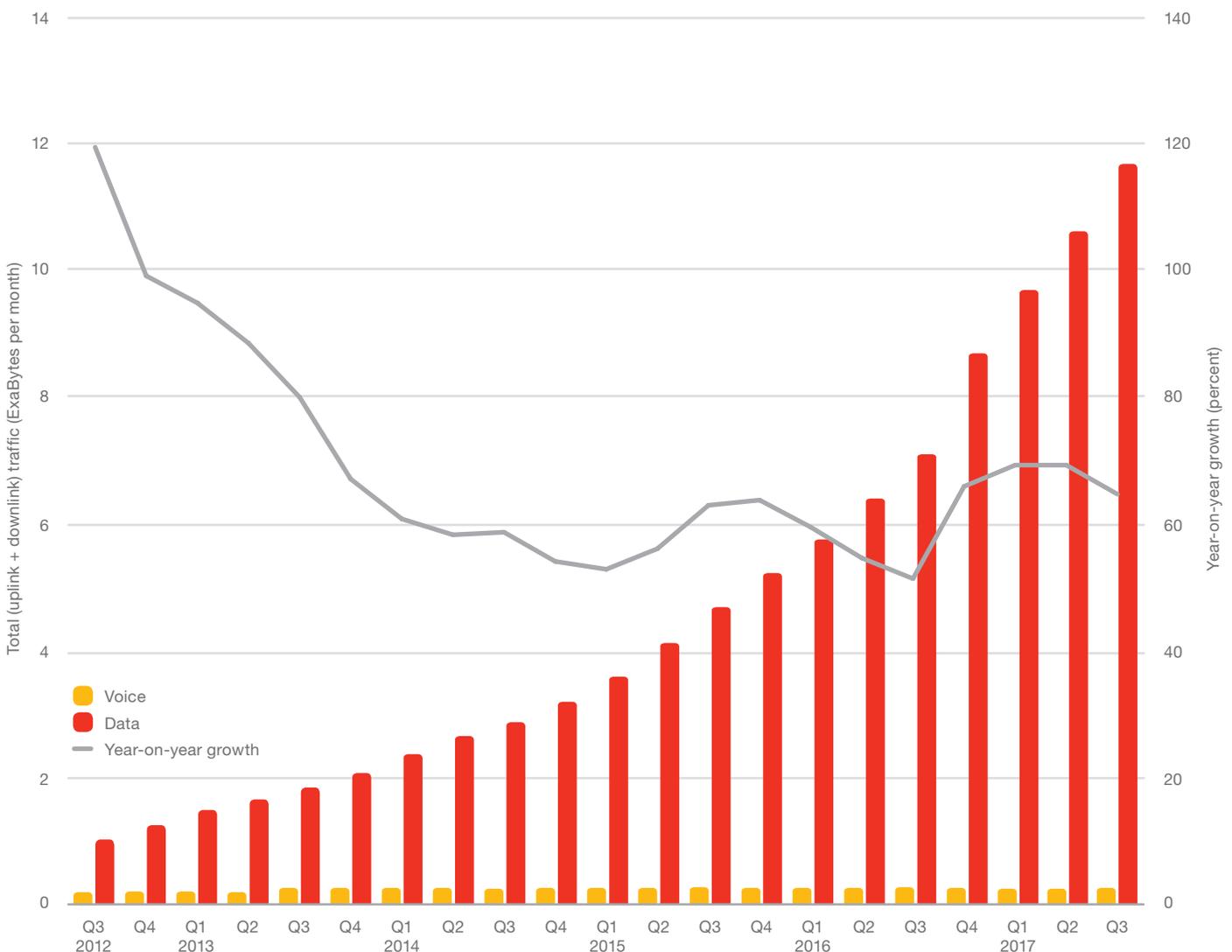
MOBILE TRAFFIC Q3 2017

Mobile data traffic[1] continues to grow. This is driven by increasing smartphone subscriptions and increasing average data volume per subscription, fueled primarily by more viewing of video content.

The graph below shows total global monthly data and voice traffic from Q3 2012 to Q3 2017, along with the year-on-year percentage change for mobile data traffic.

This curve illustrates a typical moderating growth rate as the market has evolved over time, which has been disrupted on a couple of occasions. In 2015, the growth rate was influenced by zero-rated video offers in North America. In 2016, introductory free data traffic offers in India pushed up the global traffic noticeably.

In Q3 2017, data traffic grew around 10 percent quarter-on-quarter and around 65 percent year-on-year. However, there are large differences in traffic levels between markets, regions and operators.

Data traffic grew 65% between Q3 2016 and Q3 2017

Voice
Data
Year-on-year growth

Source: Ericsson traffic measurements (Q3 2017)

[1] Traffic does not include DVB-H, Wi-Fi, or Mobile WiMAX. VoIP is included in data traffic

MOBILE TRAFFIC BY APPLICATION CATEGORY

Increased viewing of video on mobile devices, embedded video and emerging video formats will drive data consumption
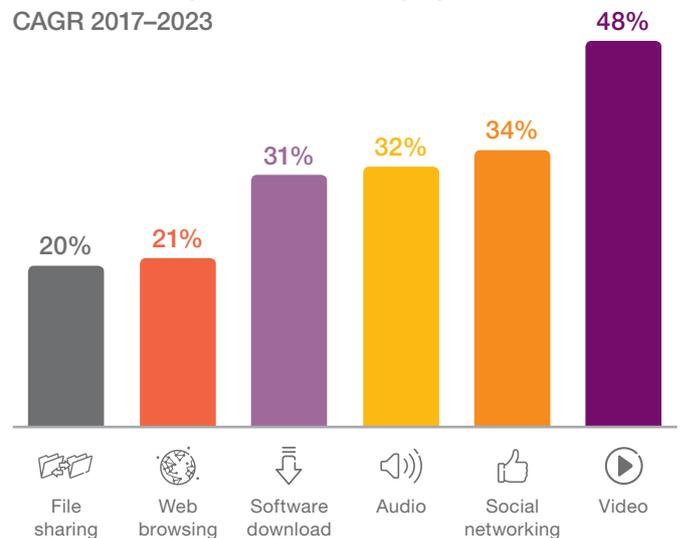
Mobile video traffic is forecast to grow by around 50 percent annually through 2023 to account for 75 percent of all mobile data traffic. Social networking is also expected to grow – increasing by 34 percent annually over the next 6 years. However, its relative share of traffic will decline from 12 percent in 2017 to around 8 percent in 2023, as a result of the stronger growth of video.

Other application categories have annual growth rates ranging from 20 to 32 percent, and so are shrinking as a proportion of overall traffic. The use of embedded video in social media and webpages (here counted as video traffic) is also growing, fueled by larger device screens, higher resolution and new platforms supporting live streaming.

The emergence of new applications and changes in consumer behavior can shift the forecast relative traffic volumes. Streaming videos in different resolutions can impact data traffic consumption to a high degree. Watching HD video (1080p) rather than video at a standard resolution (480p) typically increases the data traffic volume by around 4 times. An emerging trend with increased streaming of immersive video formats, such as 360-degree video, would also impact data traffic consumption. For example, a YouTube 360-degree video consumes 4 to 5 times as much bandwidth as a normal YouTube video at the same resolution.

Another driver is an increasing preference among consumers for on-demand and catch-up TV over scheduled linear TV viewing. Consumer research indicates that as early as 2020, half of all TV and video viewing will be done on a mobile screen.[1]

Mobile traffic by application category CAGR 2017–2023

File sharing	Web browsing	Software download	Audio	Social networking	Video
20%	21%	31%	32%	34%	48%

Mobile data traffic by application category per month (ExaBytes)

- Video
- Audio
- Web browsing
- Social networking
- Software download
- Other
- File sharing

2017
14 ExaBytes
per month

55% video

In 2023, video will account for around 75% of mobile data traffic

2023
110 ExaBytes
per month

MOBILE DATA TRAFFIC OUTLOOK

In 2023, monthly global mobile data traffic will surpass 100 ExaBytes (EB)

Monthly mobile data traffic per smartphone continues to increase in all regions. North America has the highest usage, and traffic is expected to reach 7.1 GigaBytes (GB) per month per smartphone by the end of the year and increase to 48GB by the end of 2023. Western Europe has the second highest usage, with traffic set to reach 4.1GB by the end of 2017 and 28GB by the end of 2023. Western Europe will be the region with the highest growth rate in monthly mobile data traffic per smartphone during the forecast period.
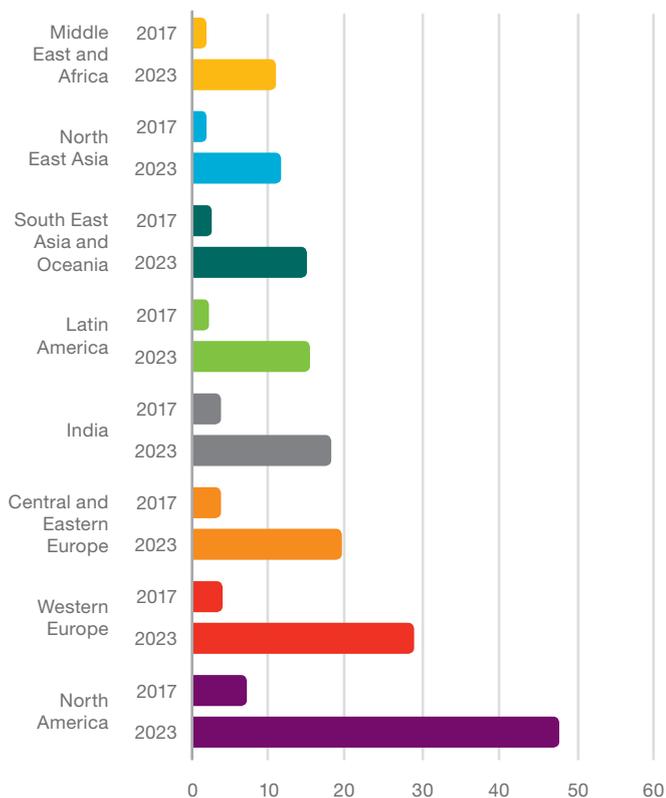
The high average usage in India – estimated to reach 3.9GB per month per smartphone at the end of 2017 – is mainly due to an introductory LTE offer by an operator during the latter half of 2016, which included free voice and data traffic. Data traffic is expected to continue to grow, reaching 18GB per month per smartphone in 2023.

Factors that will drive higher usage in general include an increase in the number of LTE subscriptions, improved device capabilities and more affordable data plans, as well as an increase in data-intensive content. As virtual reality and augmented reality technologies are more widely adopted, content will become even more data intensive.

Total mobile data traffic is expected to rise at a compound annual growth rate (CAGR) of 42 percent

Total mobile data traffic for all devices is anticipated to increase by 8 times during the forecast period, reaching around 110EB per month by the end of 2023. At close to 85 percent, data traffic generated by smartphones is already accounting for the largest proportion of mobile data traffic. Going forward, smartphone data traffic will become even more dominant, and is expected to increase by 9 times during the forecast period to account for close to 95 percent of total mobile data traffic by the end of 2023.

Data traffic per active smartphone
(GigaBytes per month)

Global mobile data traffic
(ExaBytes per month)

Close to 95% of mobile data traffic will come from smartphones in 2023

Legend: Smartphones; Mobile PCs, tablets and routers

Global mobile data traffic (ExaBytes per month)

Legend: ● Mobile PCs, tablets and routers ● Smartphones

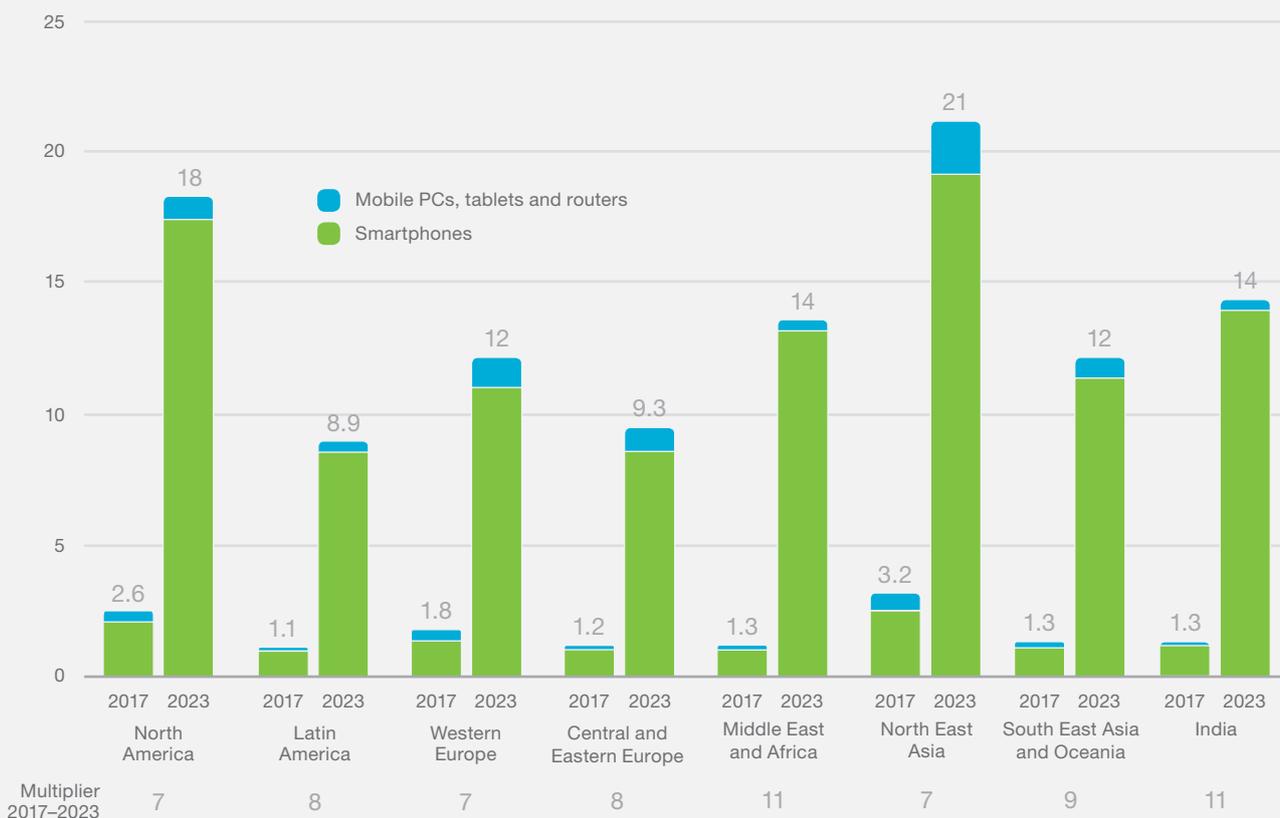|	North America		Latin America		Western Europe		Central and Eastern Europe		Middle East and Africa		North East Asia		South East Asia and Oceania		India	
Year	2017	2023	2017	2023	2017	2023	2017	2023	2017	2023	2017	2023	2017	2023	2017	2023
Value	2.6	18	1.1	8.9	1.8	12	1.2	9.3	1.3	14	3.2	21	1.3	12	1.3	14
Multiplier 2017–2023	7		8		7		8		11		7		9		11	

North East Asia is set to keep the largest share of global mobile data traffic

North East Asia is the most populous region and as such has the largest share of global mobile data traffic – 23 percent by the end of 2017. This will continue into 2023, when total mobile data traffic in the region is forecast to reach 21EB per month. South Korea and Japan engaged in early deployment of LTE with fast uptake, and markets like Singapore and Hong Kong are also highly advanced. The rapid growth in mobile broadband subscriptions is expected to continue. China is set to add 420 million mobile broadband subscriptions by the end of 2023, driving data traffic to 15EB per month.

In India, total mobile data traffic per month is expected to increase by 11 times during the forecast period to exceed 14EB in 2023. The strong growth in LTE subscriptions and increasing smartphone penetration, as well as the demand for data-intensive applications like video, will drive usage. In South East Asia and Oceania, total mobile data traffic will also show strong growth, increasing by 9 times to reach 12EB per month in 2023.

The regions of the Middle East and Africa and Central and Eastern Europe will experience an 11 times

There will be 11 times more mobile data traffic in India in 2023

and 8 times increase in mobile data traffic, respectively, up to the end of the forecast period. In 2023, total monthly mobile data traffic will reach 14EB in the Middle East and Africa and 9.3EB in Central and Eastern Europe.

North America and Western Europe have a larger share of the total traffic volume than subscription numbers imply. This is due to well built-out WCDMA and LTE networks and high penetration of high-end user devices, complemented with affordable packages offering large volumes of data. This combination leads to high data usage per subscription. Total mobile data traffic is expected to exceed 18EB per month in North America in 2023 and reach 12EB per month in Western Europe.

In Latin America, the rising number of smartphone subscriptions, as well as the increasing use of mobile broadband to access a range of online services, has led to strong growth in mobile data traffic. This growth is expected to continue over the forecast period to reach close to 9EB per month by the end of 2023.

IOT CONNECTIONS OUTLOOK

The number of connected IoT devices is expected to increase at a CAGR of 19 percent up to 2023. More than 20 massive IoT cellular networks have been commercially deployed across several regions

20 billion connected IoT devices by 2023

By 2023, over 30 billion connected devices[1] are forecast, of which around 20 billion will be related to the IoT. Connected IoT devices include connected cars, machines, meters, sensors, point-of-sale terminals, consumer electronics[2] and wearables. Between 2017 and 2023, connected IoT devices are expected to increase at a CAGR of 19 percent, driven by new use cases and affordability.

Short-range and wide-area segments

In the figure below, IoT is divided into short-range and wide-area segments. The short-range segment largely consists of devices connected by unlicensed radio technologies, with a typical range of up to 100 meters, such as Wi-Fi, Bluetooth and Zigbee. This category also includes devices connected over fixed-line local area networks and powerline technologies.

The wide-area segment consists of devices using cellular connections, as well as unlicensed low-power technologies, such as Sigfox and LoRa.
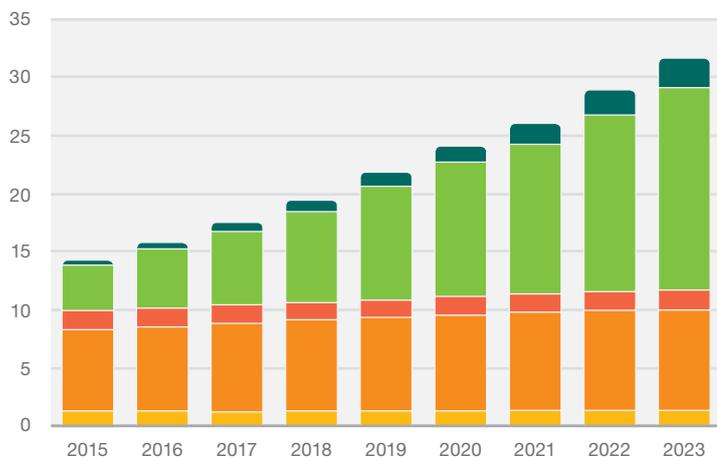
1.8 billion IoT devices with cellular connections by 2023

At the end of 2017, there will be around 0.5 billion IoT devices with cellular connections. This number is projected to reach 1.8 billion in 2023, or around 75 percent of the wide-area category.

Presently, the dominant technology in the wide-area segment is GSM/GPRS. However, by 2023, IoT cellular connectivity will mainly be provided by LTE and 5G. The majority of these connections will be over LTE networks, while 5G technology will continue to support an increase in IoT applications, especially those requiring critical communications. 5G will also provide mechanisms for rapid and cost-effective introduction and provisioning of new IoT services.

Based on technologies like Cat-M1 and NB-IoT,[3] a growing number of cellular IoT networks are being deployed, with more than 20 networks now commercially launched across several regions.[4]

Connected devices (billion)

	2017	2023	CAGR
Wide-area IoT	0.6	2.4	26%
Short-range IoT	6.4	17.4	18%
PC/laptop/tablet	1.6	1.7	0%
Mobile phones	7.5	8.8	3%
Fixed phones	1.4	1.3	0%
	17.5 billion	31.6 billion	

[1] In our forecast, a connected device is a physical object that has a processor, enabling communication over a network interface
Note: Traditional landline phones are included for legacy reasons

[2] Including: Smart TVs, digital media boxes, Blu-Ray players, gaming consoles, audio/video (AV) receivers, etc.

[3] Cat-M1 supports a wide range of IoT applications, including content-rich ones, and NB-IoT is streamlined for ultra-low throughput applications. Both of these technologies are deployed on LTE networks

[4] GSA (October 2017)

NETWORK COVERAGE

In 2023, more than 20 percent of the world's population will be covered by 5G

Demand for population and geographical coverage

Historically, mobile services have been centered on providing sufficient radio signal for the world's inhabitants where they live, which is defined as population coverage. Today, mobile networks cover around 95 percent of the world's population and this figure continues to grow.

Mobile service usage has evolved from predominantly voice to messaging and internet access, as well as to a variety of apps on a range of smart devices, placing greater demands on network performance.

For mobile broadband (WCDMA/HSPA or a later technology), population coverage is currently at around 80 percent and forecast to grow to over 95 percent in 2023.

With the expected growth of IoT services, there is a higher demand on geographical coverage – be it wide-area or dedicated coverage – as networks of sensors are installed in places with low population density such as agricultural areas or forestland.

LTE deployment continues to gain momentum

In terms of build-out and subscription uptake, LTE is the fastest-deployed mobile communication technology to date. It took just 5 years for LTE to cover 2.5 billion people, compared to 8 years for WCDMA/HSPA.

LTE is driven by demand for improved user experience and faster networks. Several drivers are further increasing the speed of LTE deployment. In India, a rise in low-cost offerings and low cost per MegaByte is making the technology attractive. Similar drivers are also prevalent in other high-growth markets.

LTE population coverage is currently around 55 percent and is forecast to grow to more than 85 percent in 2023.

Providing coverage for 5G use cases

In the past, mobile networks have first been deployed in urban areas, and then gradually expanded to areas such as suburban and major interconnecting highways.
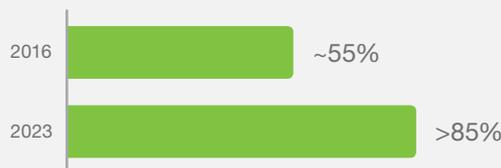
In a similar fashion, 5G is expected to be deployed first in dense urban areas to support enhanced mobile broadband services, and by 2023, more than 20 percent of the world's population is expected to be covered by the technology.
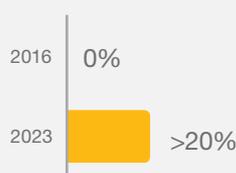
To a large extent, 5G is driven by use cases with a wide range of requirements. One of the first commercial uses for 5G is expected to be for Fixed Wireless Access (FWA), implying a coverage build-out in urban areas. Other use cases will come from industries such as automotive, manufacturing, energy and utilities, and healthcare, and will drive demand for dedicated coverage.

World population coverage by technology[1]

Total population coverage of 3GPP cellular technologies

Year	Coverage
2016	~95%
2023	>95%

LTE is driven by demand for improved user experience and faster networks

Year	Coverage
2016	~55%
2023	>85%

5G coverage will commence in metropolitan and urban areas

Year	Coverage
2016	0%
2023	>20%

[1] The figures refer to population coverage of each technology. The ability to utilize the technology is subject to factors such as access to devices and subscriptions

NETWORK EVOLUTION

Mobile networks with Gigabit speed capabilities are currently being launched and trialed in several regions worldwide. Beyond enhanced mobile broadband use cases, a range of new industrial and enterprise use cases are enabled by evolving networks. In the manufacturing industry, augmented reality-assisted maintenance and repair could improve productivity and efficiency throughout the manufacturing process

Mobile networks are evolving to deliver enhanced mobile broadband and communication services with high data throughput, quality of service and low latency requirements, as well as new IoT services with strong requirements on scalability, reliability, availability and latency. Significant radio performance enhancements, together with a more flexible and agile core network, will enable operators to serve a much broader range of use cases in the future.

Gigabit LTE network deployments gaining momentum

Operators have deployed multi-standard access networks with GSM, HSPA and LTE, and are evolving their existing LTE networks to LTE-Advanced (LTE-A), enabling Gigabit network speeds. Device ecosystems are well aligned, as most new smartphones support the latest 3GPP Category[1] (Cat 16).

By using higher order carrier aggregation, operators can combine more spectrum assets. As carrier aggregation is coupled with 4x4 MIMO and 256 QAM, operators can achieve network speeds with peak rates of Gigabit per second. This will lead to increased network capacity, a wider coverage area, and faster average end-user data speeds.

There are currently 14 Gigabit LTE networks that have been commercially launched, and the deployment rate is expected to increase during 2018. Even so, in ongoing trials (based on commercially available network infrastructure and chipsets) speeds above Gigabit per second have been achieved. Commercial launches of such networks are also expected during 2018.
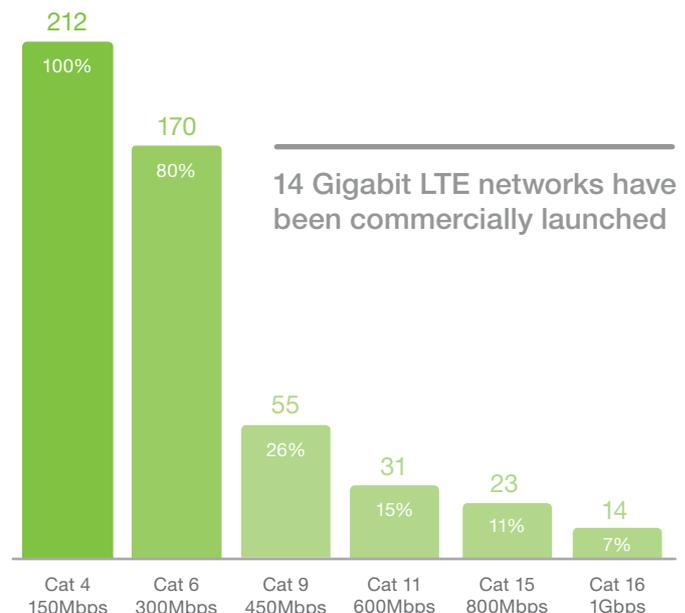
There are currently 644 commercial LTE networks deployed in 200 countries. Of these, 212 have been upgraded to LTE-A networks.

Further technology advances on the road to 5G

In the quest to offer increased capacity and faster data speeds, one of the limiting factors is the availability of a sufficient amount of licensed spectrum. Licensed Assisted Access (LAA) is a new technology that allows operators to use unlicensed spectrum in combination with their licensed spectrum to improve network capacity and speed. Commercial deployments are expected in 2018.

Another technology that improves end-user experience, as well as increasing network capacity and coverage while reducing interference, is Massive MIMO. Massive MIMO will play an important role in current generations of mobile communication and will become even more important with 5G technology. Several trials are ongoing and commercial deployments are expected during 2018.

Percentage and number of LTE-Advanced networks supporting Cat 4, Cat 6, Cat 9, Cat 11, Cat 15 and Cat 16 devices

14 Gigabit LTE networks have been commercially launched

Cat 4 150Mbps	Cat 6 300Mbps	Cat 9 450Mbps	Cat 11 600Mbps	Cat 15 800Mbps	Cat 16 1Gbps
212 (100%)	170 (80%)	55 (26%)	31 (15%)	23 (11%)	14 (7%)

Source: Ericsson and GSA (November 2017)

[1] Category (Cat) labels the theoretical maximum downlink speed a mobile device supports. The higher the Cat number, the faster the speeds

Examples of use case evolution and supporting network technologies

		Current	On the road to 5G	5G experiences
	Enhanced mobile broadband	Browsing, social media, music, video	Fixed Wireless Access, interactive live concerts and sports events	4K/8K videos, mobile AR/VR gaming, immersive media
	Automotive	Wi-Fi hotspots, on-demand GPS map data, over-the-air software updates	Predictive vehicle maintenance; capturing of sensor data for real-time traffic, weather, parking and mapping services	Autonomous vehicle control, cooperative collision avoidance, vulnerable road user discovery
	Manufacturing	Connected goods, intra/inter enterprise communication	Collaborative robots, distributed control system, remote quality inspection	Remote control of robots; AR in training, maintenance, construction and repair
	Energy and utilities	Smart metering, dynamic and bidirectional grids	Distributed energy resource management, distribution automation	Control of edge-of-grid generation, virtual power plants, real-time load balancing
	Healthcare	Remote patient monitoring, connected ambulances, electronic health records	Tele surgery, AR aiding medical treatment	Precision medicine, remote robotic surgery, ambulance drones
	Technologies	> Multi-standard network > Cat-M1/NB-IoT > Cloud-optimized network functions > VNF orchestration	> Gigabit LTE (TDD, FDD, LAA) > Massive MIMO > Network slicing > Dynamic service orchestration > Predictive analytics	> 5G New Radio > Virtualized RAN > Federated network slicing > Distributed cloud > Real-time machine learning/AI

Evolution of use cases

Beyond enhanced mobile broadband, networks are evolving to handle use cases with different demands on mobility, data rates, latency, scalability, security, integrity, reliability, availability and device density. As indicated in the table above, networks will serve an increasing number of use cases over time. These will come from a range of industries, such as automotive, manufacturing, energy and utilities, and healthcare.

As an example, digitalization in the manufacturing industry will enable a range of new use cases with the potential to improve productivity and efficiency throughout the whole manufacturing process.

Use case: Augmented reality-assisted maintenance and repair

The manufacturing industry has short business cycles and caters to increasingly varied customer demands. Now, digitalization and globalization are making the industry more competitive, requiring supply chains to be managed more efficiently as they become interconnected worldwide.

Unplanned interruptions in the manufacturing process drive increased costs, leading to lower utilization of machinery and product throughput, and extended lead times. Current operational processes create several related challenges. For example, maintenance planning is typically based on inadequate data and much time is spent on information collection and documentation, or on training repair crews to use complex and diverse machinery.

Augmented reality (AR)[2] will help to address these challenges. One example is the use of AR alongside applications supporting data analysis and diagnostics, which will enable preventive and remote maintenance. These measures optimize the cost of operations, while also increasing uptime in the manufacturing process. Depending on the specifics of the use case, AR support will be provided through a range of devices, such as smartphones, tablets, smart helmets, smart gloves and smart glasses.

Repair crews could also be supported by augmented information. For example, operational guidance and automated processes could enable them to more easily carry out preventive and corrective maintenance, with less time spent on fault identification and a reduction in human error.

The role of 5G

Many use cases can be addressed by evolved 4G (LTE) networks. As networks evolve further there will be even more opportunities to enhance existing use cases, as well as to meet the demands of new ones when 5G is implemented.

5G will be highly beneficial for industrial use cases where AR-based applications will require high data rates and low latency. Bandwidth requirements are expected to be significant to ensure consistent and secure streaming of high-resolution images, as well as large volumes of data, in a sensor-rich environment with high-connection density.

[2] Live direct or indirect view of a physical, real-world environment with elements augmented by computer-generated sensory input such as sound, video and graphics

SHIFTING MOBILE DATA PLANS

The most popular mobile broadband data plans are those with limits ranging from 2 to 5 GigaBytes (GB) per month. As mobile data consumption continues to increase globally, there is a consistent shift towards ever larger plans. However, there are steady customer segments at both ends of the scale, suggesting a demand for a broad mix of plans. Smartphone user data, collected through on-device measurements, reveals the latest mobile plan, usage and traffic trends[1]

An evolving mix of data plans

Analysis of the available data indicates a general and long-term pattern of larger data plans attracting an increasing proportion of the customer base. Over the last year, 6 to 7 percent of users have moved from a smaller plan to a plan with a data bucket larger than 5GB. Driving this shift is customers' growing demand for more data, in combination with competition among operators to offer the most attractive packages. The trend also follows the incessant growth in smartphone capabilities and the continuous increase in network performance.
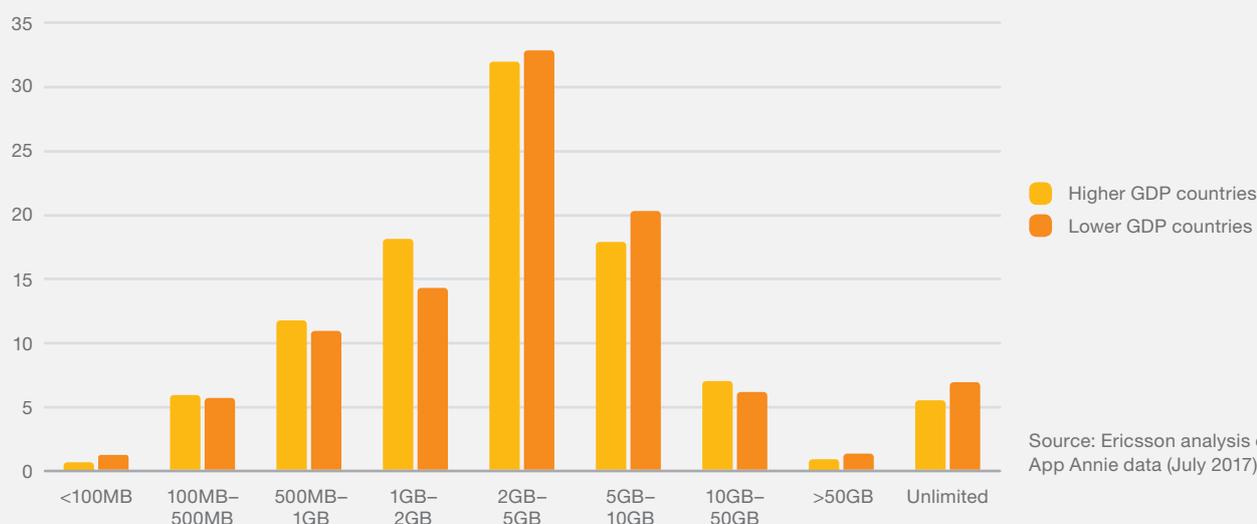
On the other hand, the 2 ends of the scale – plans with an allowance lower than 100 MegaBytes (MB) per month and plans with an allowance greater than 50GB per month (including unlimited plans) – have stable proportions of the user base, representing 1 and 7 percent of users, respectively. These are likely customer segments with specific requirements: one price-sensitive group preferring small data buckets, and the other group paying a premium for an all-you-can-use price model. This highlights the need to provide subscriptions with a range of data plans to meet customer demands.

Over a 12-month period, 6 to 7% of users moved to a data plan larger than 5GB

As a further basis for comparison, the study split the world into two market groups based on income – countries with gross domestic product (GDP) per capita higher than the world average ("higher GDP countries"), and those countries with below average GDP per capita ("lower GDP countries"). Analysis shows that there is little difference in preference patterns between the two market groups.

Distribution of mobile data plans in July 2017 – share of users (percent)

Legend: Higher GDP countries, Lower GDP countries

Source: Ericsson analysis of App Annie data (July 2017)

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[1] Data for the study includes consumption, traffic and plan size data from App Annie, and GDP per capita data from the World Bank

Monthly mobile data consumption per plan in July 2017 (GB)

Higher GDP countries
Lower GDP countries

Source: Ericsson analysis of
App Annie data (July 2017)

Usage patterns within data plans

The choice of mobile plan usually reflects customers' estimated needs for mobile data over the month. However, this does not always match their actual usage, as can be seen in the graph above.

On average, users on the smallest plans (lower than 100MB) go well beyond their limits. More than 60 percent of users in this group exceed their data allowance by over 200 percent, consuming data almost in parity with users of medium-sized plans (up to 1GB). Users of small plans do not seem to feel bound by their small data bucket, but rather consume data on a "pay-as-you-go" basis.

At the other end of the scale, unlimited users cannot consume an infinite amount of data, and here the two economic groups differ in their behavior.

In higher GDP countries, unlimited users consume around 20 percent more data than the users of very large but limited plans (10 to 50GB). However, those from lower GDP countries demonstrate an interesting behavior – consuming 40 to 45 percent less data on average per month than customers on very large but limited plans.

Despite these differences, people in both groups buy unlimited plans for peace of mind. Consumers appear to pay a premium for the assurance of not running out of data at the end of the month. Maximizing usage is not their main priority.
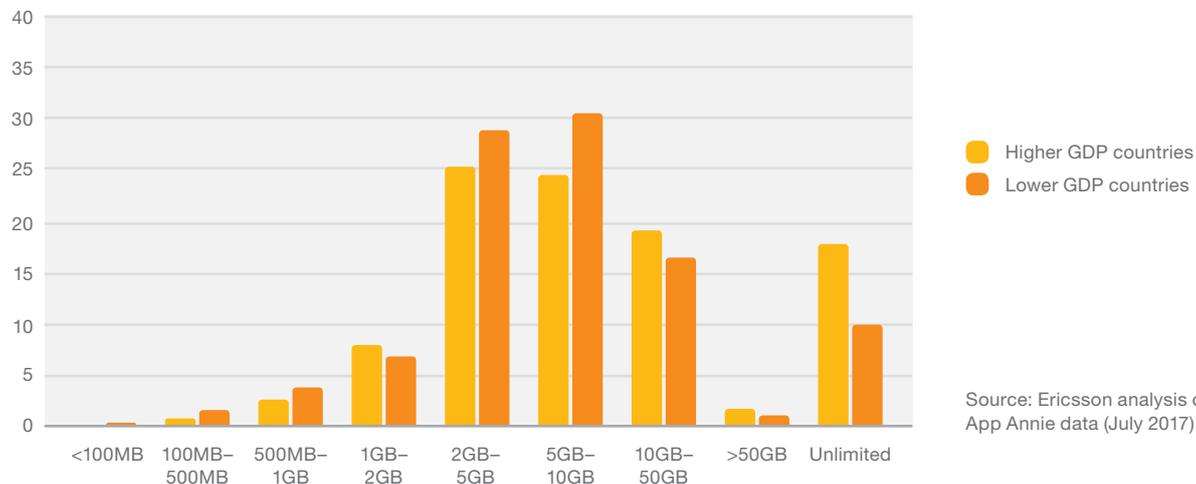
Total traffic generated from different plans

Plans with low-to-moderate allowances (lower than 2GB per month) represent around 35 percent of users and

12 percent of traffic in the networks. From a capacity point of view, these customers could be viewed as easy to serve. The relatively low consumption does, however, not say anything about the requirements these customers have on quality differentiators, such as network performance.

Consumers with medium-sized to very large data plan buckets (from 2 to 50GB per month) represent 60 percent of the user base and a significant 75 percent of traffic consumed.

Of all the traffic generated by the users of limited plans, around 30 percent is consumed above data bucket limits. This allows operators to continuously upsell data through top-ups. In addition, this demand for more data plays a key role in the shift to larger plans.

Distribution of mobile data plans in July 2017 – share of traffic (percent)

Higher GDP countries
Lower GDP countries

Source: Ericsson analysis of
App Annie data (July 2017)

Unlimited plans come with restrictions

In higher GDP countries, users of very large plans (beyond 50GB) generate around 20 percent of total traffic. Considering that this segment represents only 6 percent of users, it is over-represented in the traffic domain. However, unlimited plans usually come with restrictions in the form of fair usage policies and prioritization mechanisms. This prevents usage patterns that could negatively impact other users' experience. With such mechanisms, combined with a pricing model that captures the premium value of unlimited, the very large packages can be both controlled and monetized.

Mobile vs Wi-Fi traffic

The graph below shows that the larger the mobile plan consumers have, the less prone they are to switch to Wi-Fi. For small plans (below 100MB), only around 5 percent of traffic passes through mobile networks. For unlimited plans, this figure can be as high as 35 percent. Perceiving no boundaries, unlimited users both consume more data in total, and allow a higher share of their traffic through mobile networks.

When comparing the behavior of users on smaller data plans, those in lower GDP countries are more likely to stay on the mobile network than users in higher GDP countries. This is explained by the lower availability of fixed broadband and Wi-Fi in the former group.

For the users in lower GDP countries, however, the relation between mobile and Wi-Fi traffic changes for large and unlimited plans, with a greater share of traffic offloaded to Wi-Fi.[2] It is likely that households that can afford unlimited plans can also afford a fixed broadband connection and Wi-Fi.
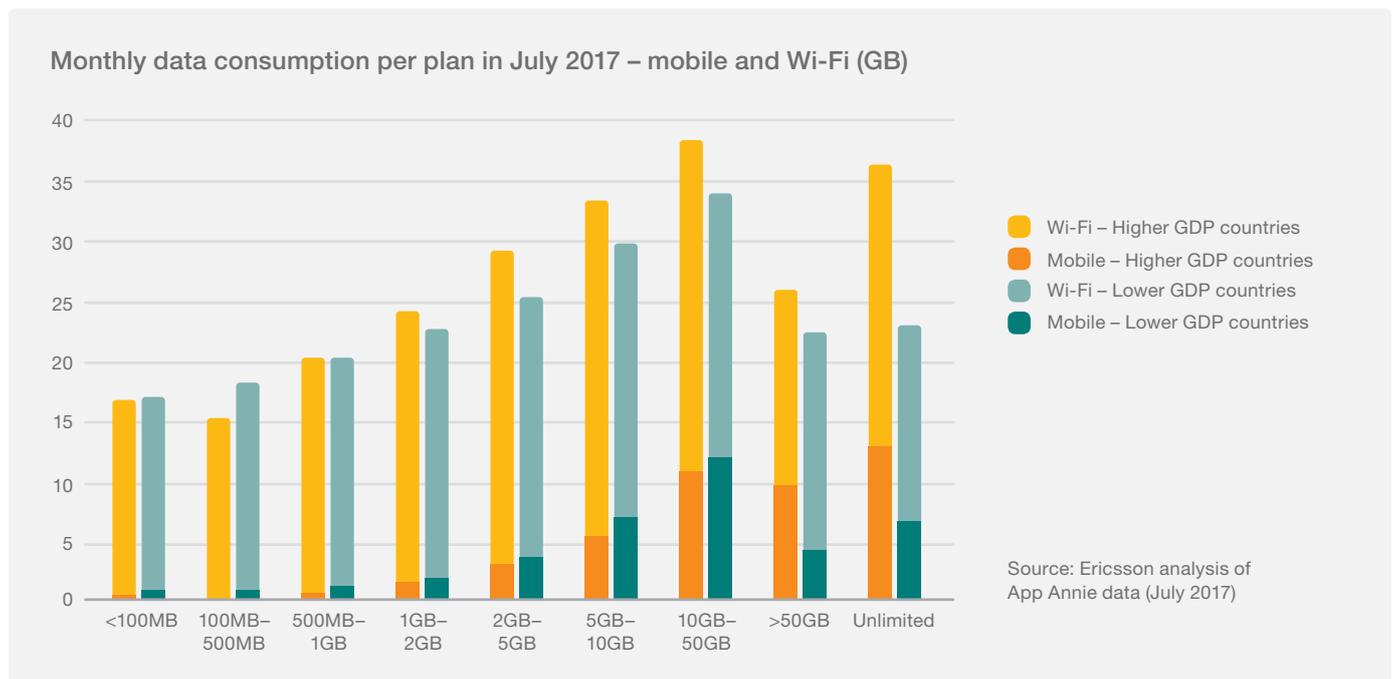
Even without restrictions on mobile usage, unlimited users consume a larger share of traffic via Wi-Fi, which is consistent with people spending a significant part of their active time indoors, where the connection often automatically switches. This indicates that the share of traffic ending up in the Wi-Fi domain will continue to be significant, even when consumers shift to larger data plans.

The total consumption of data (mobile and Wi-Fi) does not differ significantly across the customer base, with only a 2.5 times difference between users of the highest and the lowest plans. However, in terms of mobile data consumption, the 2 groups differ by as much as 24 times. This suggests that, while the basic data demand is universal, users have different ways to fulfill this demand.

Total data consumption (mobile and Wi-Fi) differs by only 2.5 times between the highest and the lowest plans

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Monthly data consumption per plan in July 2017 – mobile and Wi-Fi (GB)

Legend:
- Wi-Fi – Higher GDP countries
- Mobile – Higher GDP countries
- Wi-Fi – Lower GDP countries
- Mobile – Lower GDP countries

Source: Ericsson analysis of App Annie data (July 2017)

[2] Relative to both the users of smaller data plans in lower GDP countries and the unlimited data plan users in higher GDP countries

Meeting a range of requirements

There is no one-size-fits-all plan. The 2 to 5GB per month segment represents a sizeable proportion of the total customer base. However, the presence of stable, niche customer segments means that a good mix of plans will be important to address the variety of data requirements on the market.

There is no major difference in preference patterns across the world. While the most popular plans have data limits between 1 and 10GB per month, there is a stable proportion of customers at each end of the scale and higher growth is in the larger plans. Not only does this further highlight the need for a range of plans, but it also demonstrates that the shift towards larger plans is global.

Plans with limited allowances represent 94 percent of the customer base and 84 percent of total traffic. Thirty percent of traffic from these users is consumed above the data bucket limits. As limited users pay by usage, this represents an additional revenue stream for operators.

Unlimited data plans address a small customer segment. While there has been some concern about the increase in data traffic generated by users of unlimited plans, this traffic can be controlled through fair usage policies. In addition, 60 to 65 percent of unlimited users' traffic goes through Wi-Fi networks.

There is no one-size-fits-all plan – a good mix will be important to address the variety of user demands on the market

Methodology

Using data from the World Bank, the countries in this study were segmented into two categories: higher GDP countries and lower GDP countries. The first group includes 43 countries with a GDP per capita greater than the world average (USD 10,150), while the second group includes 33 countries with a GDP per capita lower than the world average.

The statistics on mobile consumption and bucket sizes were sourced from App Annie. App Annie Intelligence data for iPhone and Android phones was derived from mobile usage data collected from a large sample of real-world users, combined with additional proprietary data sets.

ENHANCING THE EVENT EXPERIENCE

Data from recent international sporting events illustrates spectators' growing use of mobile services during competitions. Operators now plan to use 5G technologies to showcase enhanced spectator experience at upcoming events, such as at the 2018 sports event in Pyeongchang, South Korea, and the 2020 sports event in Tokyo. Large events present an opportunity for operators and organizers to provide visitors with additional digital services throughout the entire experience

Event organizers and operators can further extend and enhance the spectator experience through ever more engaging content. Examples include video integrated with real-time data, historic event data, sports performance data, live event replays, event highlights, interactive statistics, event-related social media and exclusive behind-the-scenes content, such as press conferences and interviews.

Rising mobile data traffic at large events

At the 2016 sports event in Rio, four times more mobile data traffic was carried by networks in and around the event arenas than at the 2012 event in London. Data from anothe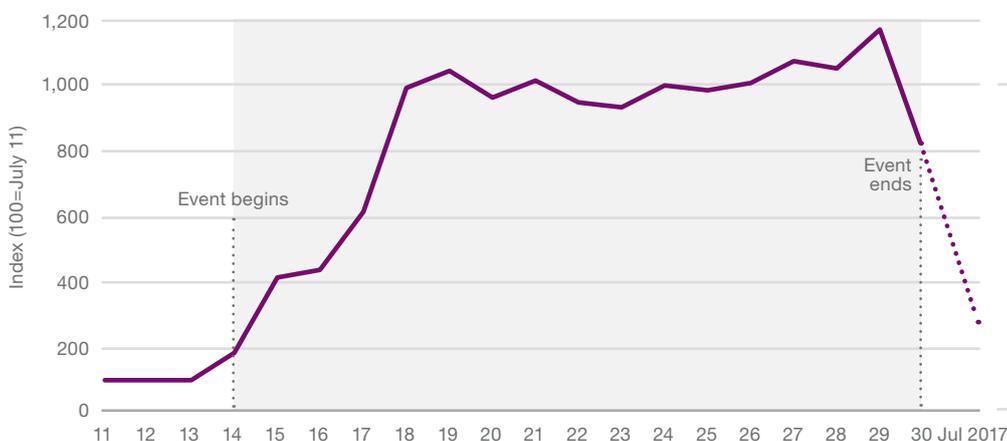r recent major event, the world championships for aquatic sports in Hungary in 2017, shows that daily mobile data traffic in areas associated with the event was as high as 10 times normal volumes. At the Rio event, the increase in traffic can be explained by a combination of better network capabilities and a general rise in consumers' use of digital services.

Increased usage of digital services, such as social media and video content, in and around an event, as well as the demands posed by new types of services, will create challenges for operators. To meet raised user expectations, operators will need to effectively prepare networks before the event and then manage network performance in real time during the event.

Shift in spectators' usage of mobile data services

Growth in mobile traffic at events can be attributed to changes in user behavior, especially among younger people. When the mobile data usage trend began, spectators were mainly using mobile devices to post selfies, make phone calls and use text services. Now spectators mainly share or stream live videos and engage with social networks. In addition, as spectators increasingly create their own content, a rise in uplink data traffic volume has occurred. For example, during the 2016 Rio event, the uplink data traffic share was as high as 33 percent of total traffic in and around the event arenas. This is significantly higher than normal.

Daily mobile data traffic level at the world championships for aquatic sports in Hungary in 2017
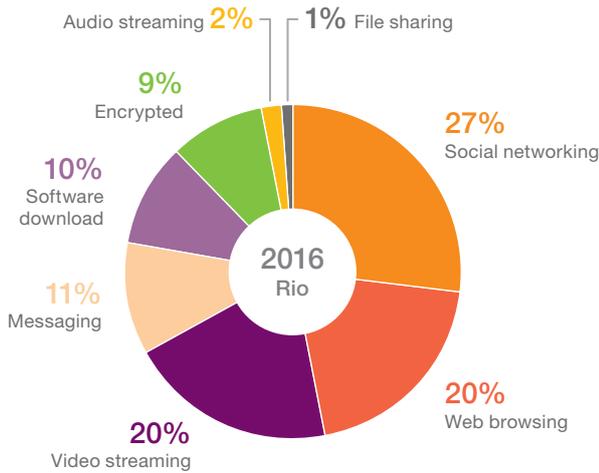

10X higher mobile data traffic levels compared to normal daily volumes

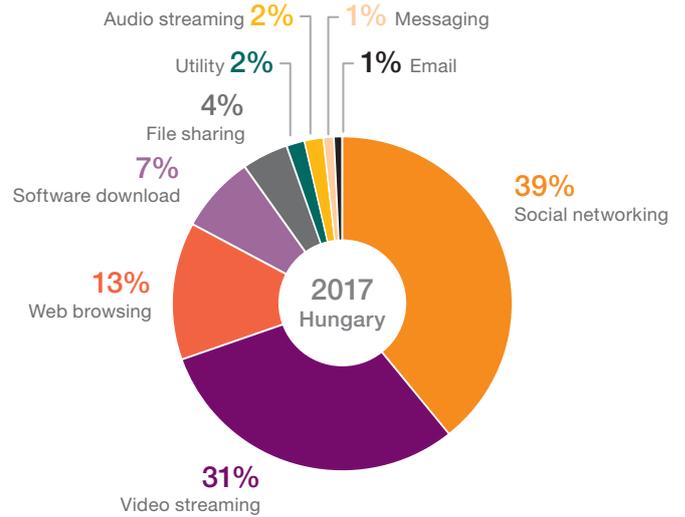Source: Ericsson (July 14–30, 2017)
Base: Network measurements from more than 400 radio cells associated with the event in Hungary, including cells deployed in the area only for the event

App category share of traffic for the top 15 apps at the 2016 Rio sports event

2016 Rio

- 2% Audio streaming
- 1% File sharing
- 9% Encrypted
- 10% Software download
- 11% Messaging
- 20% Video streaming
- 20% Web browsing
- 27% Social networking

Source: Brazilian operator network measurements (August 5–21, 2016)
Note: Top 15 apps by share of total traffic, used in and around the event

App category share of traffic for the top 15 apps at the Hungary world championships for aquatic sports in 2017

2017 Hungary

- 2% Audio streaming
- 1% Messaging
- 2% Utility
- 1% Email
- 4% File sharing
- 7% Software download
- 13% Web browsing
- 39% Social networking
- 31% Video streaming

Source: Ericsson network measurements (July 14–30, 2017)
Base: Android OS device network measurements from more than 400 radio cells associated with the event, including cells deployed in the area only for the event
Note: Top 15 apps by share of total traffic, used in and around the event

Social networking, video streaming and web browsing dominate

At the 2016 sports event in Rio, network measurements of different app categories' share of traffic for the top 15 apps used show that social networking, video streaming and web browsing dominated. Messaging was also prominent – presumably due to posting of pictures and videos.

At the world championships for aquatic sports in Hungary in 2017, there was a similar distribution. However, the social networking and video streaming categories were even more dominant.

The different app categories' share of traffic at both events can be seen in the graphs above.
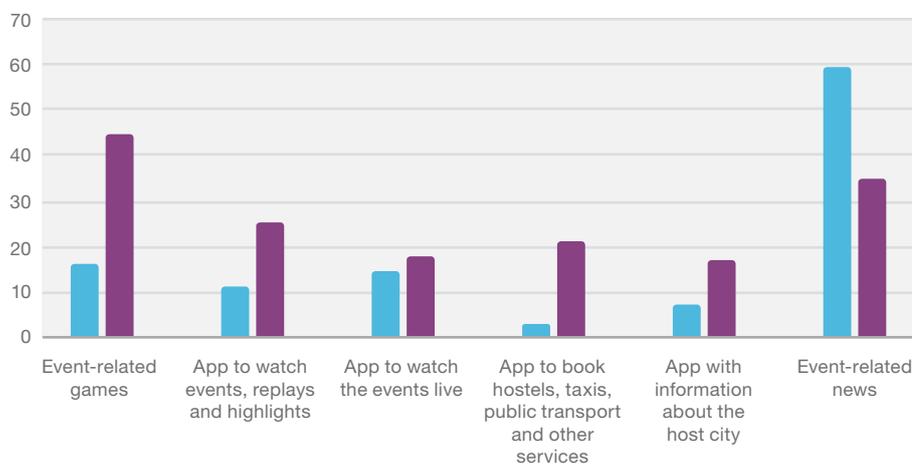
Connected venues and the role of event-related apps

In terms of data traffic volume, the usage of event-related apps in and around the arenas at the 2014 international football tournament and the 2016 sports event in Rio was insignificant. However, the interest in downloading and using an app related to the event (with the exception of event news) increased in 2016. This rise in interest can likely be attributed to the wider range of apps available

at the sports event in Rio, as well as a general increase in the use of digital services among event visitors.

Despite this increased interest, only around 25 percent of the interviewees at both the 2014 international football tournament and the 2016 sports event in Rio downloaded event-related apps. One reason for this could be limited investments in apps. However, those who did download event-related apps downloaded more of them in Rio, in comparison to those who downloaded event-related apps at the 2014 football tournament.

Comparison of event-related apps downloaded (percent)

- 2014 football tournament in Brazil
- 2016 sports event in Rio

Source: Ericsson ConsumerLab (2016)
Base: Smartphone internet users aged 15–60, watching the events in and around the main arenas.
Of the interviewees, 25 percent downloaded event-related apps

Extending the event experience with digitalized services

Recent consumer research shows that the event experience starts long before the actual event and continues after it.[1] There is the opportunity for event organizers and operators to extend and enhance the visitor experience by addressing more of visitors' needs with innovative, digitalized services. Most of the identified event-related needs for visitors, displayed to the right, are still at a low level of digitalization. The most digitalized areas are information and ticketing, as well as socializing.

The most important need for spectators is the overall live event experience, including factors such as event atmosphere and feelings of excitement, relaxation and closeness to the event activities. Augmented reality (AR), virtual reality (VR) and mixed reality (MR) technologies have the potential to enhance visitors' and remote spectators' experience of events, making them available in new ways, for example, as an on-demand service. The related development of 3D and 360-degree content is driving an emerging trend to "interact with the event", immersing people in the action, wherever they are in the world.

Connected venues and arenas – supported by 4G and 5G technology – will cater for visitors' needs for more digitalized services and immersive experiences at any event. The opportunity to transform event experiences with new digitalized services will also be relevant to large one-off arrangements such as those major events described in this article.

5G will transform the event experience

Initially, 4G systems are expected to continue to play an important role in supporting event visitors with mobile connectivity and services,

The most important event-related needs for visitors

1. Event experience: There is a great atmosphere at the event, and it is both exciting and relaxing, priceworthy and welcoming. The experience should be immersive.

2. Environment and safety: There is confidence and a feeling of safety and security in the arena. The arena should also be clean.

3. Information and ticketing: There is a smooth ticketing process and it is easy to get information about the event.

4. Belonging: The event creates a sense of community and of being part of the crowd – for example, through traditions related to the specific event.

5. Food and drink: There is a satisfactory selection of places to get food and drinks, as well as reasonable prices and a range of options.

6. Accessibility: It is easy to get to the arena and queues for toilets and restaurants, for example, are of an acceptable length.

7. Socializing: It is easy to find, mingle and socialize with friends and family at the arena.

8. Individual needs: The event is adapted to individual needs, and provides the possibility for visitors to efficiently do different things, depending on personal preference.

Source: Ericsson ConsumerLab, Connected Venues (2017)
Base: Large arena visitors in the UK

both outdoors and indoors. Enabled by functionality such as carrier aggregation and 4x4 Multiple Input Multiple Output (MIMO), as well as higher modulation techniques, these 4G systems are capable of providing Gigabit per second download speeds.

In the near future, 5G technology will have the capability to transform the experience for spectators and will enable many of the services discussed in this article on a large scale. Functionality such as Massive MIMO introduces new technology that

significantly increases the efficiency in which data is provided to end users over the available spectrum, thereby significantly increasing system capacity. This allows for very high capacity networks to serve the data traffic demands at event arenas and surrounding areas. A first version[2] of 5G specifications (3GPP Release 15) is to be completed by 3GPP by the end of 2017 to enable large-scale trials and deployments starting in 2019. Even so, early 5G trials have already progressed far enough to provide Gigabit speeds in real-world environments.

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[1] Ericsson ConsumerLab, interviews with large venue visitors in the UK (May 2017)
[2] The first version of 3GPP Release 15 will be a non-standalone version of New Radio (NR), which relies on LTE for some of its basic functionality, followed by a finalized version in June 2018 that will include standalone support

5G showcases expected at major upcoming sports events

It is anticipated that 5G technology and services will be showcased at upcoming major sports events, such as the 2018 sports event in Pyeongchang, South Korea, the 2018 international football tournament in Russia and the 2020 sports event in Tokyo. In South Korea, a pre-commercial 5G system will be used to provide 5G-like experiences, and the event organizers and operators are making investments in a range of different event-related apps.

Operators are at various stages in terms of planning the types of 5G services they will deploy at the upcoming major sports events. Among other things, the availability of 5G devices in sufficient volumes and their form factors are expected to have a significant impact on the types of applications and services that will be launched, as well as whether usage will go beyond a select number of VIP visitors and event organizers. Based on current industry initiatives and ongoing 5G trials, it is highly likely that some of the anticipated services will include AR and VR-based applications.

Enhancing the digital experience with new types of applications and immersive content

AR and VR are expected to constitute a significant proportion of the 5G showcases at upcoming major sports events. Use cases range from ultra-high definition (UHD)[3] live video streaming to a fully virtualized experience. As well as enhancing the experience at the event itself, the technology could extend the digital experience to remote fans by providing immersive content – allowing them to hear and see the real-time action, almost as if they were there themselves.

Ensuring good network quality during events

The digitalization trend creates the potential for operators and event organizers to provide ever better content at events. However, as spectators continue to consume more data and demand more digital services, preparatory actions are required to ensure a good network experience, and to meet the expectations for connectivity and performance throughout the whole event period. To achieve this,

network flexibility and scalability are important factors, as dynamic event traffic will vary greatly over time depending on service type, usage scenario and event schedules.

To optimize network performance in real time, following adaption to traffic forecasts, network parameters should be actively changed during the event to increase the quality and capacity of the system. Proactive network monitoring and optimization, feature activation and software upgrades are required prior to the event, and then in real time during the event. With the right network design, optimization and real-time support, operators will be able to handle expected traffic demand.

At future events and connected venues, with high traffic density and increasing use of demanding services such as AR and VR, proactive management and automation will be essential to meet committed service levels. This will be supported through centralized intelligence and analytics, with support from expert systems and machine-learning technologies for network monitoring and dynamic optimization.

A range of services may be included in 5G showcases, allowing venue visitors to turn from spectators into participants and enabling them to:

> Watch events from different viewpoints with interactive control

> Access multiple cameras filming an object to achieve a 3D view

> Experience sports activity from the perspective of the athlete via mini-cameras

> Enjoy an in-stadium experience outside the venue through haptic or tactile feedback

> View live holographic projections of athletes

> Integrate supplementary content into their live streams

> See athlete, event or venue statistics superimposed on their device display

> Analyze and display performance data through sensors embedded in sports equipment

> Receive real-time information on factors such as the speed and location of a ball

> View overlay and substitution content, for example, explaining rules, giving more details and personalizing the experience

[3] 4K/8K video

MILLENNIALS' EXPECTATIONS FOR 5G

Born between the early 1980s and the early 2000s, millennials have grown up in the age of the internet and mobile communications. This age group is not only leading the way in terms of the adoption of digital devices but also will most likely set the demands on future digital networks and services due to its technical knowledge and skills, as well as its high expectation level

As 5G wireless technology is rolled out, millennials will be the largest generation and in their prime years of consumer spending. They will play a pivotal role in shaping the future of the telecommunications industry and, more specifically, 5G services.

Millennials demand more from network performance

Relative to other consumer segments, millennials have high expectations for network performance and demand a lot from their mobile service providers. Younger millennials have led a clear shift in video consumption trends,

and how they engage with video today offers an insight into the way mainstream viewing patterns could develop over the next 5 to 10 years. A recent survey of 14,000 smartphone users in 14 countries revealed that 28 percent of millennials aged 15 to 24 stream on-demand videos for 1 to 3 hours a day, and 17 percent stream for 3 to 6 hours – nearly 6 times more than those aged 45 or over.[1]

The group's high video consumption pattern leads to higher expectations on network performance. In 12 of the 14 countries surveyed, millennials were more critical of network performance

than those aged over 45. Less than half of millennial smartphone users said their mobile broadband quality expectations have been met. As millennials' spending power and expectations rise, these findings suggest that operators will need to focus on how to meet the expectations of this consumer segment.

> Less than half of millennial smartphone users say their expectations have been met on mobile broadband performance

Millennials and adults aged over 45 who say their expectations on network performance have been met (percent)

[1] Ericsson ConsumerLab Analytical Platform (June 2017)

High expectations for 5G

The potential benefits of 5G networks are already creating big expectations in the market. The recent survey among smartphone users previously referenced suggests that young millennials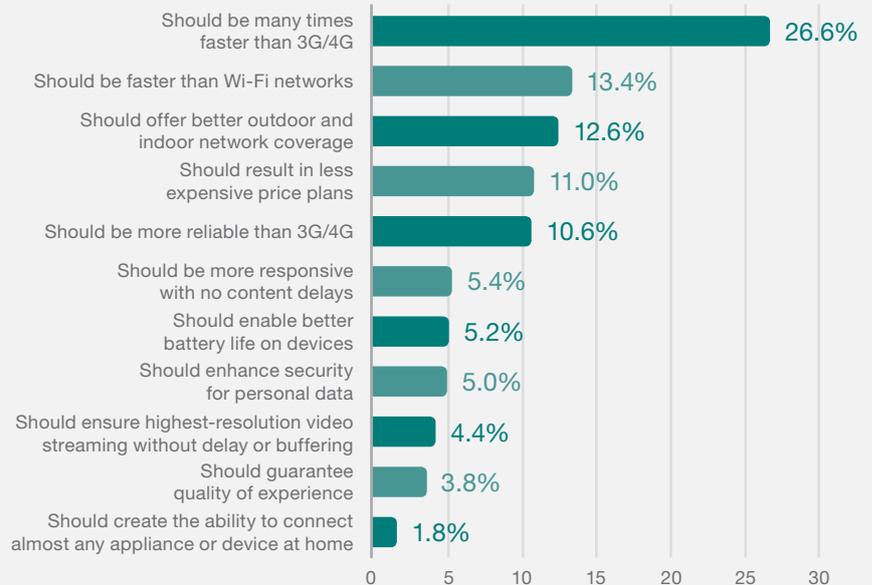 expect better speeds and coverage from 5G. In addition, when asked to choose their most important expectation, over 30 percent named a factor beyond speed and coverage, such as better battery life, high network reliability and guaranteed quality. While some of these expectations will be difficult for operators to deliver soon, many tie in well with the promise of 5G.

Over 30% of millennial smartphone users say a factor beyond better speed and coverage is their most important expectation from 5G

Millennials expect more from 5G

Expectation	%
Should be many times faster than 3G/4G	26.6%
Should be faster than Wi-Fi networks	13.4%
Should offer better outdoor and indoor network coverage	12.6%
Should result in less expensive price plans	11.0%
Should be more reliable than 3G/4G	10.6%
Should be more responsive with no content delays	5.4%
Should enable better battery life on devices	5.2%
Should enhance security for personal data	5.0%
Should ensure highest-resolution video streaming without delay or buffering	4.4%
Should guarantee quality of experience	3.8%
Should create the ability to connect almost any appliance or device at home	1.8%

Source: Ericsson ConsumerLab Analytical Platform (June 2017)

Evolving video experience

Making the expectations for 5G a reality will have significant implications for mobile networks. Up until this point, increasing video usage has been the main driver behind the growth in mobile data traffic. As video continues to merge with other types of content, beyond streaming apps and video on-demand services, this trend is expected to continue. Video now accounts for over 50 percent of all mobile traffic – a figure that is expected to increase to over 75 percent by the end of 2023.

There is much discussion within the mobile industry community about the rapid development of online video to ever more immersive formats. For example, the rise of virtual reality (VR) and augmented reality (AR) will place new demands on networks in the future. A recent survey[2] of consumers aware of VR in 8 countries suggested that 7 out of 10 early adopters expect VR/AR to fundamentally change everyday life. These early adopters expect 5G to play a significant role in enriching the shared VR experience by providing lower latencies, haptic feedback and higher resolutions.

Given that network performance is sufficient, AR and VR look set to make the transition from media and entertainment novelties to enabling a wide range of consumer and industrial use cases. This transition should accelerate as 5G network capabilities, including significantly reduced latency in the radio access, are combined with network slicing and Mobile Edge Computing (MEC).

In its current forms, AR may be much more suited than VR to mobile applications. However, the line between the two is already dissolving, with merged reality (MR), stereoscopic six degrees of freedom (6DoF) and holographic video on the horizon.

Meeting expectations

As existing mobile broadband networks improve, and consumers become more aware and exposed to the services that can be further enriched by 5G, expectations will continue to evolve. Operators preparing for 5G have an opportunity to win the trust of these millennials by keeping up with their demands – reaping the benefits of increased customer loyalty.

METHODOLOGY

Forecast methodology

Ericsson makes forecasts on a regular basis to support internal decisions and planning, as well as market communication. The subscription and traffic forecast baseline in this report uses historical data from various sources, validated with Ericsson internal data, including extensive measurements in customer networks. Future development is estimated based on macroeconomic trends, user trends (researched by Ericsson ConsumerLab), market maturity, technology development expectations and documents – such as industry analyst reports – on national and regional levels, together with internal assumptions and analyses.

Historical data may be revised if the underlying data changes – for example, if operators report updated subscription figures.

Mobile subscriptions include all mobile technologies. Subscriptions are defined by the most advanced technology that the mobile phone and network are capable of. Figures are rounded and therefore summing up rounded data may result in slight differences from the actual totals. In the key figures tables, subscriptions have been rounded to the nearest 10th million. However, when used in highlights in the articles, subscriptions are usually expressed in full billions or to one decimal. Compound annual growth rate (CAGR) is rounded to the nearest full percentage figure, and traffic volumes are expressed in two digits, for example, 69GB/month or 8.5GB/month.
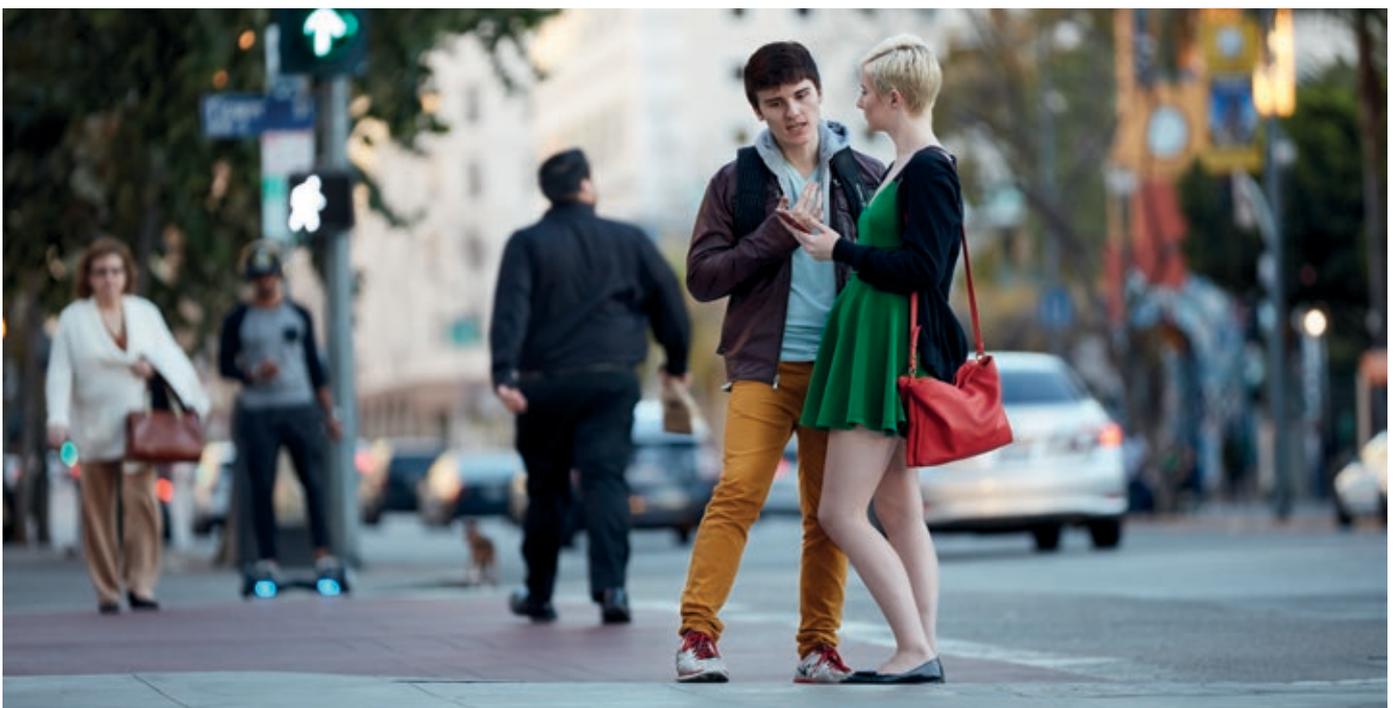
Traffic refers to aggregated traffic in mobile access networks and does not include DVB-H, Wi-Fi or Mobile WiMAX traffic. VoIP is included in data traffic.

Traffic measurements

New devices and applications affect mobile networks. Having a deep and up-to-date knowledge of the traffic characteristics of different devices and applications is important when designing, testing and managing mobile networks. Ericsson regularly performs traffic measurements in over 100 live networks covering all major regions of the world. Detailed measurements are made in a selected number of commercial WCDMA/HSPA and LTE networks with the purpose of discovering different traffic patterns. All subscriber data is made anonymous before it reaches Ericsson's analysts.

Population coverage methodology

Population coverage is estimated using a database of regional population and territory distribution based on population density. This is then combined with proprietary data on the installed base of Radio Base Stations (RBS) combined with estimated coverage per RBS for each of six population density categories (from metro to wilderness). Based on this, the portion of each area that is covered by a certain technology can be estimated, as well as the percentage of the population it represents. By aggregating these areas on a regional and global level, world population coverage per technology can be calculated.

GLOSSARY

2G: 2nd generation mobile networks (GSM, CDMA 1x)

3G: 3rd generation mobile networks (WCDMA/HSPA, TD-SCDMA, CDMA EV-DO, Mobile WiMAX)

3GPP: 3rd Generation Partnership Project

4G: 4th generation mobile networks (LTE, LTE-A)

5G: 5th generation mobile networks (not yet standardized)

App: A software application that can be downloaded and run on a smartphone or tablet

CAGR: Compound annual growth rate

Cat-M1: A 3GPP standardized low-power wide-area (LPWA) cellular technology for IoT connectivity. Cat-M1 is a solution that can be deployed on LTE, targeting a wide range of IoT applications from simple to rich content

CDMA: Code Division Multiple Access

dB: In radio transmission, a decibel is a logarithmic unit that can be used to sum up total signal gains or losses from a transmitter to a receiver through the media a signal passes

DL: Downlink

EB: ExaByte, 10^{18} bytes

EDGE: Enhanced Data Rates for Global Evolution

EPC: Evolved Packet Core

GB: GigaByte, 10^{9} bytes

GHz: Gigahertz, 10^{9} hertz (unit of frequency)

Gbps: Gigabits per second

GSA: Global mobile Suppliers Association

GSM: Global System for Mobile Communications

GSMA: GSM Association

HSPA: High Speed Packet Access

ICT: Information and Communications Technology

IMS: IP Multimedia Subsystem

ITU: International Telecommunication Union

IoT: Internet of Things

Kbps: Kilobits per second

LTE: Long-Term Evolution

MB: MegaByte, 10^{6} bytes

MBB: Mobile Broadband (defined as CDMA2000 EV-DO, HSPA, LTE, Mobile WiMAX and TD-SCDMA)

Mbps: Megabits per second

MHz: Megahertz, 10^{6} hertz (unit of frequency)

MIMO: Multiple Input Multiple Output is the use of multiple transmitters and receivers (multiple antennas) on wireless devices for improved performance

Mobile PC: Defined as laptop or desktop PC devices with built-in cellular modem or external USB dongle

Mobile router: A device with a cellular network connection to the internet and Wi-Fi or Ethernet connection to one or several clients (such as PCs or tablets)

NB-IoT: A 3GPP standardized low-power wide-area (LPWA) cellular technology for IoT connectivity. NB-IoT is a narrowband solution that can be deployed on LTE, or as a standalone solution, targeting ultra-low-throughput IoT applications

NFV: Network Functions Virtualization

NR: New Radio as defined by 3GPP Release 15

OS: Operating System

PB: PetaByte, 10^{15} bytes

QAM: Quadrature Amplitude Modulation

SDN: Software-Defined Networking

Smartphone: Mobile phone with OS capable of downloading and running "apps" e.g. iPhones, Android OS phones, Windows phones and also Symbian and Blackberry OS

TD-SCDMA: Time Division-Synchronous Code Division Multiple Access

TDD: Time Division Duplex

VoIP: Voice over IP (Internet Protocol)

VoLTE: Voice over LTE as defined by GSMA IR.92 specification. An end-to-end mobile system including IP Multimedia Subsystem (IMS), Evolved Packet Core (EPC), LTE RAN, Subscriber Data Management and OSS/BSS

UL: Uplink

WCDMA: Wideband Code Division Multiple Access

GLOBAL AND REGIONAL KEY FIGURES

In this edition of the Ericsson Mobility Report, we have included the regional key figures in addition to the global figures

To find out more, scan the QR code, or visit
www.ericsson.com/mobility-report

Traffic Exploration Tool:

Create your own graphs, tables and data using the Ericsson Traffic Exploration Tool. The information available here can be filtered by region, subscription, technology, traffic and device type. You may use charts generated from this tool in your own publications as long as Ericsson is stated as the source.

Regional versions:

This time we have provided five versions of the report: a standalone global version as well as four variations of this, each containing a section for a different region of the world.

GLOBAL KEY FIGURES

	2016	2017	2023 forecast	CAGR** 2017–2023	Unit
Mobile subscriptions					
Worldwide mobile subscriptions	7,510	7,790	9,120	3%	million
> Smartphone subscriptions	3,840	4,410	7,270	9%	million
> Mobile PC, tablet and mobile router* subscriptions	240	260	330	4%	million
> Mobile broadband subscriptions	4,410	5,160	8,450	9%	million
> Mobile subscriptions, GSM/EDGE-only	3,010	2,560	640	-21%	million
> Mobile subscriptions, WCDMA/HSPA	2,260	2,380	1,970	-3%	million
> Mobile subscriptions, LTE	1,900	2,620	5,470	13%	million
> Mobile subscriptions, 5G			1,000		million
Mobile data traffic*					
> Data traffic per smartphone	2.1	2.9	17	34%	GB/month
> Data traffic per mobile PC	7.7	9.8	27	18%	GB/month
> Data traffic per tablet	3.6	4.6	12	18%	GB/month
Total data traffic*					
Total mobile data traffic	8.8	14	110	42%	EB/month
> Smartphones	7.2	11	100	44%	EB/month
> Mobile PCs and routers	1.3	1.6	4.5	19%	EB/month
> Tablets	0.32	0.47	1.8	25%	EB/month
Total fixed data traffic	70	80	250	20%	EB/month

* Active devices
** CAGR is calculated on unrounded figures
*** Figures are rounded (see methodology) and therefore summing up of rounded data may result in slight differences from the actual total

[1] These figures are also included in the figures for North East Asia
[2] These figures exclude Pakistan
[3] These figures are also included in the figures for Middle East and Africa

REGIONAL KEY FIGURES

	2016	2017	2023 forecast	CAGR** 2017–2023	Unit
Mobile subscriptions					
North America	380	390	460	3%	million
Latin America	690	700	780	2%	million
Western Europe	520	520	560	1%	million
Central and Eastern Europe	580	610	640	1%	million
North East Asia	1,720	1,780	2,090	3%	million
China[1]	1,320	1,380	1,600	3%	million
South East Asia and Oceania	1,070	1,110	1,290	3%	million
India, Nepal and Bhutan	1,160	1,240	1,500	3%	million
Middle East and Africa[2]	1,390	1,440	1,800	4%	million
Sub-Saharan Africa[3]	660	700	990	6%	million
Smartphone subscriptions					
North America	290	310	390	4%	million
Latin America	410	460	610	5%	million
Western Europe	380	400	480	3%	million
Central and Eastern Europe	240	270	490	10%	million
North East Asia	1,310	1,430	1,940	5%	million
China[1]	1,050	1,150	1,560	5%	million
South East Asia and Oceania	470	560	1,050	11%	million
India, Nepal and Bhutan	270	380	970	17%	million
Middle East and Africa[2]	470	600	1,340	14%	million
Sub-Saharan Africa[3]	260	340	850	17%	million
Data traffic per smartphone*					
North America	5.2	7.1	48	37%	GB/month
Latin America	1.7	2.4	16	36%	GB/month
Western Europe	2.8	4.1	28	38%	GB/month
Central and Eastern Europe	2.7	3.8	19	31%	GB/month
North East Asia	1.2	1.9	12	35%	GB/month
China[1]	0.84	1.5	9.5	36%	GB/month
South East Asia and Oceania	1.8	2.7	15	34%	GB/month
India, Nepal and Bhutan	4.1	3.9	18	30%	GB/month
Middle East and Africa	1.3	2.0	11	34%	GB/month
Sub-Saharan Africa[3]	1.0	1.4	7.0	31%	GB/month
Total mobile data traffic					
North America	1.8	2.6	18	39%	EB/month
Latin America	0.7	1.1	8.9	42%	EB/month
Western Europe	1.2	1.8	12	37%	EB/month
Central and Eastern Europe	0.76	1.2	9.3	41%	EB/month
North East Asia	1.9	3.2	21	37%	EB/month
China[1]	1.0	1.8	15	41%	EB/month
South East Asia and Oceania	0.79	1.3	12	45%	EB/month
India, Nepal and Bhutan	1.0	1.3	14	48%	EB/month
Middle East and Africa	0.71	1.3	14	48%	EB/month
Sub-Saharan Africa[3]	0.25	0.41	4.6	50%	EB/month

Ericsson is a world leader in communications technology and services with headquarters in Stockholm, Sweden. Our organization consists of more than 111,000 experts who provide customers in 180 countries with innovative solutions and services. Together we are building a more connected future where anyone and any industry is empowered to reach their full potential. Net sales in 2016 were SEK 222.6 billion (USD 24.5 billion). The Ericsson stock is listed on Nasdaq Stockholm and on NASDAQ in New York. Read more on www.ericsson.com