

# ERICSSON MOBILITY REPORT

ON THE PULSE OF THE NETWORKED SOCIETY



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# ERICSSON MOBILITY REPORT

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June 2014

The number of mobile subscriptions worldwide grew approximately 7 percent year-on-year during Q1 2014. The number of mobile broadband subscriptions grew even faster over this period – at a rate of 35 percent year-on-year, reaching 2.3 billion. The amount of data usage per subscription also continued to grow steadily. Around 65 percent of all mobile phones sold in Q1 2014 were smartphones. Together, these factors have contributed to a 65 percent growth in mobile/cellular data traffic between Q1 2013 and Q1 2014.

In the last report, we described the challenges of providing sufficient app coverage for different app types in dense urban areas and indoor environments. In this edition, we explain how one way to serve the demand for increasing capacity and app coverage is to evolve mobile broadband networks into seamless heterogeneous networks. Continuing on the theme of app coverage, we also examine how the distribution of smart mobile device categories that are connected to a radio access network impacts the user experience as well as network resource efficiency.

Our article on Machine-to-Machine (M2M) communication in cellular networks explores the radio capabilities and traffic characteristics of the installed base and discusses how this is expected to change in the coming years. We also include consumer research results about video use over cellular and Wi-Fi.

Finally, you will find our table of key figures at the end of this document. We hope you find this report engaging and valuable.



## ABOUT THIS REPORT

Ericsson has performed in-depth data traffic measurements in mobile networks from the world's largest installed base of live networks. These measurements have been collected from all regions of the world since the early days of mobile broadband.

The aim of this report is to share analysis based on these measurements, internal forecasts and other relevant studies to provide insights into the current traffic and market trends.

**Publisher:** Rima Qureshi  
Senior Vice President,  
Chief Strategy Officer

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**SUBSCRIPTIONS** 7  
1.9 billion smartphone  
subscriptions in 2013

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**TRAFFIC** 11  
10x growth in mobile  
data traffic between  
2013 and 2019

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**STATE OF THE NETWORKS** 15  
20% world LTE  
population coverage  
in 2013

# MOBILE SUBSCRIPTIONS Q1 2014

Total mobile subscriptions in Q1 2014 were around 6.8 billion. This included the addition of 120 million new subscriptions during the first quarter. Global mobile subscriptions have continued to grow 7 percent year-on-year and 2 percent quarter-on-quarter. Global mobile penetration reached 93 percent in Q1 2014.

Smartphone uptake continued its strong momentum throughout the world. These devices accounted for around 65 percent of all mobile phones sold in Q1 2014, compared to around 50 percent during Q1 2013. And it doesn't show any sign of slowing down. Of all mobile phone subscriptions today, around 35 percent are associated with smartphones, leaving considerable room for further uptake.

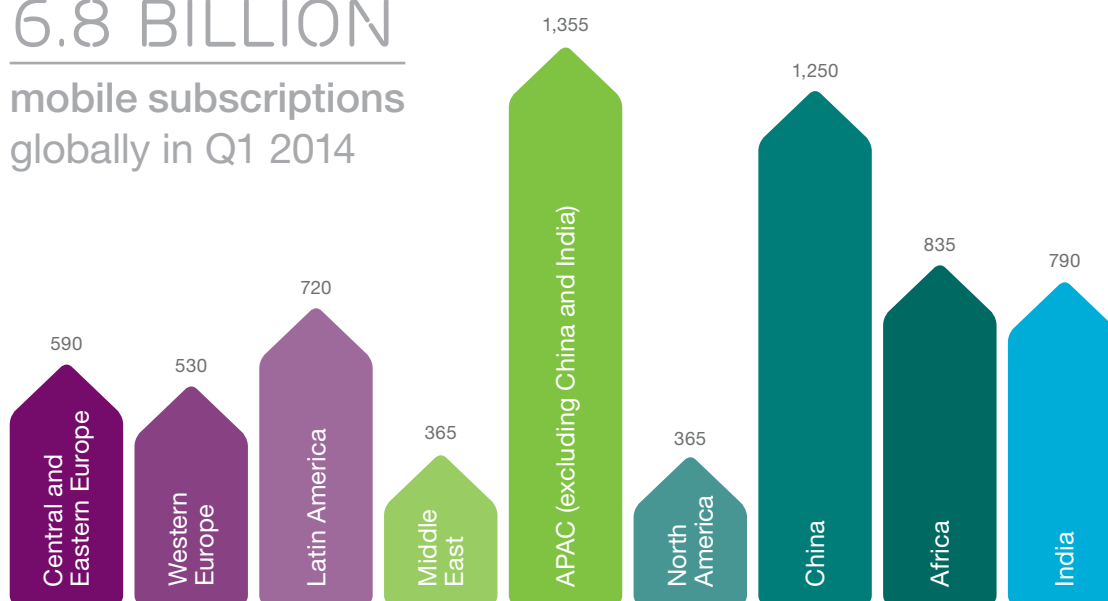
Global mobile broadband subscriptions<sup>1</sup> grew by around 35 percent year-on-year and reached 2.3 billion in Q1 2014.

LTE continues to grow strongly and has reached 240 million subscriptions, with around 35 million additions in Q1 2014. WCDMA/HSPA had the highest net additions during the quarter at around 70 million. Almost all of these 3G/4G subscriptions have access to GSM/EDGE as a fallback. The number of GSM/EDGE-only subscriptions remained flat.

## >2 BILLION

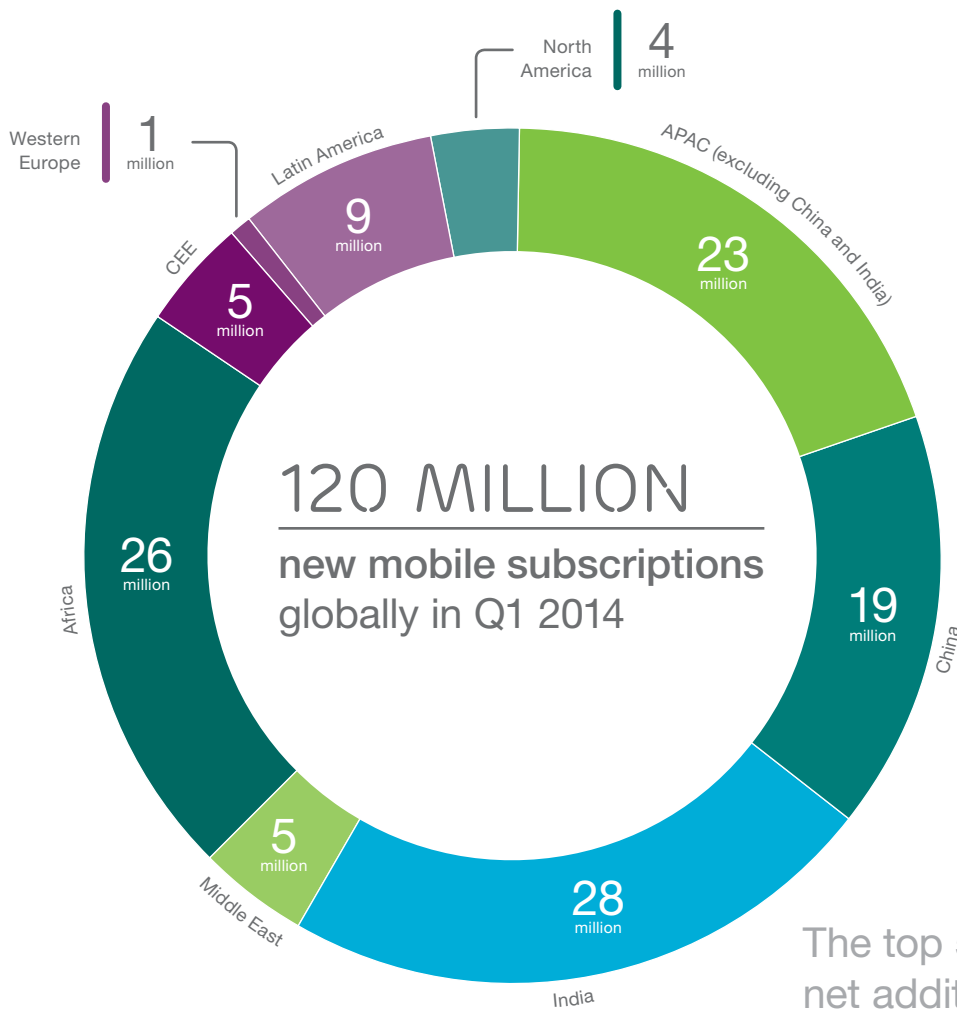
mobile broadband subscriptions globally in 2013

6.8 BILLION  
mobile subscriptions globally in Q1 2014



Mobile subscriptions (million)

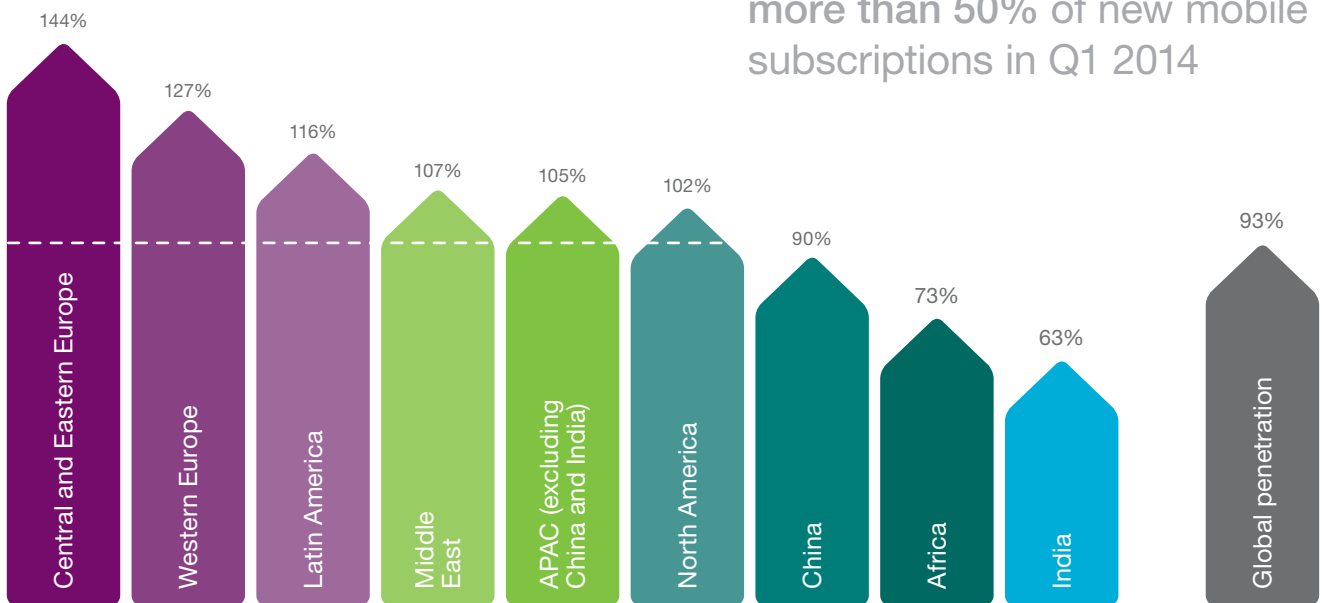
<sup>1</sup> Mobile broadband is defined as HSPA, LTE, CDMA2000 EV-DO, TD-SCDMA and Mobile WiMax. Indian subscriptions include active VLR subscriptions.



**Top 5 countries by net additions**

India	+28 million
China	+19 million
Indonesia	+7 million
Thailand	+6 million
Bangladesh	+4 million

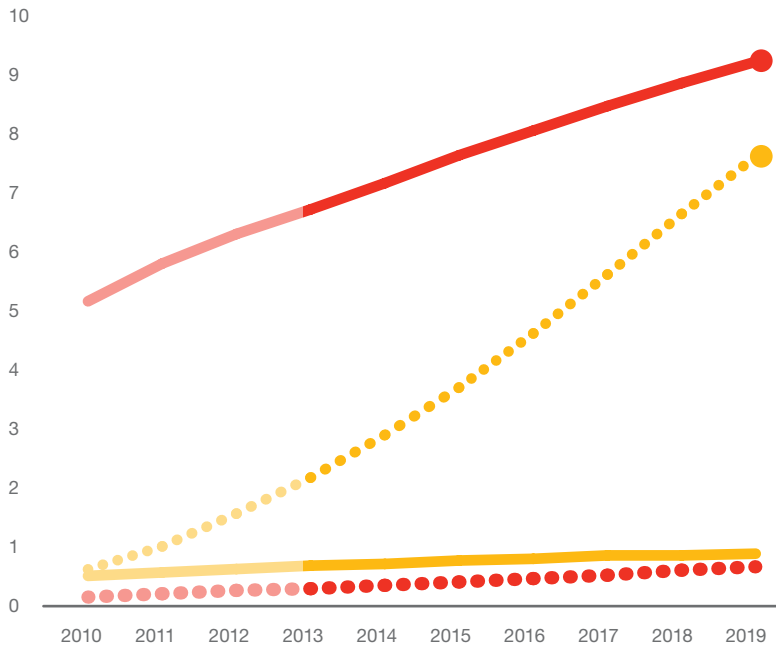
The top 5 countries by net additions accounted for more than 50% of new mobile subscriptions in Q1 2014



Penetration

# MOBILE SUBSCRIPTIONS OUTLOOK

Subscriptions/lines (billion)

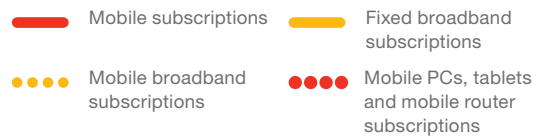


9.2 BILLION

mobile subscriptions by the end of 2019

>80%

of mobile subscriptions will be for mobile broadband by the end of 2019



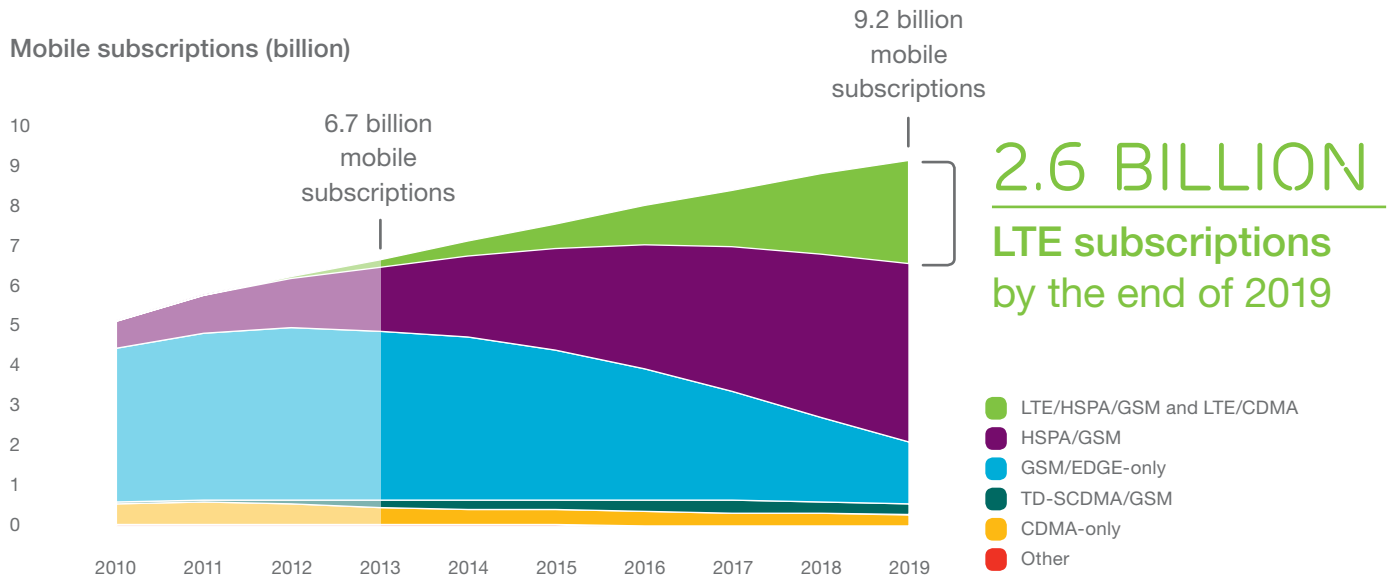
Total mobile subscriptions are expected to grow from 6.8 billion in Q1 2014 to 9.2 billion by the end of 2019. Global mobile broadband subscriptions are predicted to reach 7.6 billion by 2019 and will gain an increasing share of the total mobile subscriptions over time. By the end of 2019, mobile broadband subscriptions are expected to account for more than 80 percent of all mobile subscriptions, compared to around 30 percent in 2013. Mobile broadband will also gain a larger share of total broadband subscriptions in many markets, complementing fixed broadband,<sup>1</sup> and in certain segments replacing it. In developing ICT (Information and Communications Technology) markets, smartphones already provide consumers with their first internet contact. This is due to limited access to fixed internet, combined with the influx of cheaper smartphones. The majority of mobile broadband devices are, and will continue to be, smartphones.

## Mobile technology

GSM/EDGE-only subscriptions represent the largest share of mobile subscriptions today. In developed markets there has been rapid migration to more advanced technologies, resulting in a decline in GSM/EDGE-only subscriptions. Despite this, GSM/EDGE will continue to represent a large share of total mobile subscriptions. This is because new, less affluent users in developing markets will likely choose a low-cost mobile phone and subscription. In addition, it takes time for the installed base of phones to be upgraded. GSM/EDGE networks will also continue to be important in complementing WCDMA/HSPA and LTE coverage in all markets. Today, LTE is being deployed in all regions, and subscriptions for this technology are predicted to reach 2.6 billion by 2019, representing around 30 percent of total mobile subscriptions. WCDMA/HSPA subscriptions are predicted to reach 4.5 billion by 2019.

<sup>1</sup> The number of fixed broadband users is at least three times the number of fixed broadband connections, due to multiple usage in households, enterprises and public access spots. This is the opposite of the mobile phone situation, where subscription numbers exceed user numbers.

## Mobile subscriptions (billion)

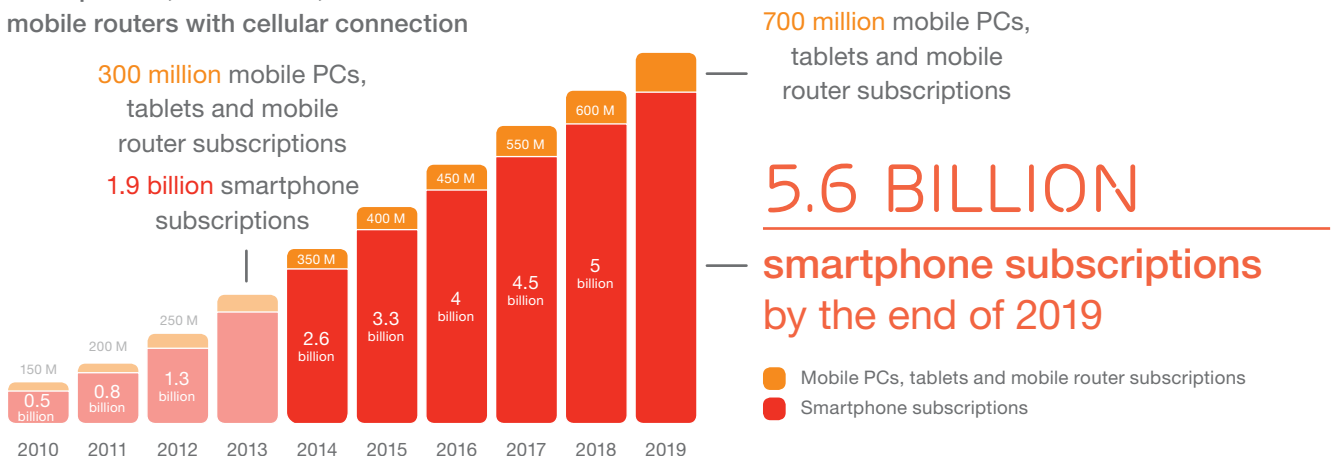


## Mobile devices

Total smartphone subscriptions reached 1.9 billion in 2013 and are expected to grow to 5.6 billion in 2019. One of the main reasons for this is a notable increase in subscriptions in Asia Pacific and Middle East and Africa, as medium-high income users in these markets exchange their basic phones for smartphones. This is due in part to the availability of smartphones in lower price ranges. Today, the majority of mobile subscriptions – around 4.5 billion – are still for basic phones, but it is predicted that the global figure for smartphone subscriptions will exceed those for basic phones by 2016. Regional differences will be significant. In 2019, the number of smartphone subscriptions in Europe will be around 765 million – surpassing the total population number. In comparison, 50 percent of handset subscriptions in Middle East and Africa will be for smartphones.

The number of mobile subscriptions for mobile PCs, tablets and mobile routers is expected to grow from 300 million in 2013 to around 700 million in 2019. There is a large number of PCs and tablets without a mobile subscription. Many do not have a subscription because of the current price difference between models that are Wi-Fi-only and those with mobile capabilities. Another reason is that some tablets that do have mobile capabilities do not have a cellular subscription – their owners choose to connect using Wi-Fi instead. However, mobile-capable models are expected to account for an increasing share of tablet sales.

## Smartphones, mobile PCs, tablets and mobile routers with cellular connection





# REGIONAL SUBSCRIPTIONS OUTLOOK

All regions are showing continued growth in mobile subscriptions. In Asia Pacific, this is driven by new subscribers. In more mature markets, such as North America and Western Europe, the growth comes from the increasing number of subscriptions per individual – for example, many have recently added a tablet to their device setup. This is supported by recent operator strategies to optimize tariffs, launching services such as special sharing price plans for families and multiple devices on one account. Another driver for multi-SIM is the separation of private and business mobiles.

Each region's maturity level is reflected in its radio technology mix. Developing regions are dominated by 2G technologies like GSM/EDGE, while developed ones are dominated by WCDMA/HSPA. LTE is rapidly being embraced by both operators and subscribers, particularly in North America. In all regions, 2G networks (GSM/EDGE, CDMA 1X) remain as fallback technology for 3G and 4G subscriptions where coverage is missing.

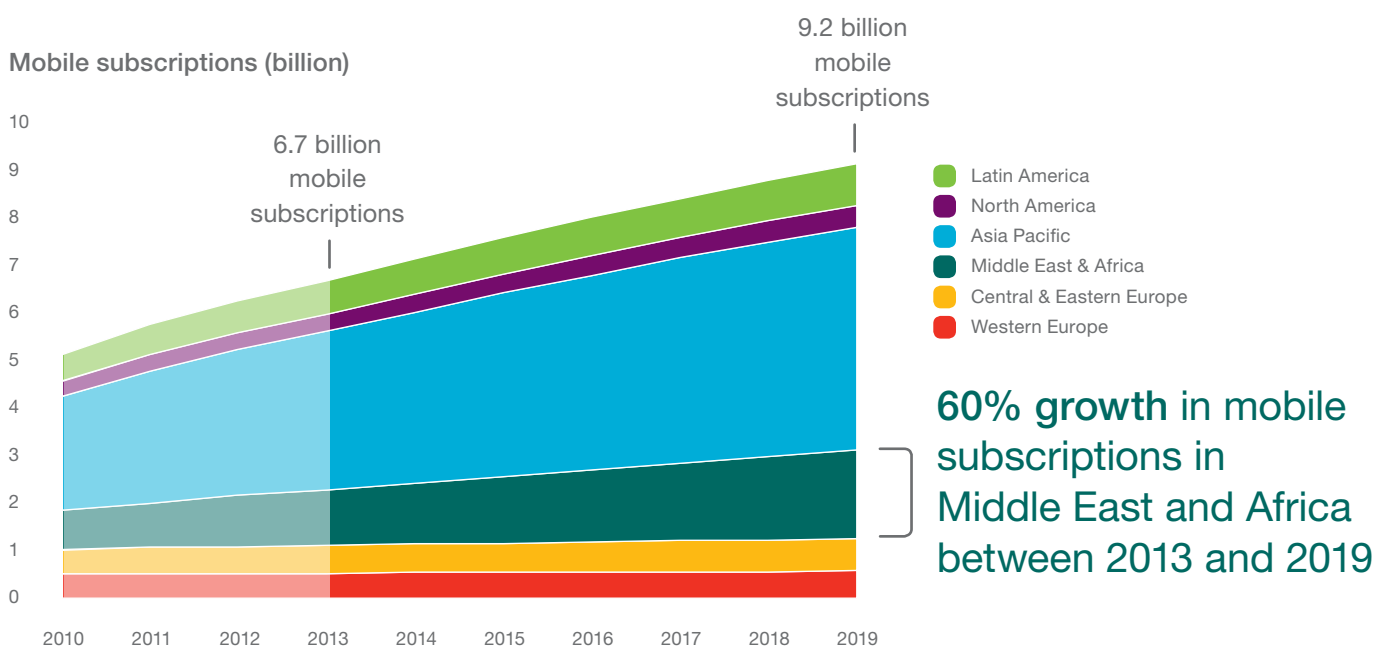
In North America, LTE will represent the majority of subscriptions by 2015, growing to around 85 percent in 2019. This rapid growth in LTE subscriptions is driven by

strong competition, consumer demand and CDMA operators' early decisions to migrate to LTE.

Mobile subscriptions in Latin America will reach around 900 million in 2019. The strong growth in subscriptions in this region will be driven by economic development and consumer demand. Latin America currently has a large GSM/EDGE subscriber base. In 2019, WCDMA/HSPA will be the dominant technology and LTE subscriptions are expected to be more than double the number for GSM/EDGE-only.

In Europe, every country has WCDMA/HSPA networks and more than half have launched LTE.

In Western Europe, WCDMA/HSPA is the dominant technology today. By the end of the forecast period, LTE will make up around 50 percent of the subscriptions base. Data services were rolled out early in this region, initially accessed via dongle or mobile PC. Western Europe is at the forefront of mobile broadband uptake, but the drive for LTE has not yet been as strong in the region as in North America, due to factors such as having many well-developed 3G networks.



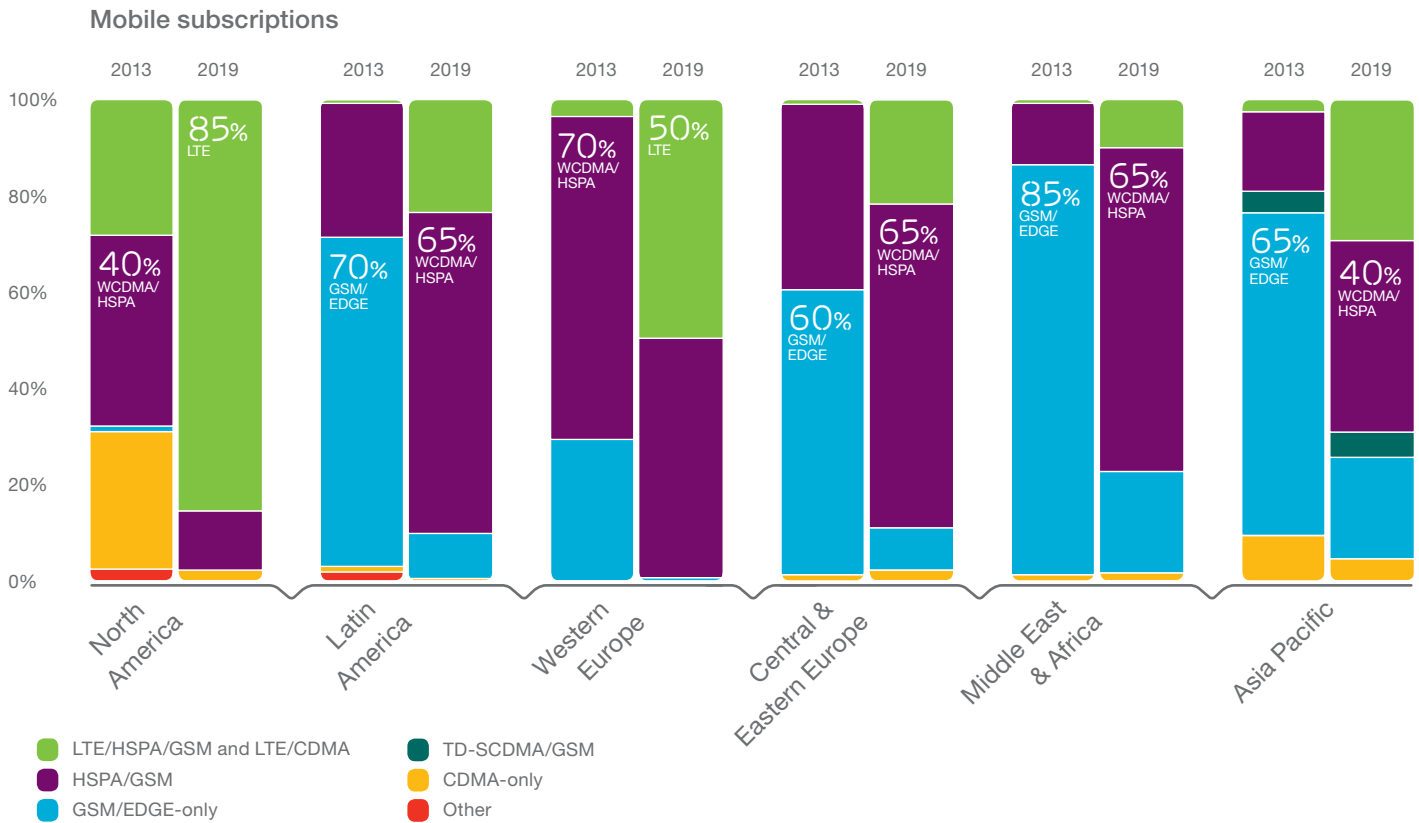


# 85%

of North American mobile subscriptions will be LTE by 2019

# 80%

of mobile subscriptions in Asia Pacific will be 3G/4G in 2019



Central and Eastern Europe shows a strong increase in HSPA subscriptions. LTE will initially grow in the most developed parts of the region and will be present in almost all countries by 2015.

The Asia Pacific market continues to see a significant increase in mobile subscriptions with 1.4 billion net additions by the end of 2019. This market represents more than 50 percent of mobile subscription additions globally. Markets such as Japan and South Korea took up LTE subscriptions earlier than emerging markets. By the end of 2013, LTE penetration had already reached over 30 percent in Japan and over 50 percent in South Korea – the highest in the world. It is estimated that Japan and South Korea will account for around 25 percent of the world’s LTE subscriptions at the end of 2014. Mainland China has started to roll out LTE and will add a significant number of LTE subscriptions during

the forecast period, reaching over 700 million by the end of 2019. This means that China will represent more than 25 percent of total global subscriptions for LTE. In 2013, around 75 percent of mobile subscriptions in Asia Pacific were 2G, whereas in 2019 around 80 percent will be 3G/4G.

In 2013, the Middle East and Africa was dominated by GSM/EDGE, which represented around 85 percent of mobile subscriptions in the region. Mobile subscriptions will grow from 1.2 billion in 2013 to 1.9 billion in 2019. By this time WCDMA/HSPA will be the dominant technology with 65 percent of total mobile subscriptions. However, GSM/EDGE-only subscriptions will still be significant. In Sub-Saharan Africa, for example, GSM will remain the dominant technology until 2018, due to the dominance of lower income consumers using 2G-enabled handsets.

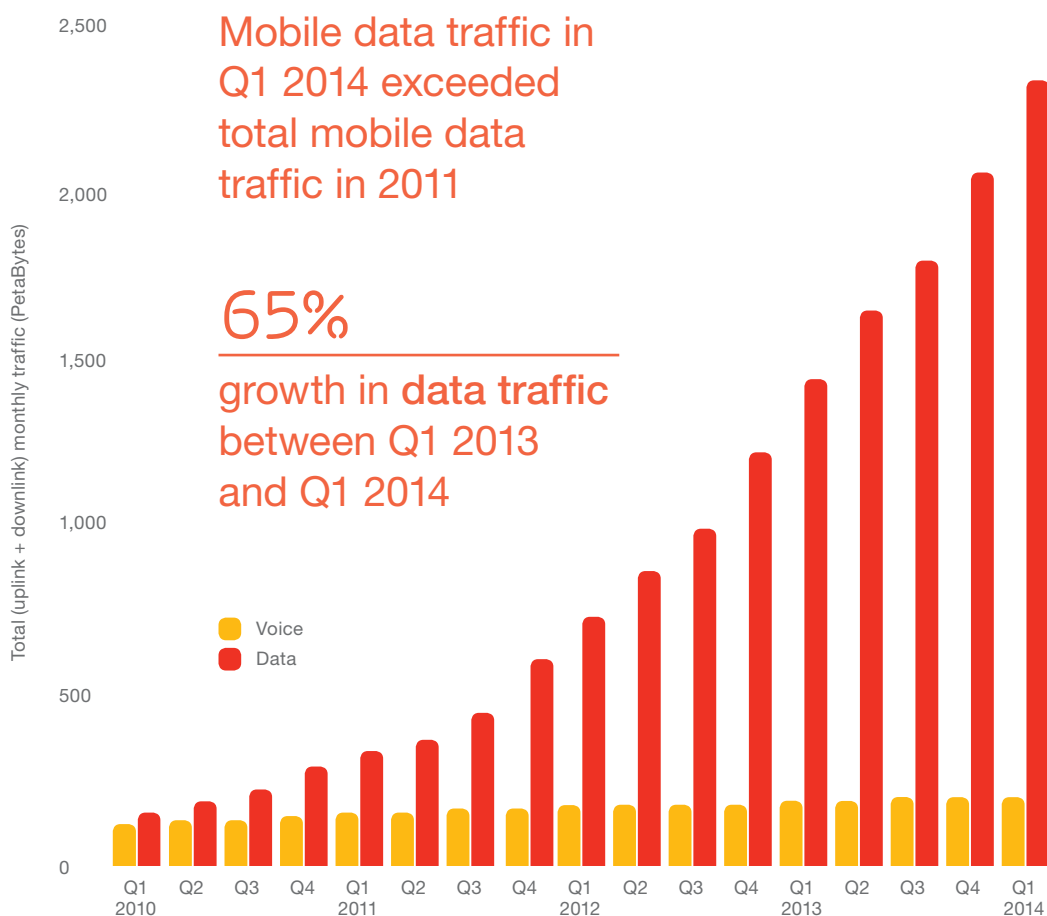
# MOBILE TRAFFIC Q1 2014

## Global traffic in mobile networks

The graph below shows total global monthly data and voice traffic. It depicts a stable trend of data traffic growth with moderating rate of growth, and almost flat voice traffic development. The number of mobile data subscriptions is increasing rapidly, and driving growth in data traffic along with a continuous increase in the average data volume per subscription. Mobile phones are increasingly becoming a tool for accessing services that traditionally required a computer. In advanced mobile markets, voice calls and SMSs are no longer the dominant services, especially for smartphone users, who are increasingly making daily use of data-based services. Data traffic grew around 15 percent between Q4 2013 and Q1 2014.

It should be noted that there are large differences in traffic levels between markets, regions and operators.

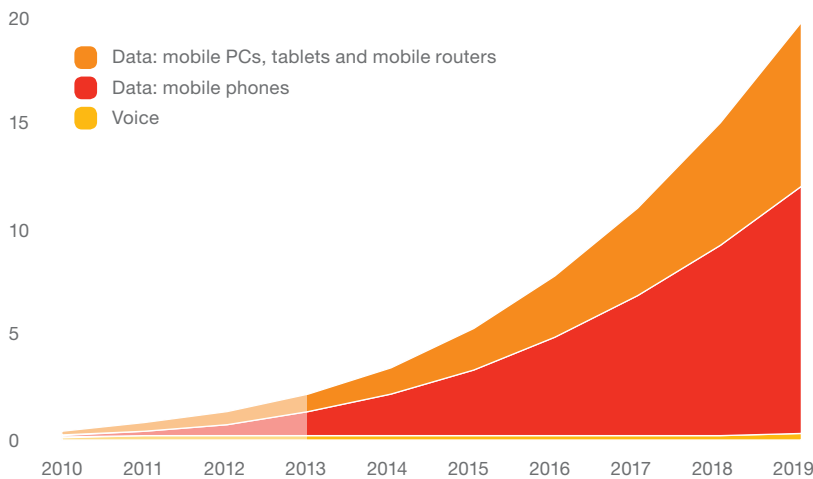
These measurements have been performed by Ericsson over several years using a large base of commercial networks that together cover all regions of the world. They form a representative base for calculating total world traffic in mobile networks.<sup>1</sup>



<sup>1</sup> Traffic does not include DVB-H, Wi-Fi, or Mobile WiMax. Voice does not include VoIP. M2M traffic is not included.

# MOBILE TRAFFIC OUTLOOK

Global mobile traffic (monthly ExaBytes)



10X

growth in mobile data traffic between 2013 and 2019

Mobile traffic generated by mobile phones has exceeded that from mobile PCs, tablets and routers

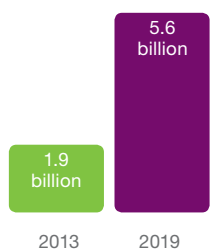
Mobile data traffic is expected to grow at a CAGR of around 45 percent (2013–2019). This will result in a 10-fold increase by the end of 2019. The rising number of smartphone subscriptions is the main driver for mobile data traffic growth. Users consuming more mobile/cellular data per subscription – mainly driven by video – are also adding to this increase.

Total mobile traffic generated by mobile phones has exceeded that of mobile PCs, tablets and mobile routers. Traffic in the mobile phone segment is primarily generated by smartphones. By 2019, smartphone subscriptions are expected to triple, resulting in rapid traffic growth. Total monthly smartphone traffic over mobile networks will increase around 10 times between 2013 and 2019.

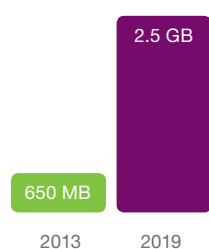
Mobile data traffic will grow considerably faster than fixed data traffic over the forecast period – the fixed data traffic CAGR will be around 25 percent between 2013 and 2019. However, in absolute volume, fixed data traffic will remain dominant. Mobile data traffic represented 5 percent of total mobile and fixed traffic in 2013, and is expected to be 12 percent in 2019.

Note that there are large differences in user patterns between different networks, markets and user types. A significant portion of data traffic is generated by a limited number of users. Factors such as operator data volume caps, tariff plans, and the screen size and resolution of the user’s device all impact data traffic volumes per subscriber.

Smartphone subscriptions



Mobile traffic per active subscription per month



Total monthly smartphone traffic



10X

growth in smartphone traffic between 2013 and 2019

Active subscriptions here refer to the number of used devices, i.e. not including multiple-SIMs or inactive devices.

# REGIONAL MOBILE TRAFFIC

Asia Pacific will have a large share of total mobile traffic in 2019 due mainly to the rapid growth in subscriptions. China alone will add over 540 million mobile subscriptions. There are large differences in usage volumes and patterns within Asia Pacific. South Korea and Japan are deploying LTE early, while several world-firsts in mobile broadband have been achieved in Australia. This includes the first LTE Advanced and LTE Broadcast calls. However, other countries are still dominated by GSM, and insufficient network quality continues to contribute to lower mobile data consumption. The cost of data is also a hot topic in low-income markets where users still consider mobile data consumption a luxury.

In 2013, North America and Western Europe had a significantly larger share of total traffic volume than their subscription numbers alone would imply. This is due to a high proportion of data-rich devices in WCDMA/HSPA and LTE networks leading to a higher usage per subscription.

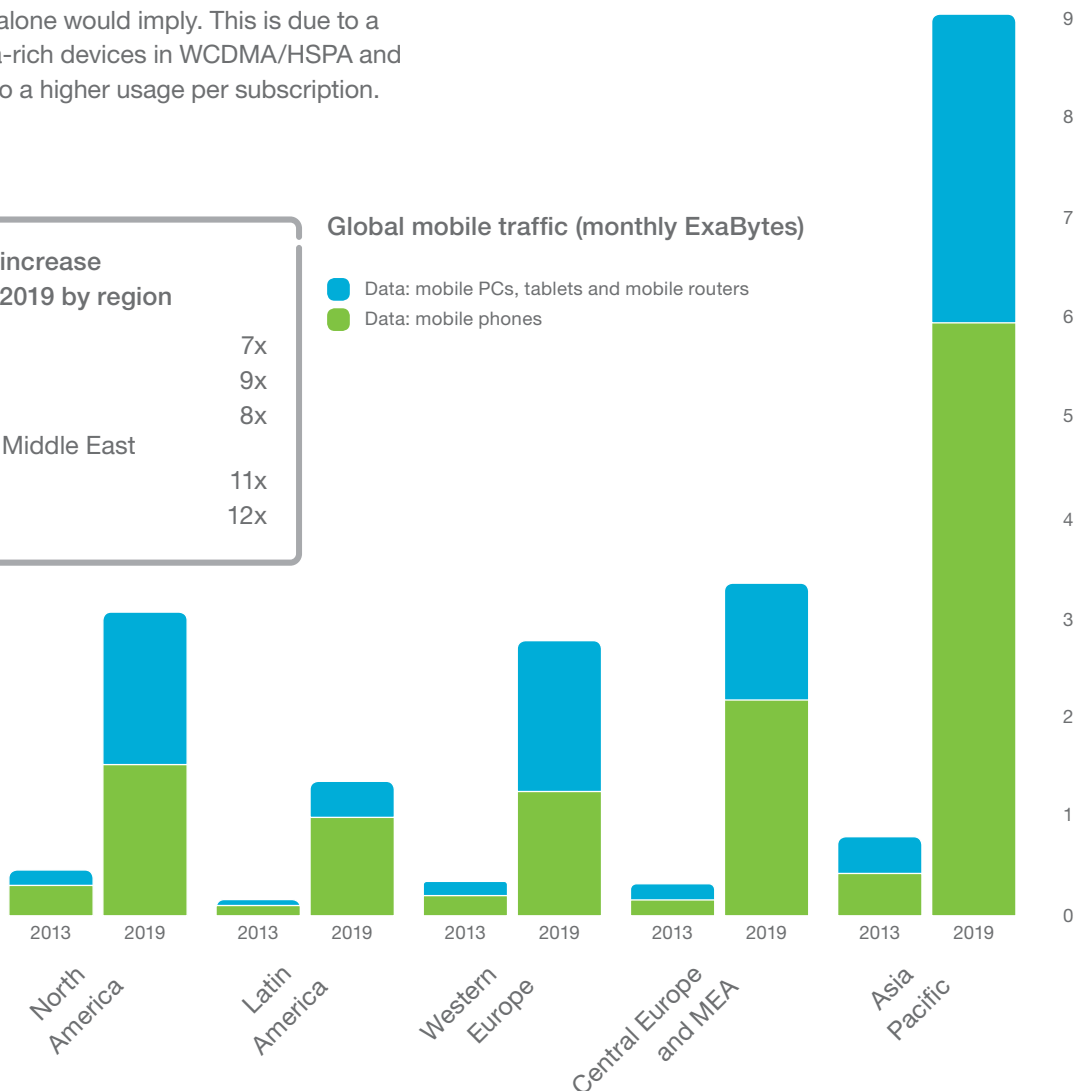
North America will have a smaller share of global traffic in 2019 than in 2013. This is because the smartphone share of total phone subscriptions – expected to be over 90 percent in 2016 – will be saturated before the other regions.

In Western Europe, mobile data traffic is expected to grow more than 8 times between 2013 and 2019. The improved speed and capacity of HSPA networks combined with the deployment of LTE will fuel consumer demand for a better user experience.

Mobile data traffic increase between 2013 and 2019 by region	
North America	7x
Latin America	9x
Western Europe	8x
Central Europe and Middle East and Africa (MEA)	11x
Asia Pacific	12x

Global mobile traffic (monthly ExaBytes)

- Data: mobile PCs, tablets and mobile routers
- Data: mobile phones



# MOBILE APPLICATION TRAFFIC OUTLOOK

Video is the largest and fastest growing segment of mobile data traffic. It is expected to grow around 13 times by 2019, by which time it is forecasted to account for over 50 percent of all global mobile data traffic. Social networking constitutes more than 10 percent of total mobile data traffic today and is predicted to grow 10 times between 2013 and 2019. The share will remain at the same level in 2019, even though social networking increasingly will include data-rich content.

Music streaming is gaining popularity, but functions such as caching of content and offline playlists limit the impact on traffic growth. Audio traffic is still expected to increase 8-fold by 2019. Web browsing is predicted to grow 6-fold over the same period. Its relative share will however decline by 2019 from today's 10 percent as a result of stronger growth in other categories, such as video and social networking.

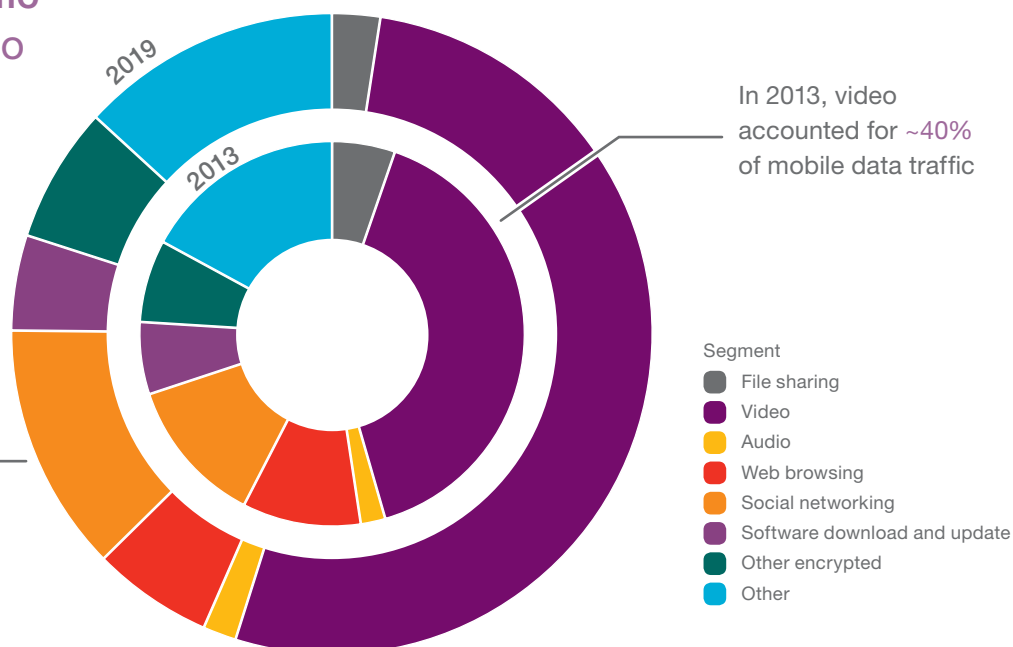
It is interesting to note how the most widely used online applications contribute differently to mobile data traffic volumes, depending on the type of device they are accessed on. Video for example, is the largest contributor to traffic volumes on any device. Despite this it represents 35 percent of the mobile data traffic associated with smartphones, versus 50 percent of that associated with tablets. Social networking is already the second largest traffic volume contributor for smartphones with an average share of over 15 percent, while it represents less than 10 percent of the mobile data traffic for Mobile PCs and tablets.<sup>1</sup>

The arrival of new devices or content can rapidly change people's behavior and hence traffic patterns, adding new traffic types. Furthermore, there will be broad variations between networks with different device profiles – for example, some will be PC dominated while others will mainly facilitate smartphone use. Traffic will also vary between markets due to differences in content availability and content rights issues.

## >50%

of mobile data traffic will come from video in 2019

Social networking accounted for more than 10% of mobile data traffic in 2013 and will have the same share in 2019



Video is also likely to form a major part of file sharing traffic and a sizeable portion of encrypted traffic, in addition to the identified application type 'video'. By encrypted traffic we mean encryption on the network layer (e.g. VPNs) or transport layer (e.g. TLS/SSL). Application layer encryption such as DRM for video content is not included.

<sup>1</sup> This is based on average values from measurements in a selected number of commercial networks in Asia, Europe and the Americas. Does not take into account Wi-Fi offload traffic. Smartphones in measured networks include Android and iPhone models only.

### Mobile video traffic growth – insights and drivers

A number of converging factors are contributing to the strong growth in mobile video traffic. For example, the increasing number of video-capable devices in consumers' hands or the growing availability of video content that can be streamed to mobile devices. For instance, as operators increasingly make their own TV services available via streaming, it is becoming more common to watch video over mobile networks. This has contributed to the growth in mobile data traffic and is changing the way we watch TV and video, by enabling us to watch it over multiple devices. The growth of mobile video traffic is also facilitated by the better network speeds that come with HSPA and LTE deployment.

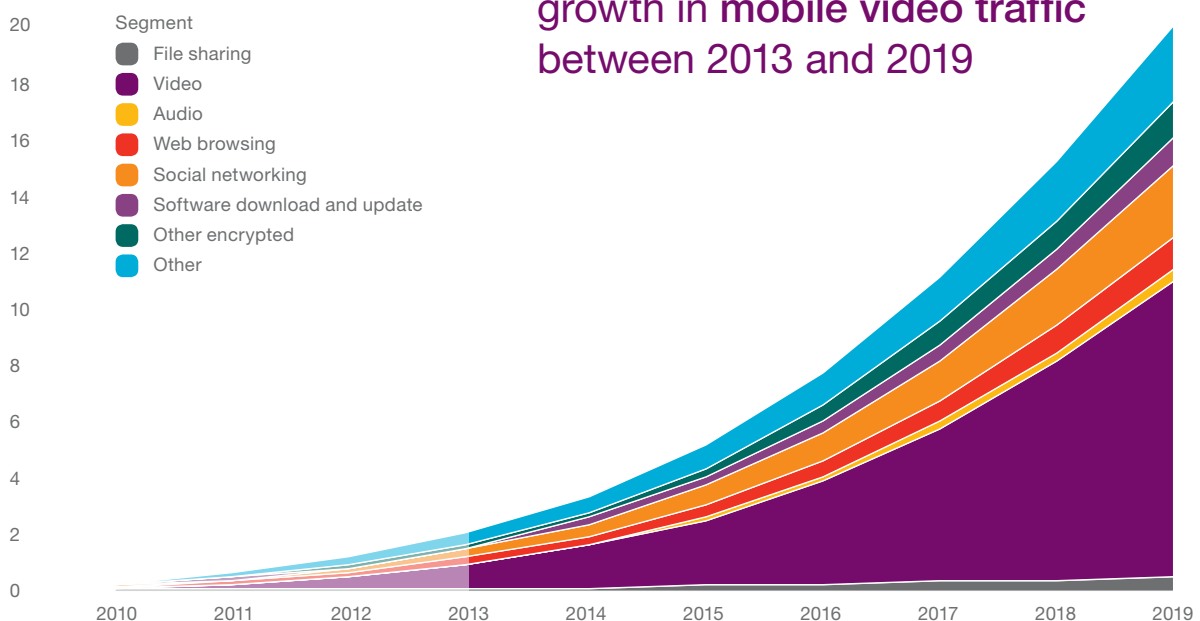
But this is only part of the story. User behaviors are changing, resulting in more video consumption over mobile devices. People watch video on all types of devices. This is increasingly the case when they are out and about. An Ericsson study conducted in France, for example, shows that around 65 percent of internet users use mobile screens, including laptops, tablets and smartphones to consume video on a weekly basis, with close to 30 percent of users doing so out of the home. The same study in South Korea found that around

80 percent of people in the country use mobile screens for video viewing on a weekly basis, whereas watching TV on fixed screens has declined. More than half use smartphones to watch TV/video outside the home and 25 percent view TV or videos while commuting.<sup>2</sup>

Devices are also evolving to include larger screens, which highlights the importance of picture quality for streamed video. Advertisements are increasingly linked to streamed video. Higher video resolutions are also emerging, such as UltraHD, though the impact of this on mobile devices has yet to be seen. All of these changes are leading to greater video consumption.

The strong growth predicted for mobile video will also heighten the importance of efficiently handling traffic volumes. Technological improvements like new video compression techniques will lead to more effective usage of data throughput, and will be beneficial to mobile network operators in accommodating the large expected demand. Improved encoding efficiency will be made possible, largely due to improved processing power in newer devices. This will give smartphones and tablets the ability to process more complex decoding algorithms.

Mobile data traffic by application type (monthly ExaBytes)



<sup>2</sup> Source: Ericsson Consumer Lab (2013)

# STATE OF THE NETWORKS

Today's markets are highly competitive and subscribers expect a high-quality user experience, as well as continuous enhancements to their services. Mobile network capabilities are the key enabler to providing such a user experience. This article provides an overview of the world's networks, focusing on population coverage, as well as some of the key functionalities and service capabilities that have been implemented.

## World population coverage

As more base stations are deployed, the population coverage of the world's mobile networks constantly increases. GSM/EDGE technology has the widest reach and covers over 85 percent of the world's population. However, there are still sparsely populated areas in countries using GSM/EDGE that are not yet covered by the technology.

At the end of 2013, WCDMA/HSPA covered approximately 60 percent of the world's population. This is an increase of around 10 percent worldwide on WCDMA/HSPA population coverage compared to 2012. Further build-out of WCDMA/HSPA will be driven by

increased demand for internet access, the affordability of smartphones, and regulatory requirements to connect the unconnected. By the end of 2019, around 90 percent of the world's population will have the opportunity to access the internet using WCDMA/HSPA networks.<sup>1</sup>

LTE covered around 20 percent of the world's population at the end of 2013. This was a doubling of LTE population coverage compared to 2012. It is predicted that this will increase to over 65 percent by 2019.

## European population coverage

Europe was one of the earliest adopters of wireless technologies. During the early 1990s, GSM was rolled out across the continent. 10 years later, commercial WCDMA networks were being deployed. These early rollouts are reflected in today's high population coverage – over 90 percent for GSM/EDGE, and around 75 percent for WCDMA/HSPA. It is predicted that GSM/EDGE coverage will increase to over 95 percent by 2019, and that WCDMA/HSPA coverage will reach around 90 percent by the same date.

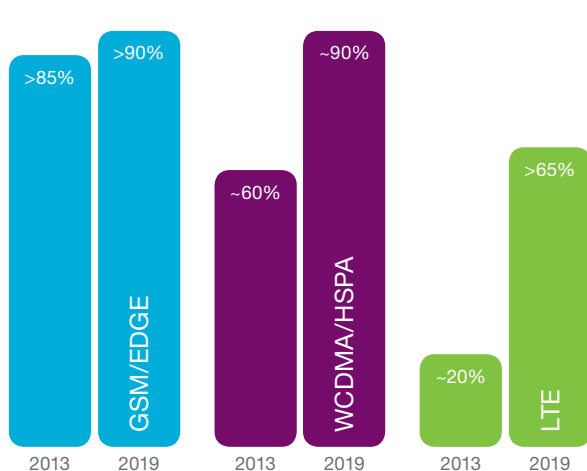
>65%

of the world's population will be covered by LTE in 2019

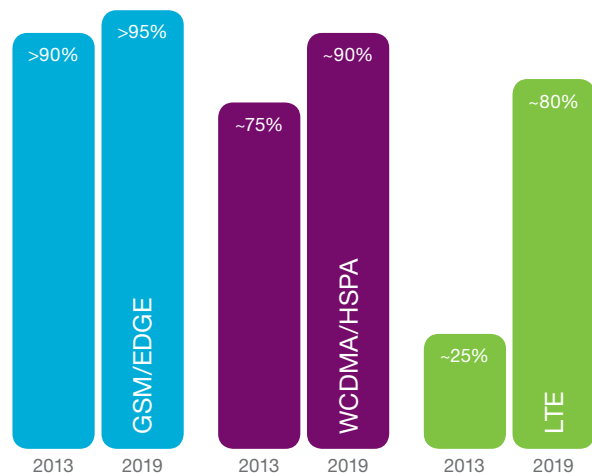
~80%

of Europe's population will be covered by LTE in 2019

World population coverage by technology



Europe population coverage by technology



<sup>1</sup> The figures refer to population coverage of each technology. The ability to utilize the technology is subject to other factors as well, such as access to devices and subscriptions.



Early mobile network rollouts in Europe left the continent with older base stations than those areas of the world that launched networks later. This has resulted in the need for major modernization projects in the region during recent years. The modernization was primarily driven by the introduction of more efficient base stations that were capable of handling multi-standard technologies such as GSM/EDGE and WCDMA/HSPA. By contrast, modernization in other regions was primarily driven by the introduction of LTE.

It was estimated that LTE covered around 25 percent of the European population at the end of 2013. It is forecast that it will cover around 80 percent by 2019. Hence in 2019, Europe will have an LTE population coverage that is around 15 percentage points greater than the worldwide average. European networks can easily be upgraded to handle LTE, given that a large proportion of them have been modernized and support multi-standard technologies.

### WCDMA/HSPA networks

There are 547 WCDMA/HSPA networks that currently provide coverage to around 60 percent of the world's population. All WCDMA networks deployed worldwide have been upgraded with HSPA. It is calculated that 466 of these HSPA networks have been upgraded to a peak downlink speed of 7.2 Mbps or above and 363 of these networks have been upgraded to 21 Mbps or higher.<sup>2</sup>

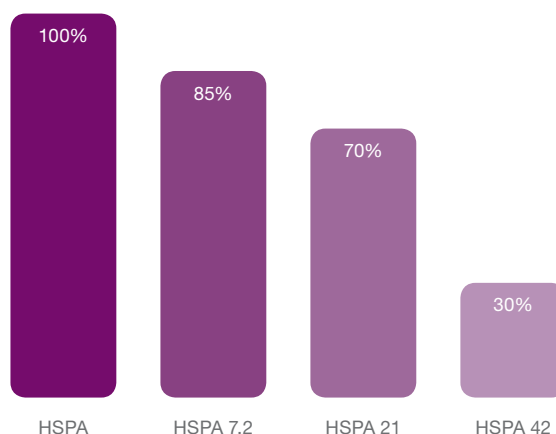
Multi-carrier HSPA corresponds to simultaneous transmission for a given terminal (user equipment) on more than one carrier in downlink and/or uplink. By aggregating radio resources of multiple carriers, peak data rates and capacity can be increased substantially. 159 HSPA networks now support 2x5 MHz multicarrier with speeds of up to 42 Mbps in whole or parts of the network. Around 60 percent of operators that have launched 42 Mbps HSPA networks have also launched LTE networks. During 2015 we will see evolutionary steps towards providing 3x5 MHz multi-carrier with speeds of up to 63 Mbps in downlink and 12 Mbps in uplink. These improvements will include both network and terminal support.

The next phase of HSPA evolution will further increase user data speeds. For instance, on HSPA uplink, there are a number of future technology enhancements that will provide data rates of 24 Mbps or higher.

Low band networks can complement 2,100 MHz deployments as lower-frequency bands improve coverage and quality of service as well as user experience. The primary advantage of lower frequencies is that lower-frequency radio signals propagate further. Deploying WCDMA/HSPA in low frequency bands (e.g. 900 MHz), is therefore a way to increase application coverage compared to 2,100 MHz. Today, there is a well-established ecosystem for low-frequency band terminals and the technology is considered mainstream, with 80 commercial WCDMA/HSPA 900 MHz networks in 53 countries.<sup>3</sup>

Dual-band multi-carrier HSPA will enable simultaneous transmission to a user on 2x5 MHz carriers located in two different bands, for instance 5 MHz in 2,100 MHz and 5 MHz in 900 MHz. This improves the application coverage compared to single-band multi-carriers by combining the gain of using a larger bandwidth with the gain from using a low-frequency spectrum.

Percentage of WCDMA networks upgraded to HSPA and to 7.2, 21 and 42 Mbps



Source: Ericsson and GSA (February 2014)

## 159

**42 Mbps HSPA networks are commercially launched in 83 countries**

### LTE networks

There are 288 LTE networks commercially launched in 104 countries.<sup>4</sup> This number continues to grow. 154 manufacturers have announced 1,563 commercially available LTE-enabled devices on the market.<sup>5</sup>

<sup>2</sup> GSA and Ericsson, February, 2014

<sup>3</sup> GSA, February, 2014

<sup>4</sup> GSA, May 2014

<sup>5</sup> GSA, March, 2014

## LTE networks have been launched commercially in 104 countries

### LTE Advanced and carrier aggregation

LTE Advanced (LTE-A) carrier aggregation (CA) continues to increase in importance for operators as a means to make more efficient use of spectrum assets, and to deliver improved app coverage with higher peak data rates and better performance across the entire cell.

A few operators in South Korea and Australia commercially launched LTE-A CA in 2013. Further developments have been made in CA since this initial introduction. The initial focus in 2013 was the aggregation of 2x10 MHz LTE carriers to achieve a single 20 MHz LTE carrier that would support download speeds of up to 150 Mbps. Now, operators are shifting their focus to the aggregation of two and three 20 MHz carriers to achieve 40 MHz and 60 MHz LTE carriers respectively.

Using an LTE category 6 mobile device, 40 MHz of LTE spectrum can support download data speeds up to 300 Mbps. Several trials aggregating up to 40 MHz of spectrum on a commercial network have been completed to date. The deployment of CA is expected to continue in the second half of 2014 as category 6 devices (300 Mbps) become more widely available.

In recent trials three 20 MHz LTE carriers were combined, resulting in a total of 60 MHz of aggregated spectrum. This provided download speeds of up to 450 Mbps using category 9 test devices.

### LTE Broadcast

LTE Broadcast will address the growing consumer demand for video services by efficiently delivering video content with guaranteed quality levels. LTE Broadcast achieves these efficiencies by simultaneously delivering media content to multiple users over a single LTE data stream, rather than over a single data stream to each single user. LTE Broadcast also allows the operator to predefine the quality level for the content to be delivered by dimensioning the data bitrate to meet the service requirement needed for different types of content and resolutions.

In environments such as stadiums and public venues, where subscriber densities can reach extremely high levels, broadcasting content is an efficient method for delivering a consistent and reliable user experience. LTE Broadcast will enable operators to launch new video services in a way that makes the best use of their network

resources and available spectrum. LTE Broadcast has been commercially launched in Korea, and trials have been successfully completed in the United States, Australia, Germany, and the Netherlands. Additional commercial launches are expected during 2014.

### Mobile HD voice

HD voice improves the quality of voice calls with a more natural sound, providing improved intelligibility and voice recognition including advanced noise cancellation in the device. Enabling HD voice requires network functionality and terminal capability and can be offered on several network technologies including GSM, CDMA, WCDMA and LTE.

The first commercial mobile HD voice service went live in September 2009<sup>6</sup> and HD voice has now been commercially launched by 100 operators in 71 countries. The majority of these launches have been on WCDMA networks, but a handful of launches on both GSM and LTE networks (VoLTE) have also taken place.

During 2013 alone, 29 new operators launched HD voice, and interoperability for the service between operators is being established in several markets.<sup>6</sup> These new launches highlight the importance operators are putting on improving the quality of voice services. The increase in number of launches is fueled by a growing number of HD voice-capable handsets. There are at least 329 HD voice-capable products available today.<sup>6</sup>

### Voice over LTE (VoLTE)

VoLTE provides users with telecom-grade HD voice, video calling and other new, richer communication services on LTE smartphones, while enabling simultaneous LTE data services. As LTE is optimized for data transfer, it does not include the circuit-switched domain currently used for regular voice and SMS services. VoLTE is enabled by deploying an IP Multimedia Subsystem (IMS) core network to provide the telephony services over IP, and the LTE radio network and Evolved Packet Core only require software upgrades. In addition, LTE smartphones with VoLTE capabilities are required. Many of the latest high-end LTE smartphones already have the embedded VoLTE chipset, and only require a software upgrade to enable VoLTE services.

The world's first commercial VoLTE networks were launched in August 2012. There are currently three commercial networks that offer the service in South Korea, with millions of consumers using HD voice services on different models of VoLTE smartphones from several device vendors. Several operators in other regions are about to deploy VoLTE during 2014, primarily in Asia and North America.

<sup>6</sup> GSA, March 2014

## Mobile backhaul

Backhaul plays an important role in providing a good user experience and overall network performance. As network density increases with higher capacities, backhaul becomes more critical, as it needs to be aligned with the radio access capacities to avoid creating bottlenecks.

The demand for mobile broadband backhaul capacity will continue to grow over the coming years. The capacity needed per base station site will differ substantially, depending on target data rates and population density.

In 2019, high capacity base stations are expected (in the more advanced mobile broadband networks) to require backhaul in the 1 Gbps range, whereas low capacity base stations are expected to require backhaul in the 100 Mbps range.

### Typical mobile base station site capacity required for two different deployment scenarios up to 2019

#### 2G operator introducing WCDMA in 2013 and LTE in 2019

	2013	2016	2019
~80% of sites	4 Mbps	4 Mbps	25 Mbps
Few % of sites	25 Mbps	50 Mbps	180 Mbps

#### 3G operator introducing LTE in 2013 evolving to LTE advanced

	2013	2016	2019
~80% of sites	50 Mbps	180 Mbps	270 Mbps
Few % of sites	360 Mbps	900 Mbps	1.8 Gbps

Source: Ericsson (2013)

Microwave and optical fiber are major transmission media technologies and are the best suited to meeting these capacity requirements. Optical fiber transmission will increase its share of the mobile backhaul market and it is estimated it will connect more than 40 percent by 2019. Today, microwave dominates the market for transmission technologies for mobile backhaul worldwide. It enables cost-efficient and fast rollout of mobile broadband. Microwave now connects 60 percent of all base stations, and will continue to connect to around 50 percent in 2019. Due to continuous innovations and the availability of additional spectrum, microwave can now provide over 1 Gbps per site, and has the potential to provide 10 Gbps or beyond.

# ~50%

## of all sites will be connected with microwave in 2019

### Small cells backhaul

The introduction of small cells in the radio access network as a complement to the macro cell layer will introduce many site and backhaul challenges. Typical outdoor small cell sites are 3–6 meters above street level on lamp posts or building facades. Small cells will require more cost-effective, scalable and easy-to-install backhaul solutions that support a uniform user experience across the entire radio access network. Traditional backhaul technologies such as microwave, fiber and copper are being adapted to meet this emerging need. However, due to positioning beneath roof height, there will be a substantial number of small cells without access to either a wired backhaul or without a clear line of sight – better known as Non-Line-Of-Sight (NLOS) – to an existing macro cell or remote fiber backhaul point-of-presence.

The traditional belief has been that frequencies below 6 GHz are required to ensure performance in locations where NLOS conditions exist. Available spectrum below 6 GHz is very limited and would be insufficient for small-cell backhaul. After extensive research and customer trials of higher frequency microwave systems in NLOS (>20 GHz), these solutions are now in commercial use. Such systems can overcome obstructions over short hops between the macro and small cells through intelligent use of diffraction and reflection techniques. High performance NLOS solutions enable operators to deploy sites in an optimal location from a radio planning point of view, at the same time enabling 4–6 times more capacity in backhaul compared to traditional NLOS solutions.

### Microwave technology evolution

Microwave technology has improved in terms of capacity and spectrum efficiency. Gigabit capacities can now be made available anywhere. In recent years, microwave products have pushed capacity limits using multiple technologies such as higher order modulation, wider channels and carrier aggregation. They have also evolved to work more efficiently using built-in packet aggregation and adaptive modulation to minimize costs for initial rollout or network upgrade.

# SEAMLESS HETEROGENEOUS NETWORKS

The majority of traffic over mobile broadband networks today is generated by smart mobile devices running a wide variety of apps. As both smart devices and apps evolve and increase in complexity, data traffic is growing.

Mobile networks were first dimensioned primarily to serve voice traffic. The need to cater to the increasing requirements for high performance and capacity for data has led operators to invest in network modernization and adopt new technologies such as HSPA and LTE. The process of increasing performance and capacity with heterogeneous networks involves three discrete steps: improving, densifying and complementing the macro layer by adding low power nodes such as micro, pico, Wi-Fi, and indoor solutions.

## **Demand for app coverage drives network evolution**

Rising traffic levels and app requirements are driving the evolution of heterogeneous networks.

Given the high pace of innovation in smart mobile devices and applications, demands on data rates and coverage grow continuously. It is worth noting that most data traffic generated indoors by users is supported, either from indoor solutions or by radio access provided from outdoor solutions. Outside-in is the most cost effective way to provide indoor coverage, but in buildings with very high density of users or with high attenuation of the radio signals it can be motivated to build dedicated in-building cells.

One solution for increasing capacity and app coverage is to evolve mobile broadband networks into heterogeneous networks that leverage an evolved macro cell layer complemented with integrated small cells. How, when and where operators migrate to heterogeneous networks will be dictated by their mobile broadband services strategy and their existing networks.

## **Providing a seamless user experience**

To provide a seamless user experience in a heterogeneous network, all network layers, domains and nodes need to be tied closely together to an unprecedented degree.

Functionalities that are critical to managing high performance, high capacity heterogeneous networks include radio coordination between macro and small cells, common network management, and common mobility and traffic management.

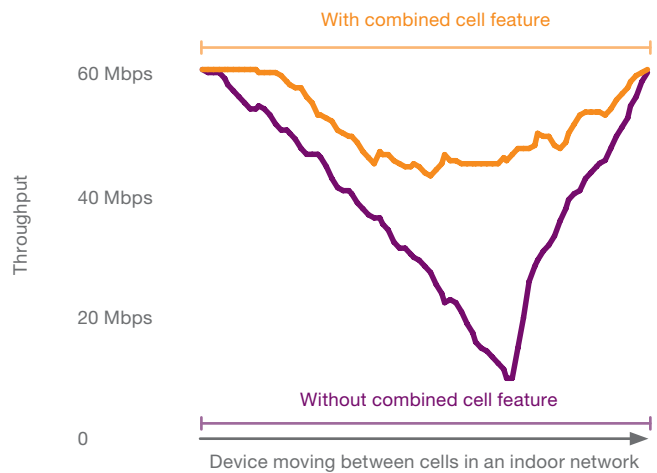
### **Heterogeneous networks**

Heterogeneous network is a term used for a network that is typically composed of multiple radio access technologies, architectures, transmission solutions, and base stations of varying transmission power. The main objective of deploying heterogeneous networks is to create a seamless user experience. This implies the use of various access nodes in a wireless network. Such a network can use a combination of macro cells, micro cells, and pico cells deployed in a variety of environments. The degree of integration that can be achieved between the macro cell and the small cell layers will to a large extent determine the overall network performance.

**Radio coordination** – has been shown to double user data rates by treating cells jointly rather than independently. It includes functionalities such as soft handover, uplink-Coordinated Multipoint (CoMP) reception and combined cell. Many types of coordination exist and, generally, the tighter the baseband coordination, the better the gains that can be obtained. As an example, the effect of combined cells – wherein signals for one terminal are received and transmitted to multiple base stations – is illustrated in the graph to the right. It shows a trace of user throughput for a device moving between cells in an indoor network. With combined cells, a significantly higher and more consistent user throughput is achieved.

**Coordination between cell layers** – doubling capacity in a city by adding small cells would require 9 uncoordinated small cells per macro site. However, by coordinating between macro and small cell layers, only 5 or 3 small cells per macro site would be needed. Coordinated small cells will therefore improve user experience, reduce site count, and lower the total cost of ownership for the heterogeneous network operator. This is illustrated in the graph below. Moving from left to right in the graph illustrates increasingly tight coordination between macro cells and small cells while improving user experience with a lower number of small cells needed for the same capacity scenario.

### Higher and more consistent user throughput with combined cells



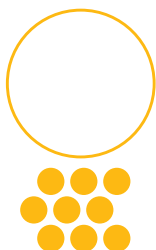
Source: LTE trial using commercial software

## UP TO 2/3 FEWER small cells needed by using coordination between cell layers

Coordinated small cells improve user experience, reduce site count, and lower the total cost of ownership

### UNCOORDINATED SMALL CELLS

- > Split spectrum, no carrier aggregation
- > No or limited mobility
- > Multi-vendor integration



### COORDINATED SMALL CELLS

- > Reuse spectrum, carrier aggregation
- > Seamless mobility and interference control
- > Easy SW upgrade



### TIGHTLY COORDINATED SMALL CELLS

- > CoMP tx/rx
- > Handover-less mobility
- > Common scheduler, fast interference control



○ Macro cell    ● Small cell

○ Macro cell    ● Small cell

○ Macro cell    ● Small cell



**Common mobility and traffic management** – coordinated decisions to move terminals effectively across Radio Access Technologies (RATs), frequency bands, and cell layers secure user performance and network efficiency. This includes all 3GPP accesses, as well as Wi-Fi, where it is as a part of the mobile broadband offering.

The benefit of traffic steering Wi-Fi for a user moving out of a Wi-Fi coverage area is illustrated in the graph below. Instead of the conventional non-integrated behavior where devices switch to Wi-Fi as soon as it is available, Wi-Fi is used only when it actually provides a better user experience than the cellular service. Hence, the integrated cellular and Wi-Fi solution ensures that users are always connected to the best service.

**Common network management** – a user performance-driven network management philosophy requires a single architecture with full visibility of user KPIs, and coherent tools to take correct remedial action when needed. By implementing this, a unified user experience is ensured across radio access technologies and layers.

Moreover, the mobile broadband network infrastructure needs to be continuously optimized to achieve a cost-effective network evolution.

**Cost effective network expansion**

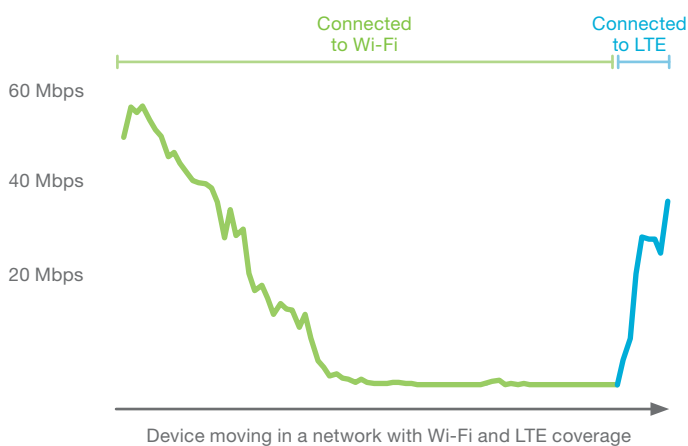
Leveraging the economies of scale of macro cells remains key to cost effective coverage and capacity expansions. By improving the capacity and range of existing macro sites, a 10-fold capacity gain can be achieved compared to an HSPA network designed only for basic coverage. Hence, a significant improvement in app coverage is often possible using existing technology. This can be done with the addition of new spectrum, refarming low spectrum GSM bands to mobile broadband, adding LTE and deploying the latest radio access network performance functionality.

Macro cell networks can be further strengthened through the deployment of smaller and more flexible base station configurations. Notably, the more advanced urban cellular networks typically offer 12 times higher capacity compared to less dense networks, accounting for a 3.5 times shorter inter-site distance alone, e.g. 200 m instead of 700 m. However, such an aggressive densification of the macro layer is not possible in many cities due to site acquisition limitations.

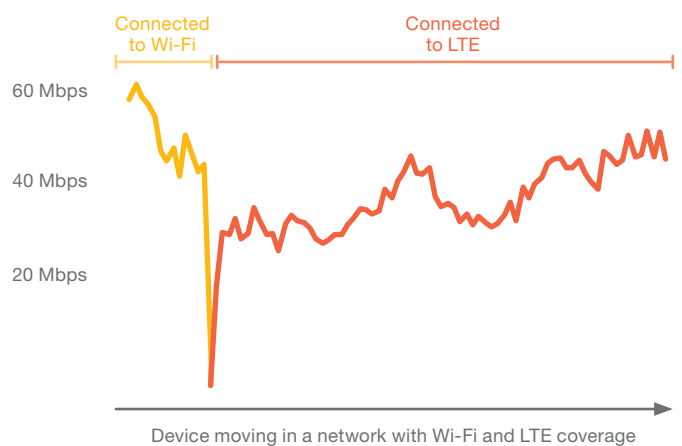
In turn, small cells offer an increasingly important means to add localized coverage and capacity. They should primarily be added where users experience unsatisfactory data rates and are difficult to reach using the macro cell layer alone – which in practice often means small cells are deployed to improve indoor performance.

**Smart traffic steering across Wi-Fi and HSPA/LTE minimizes connectivity gaps and ensures a higher and more consistent user throughput**

Conventional Wi-Fi to LTE handover



Integrated Wi-Fi with smart traffic steering



Source: Trial using commercial software

## Small cell deployment scenarios

In urban city streets and squares, outdoor micro cells are attractive to cover outdoor hotspot areas and to reach indoor users in the surrounding buildings. A selective outdoor micro cell deployment, complementing an existing macro network, offers a cost-efficient alternative to a densified macro network. Successful outdoor micro cell deployment entails challenges in both finding the optimal site locations and acquiring the sites.

For small indoor hotspots such as cafes and small offices, operators can often deploy indoor pico base stations, backhauled over the available fixed broadband. Existing legacy standalone Wi-Fi can be replaced by Wi-Fi integrated with the mobile broadband network for a better user experience.

In certain in-building situations – such as stadiums, shopping malls, train stations, airports and large offices – dedicated in-building solutions may be required to meet local capacity and user data rate needs. A mix of cell types can be used, depending on the nature of the building and the backhaul available.

Fiber cabling enables the use of distributed Remote Radio Units (RRU), while many pico base stations and Radio Dot Systems (RDS)<sup>1</sup> can be deployed over LAN cables. For larger installations, RRU and RDS solutions utilizing a common baseband are favorable for maximum performance at a manageable cost and complexity. To facilitate continued basic multi-operator coverage, the legacy Distributed Antenna System (DAS) may also be overlaid by an operator-specific high capacity system to strengthen the offering.

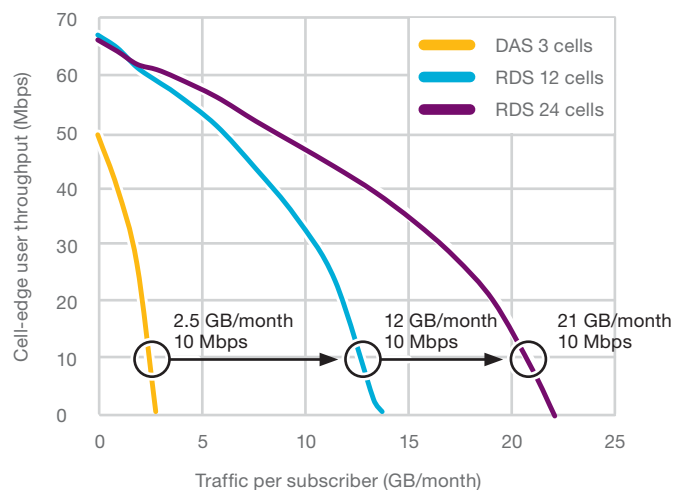
### Radio Dot System

The Radio Dot System refers to a new in-building radio base station architecture. The architecture simplifies the planning and deployments of in-building systems by introducing small frequency-specific distributed Radio Dots (RD), which are mounted on the ceiling and connected and powered via LAN cables.

## Improving indoor app coverage and capacity

The graph below illustrates the app coverage and per-user traffic that can be supported by deploying a DAS or RDS (LTE 20 MHz FDD) in an office building.<sup>2</sup> While maintaining coverage with a speed of 10 Mbps with 95 percent probability, a monthly traffic per subscriber of 2.5 GB can be supported with a conventional DAS, with each cell covering eight floors. By splitting cells so that each covers two floors, and introducing support for multiple antenna transmission, 12 GB per month is supported. This is realized by an RDS. Further upgrading of the RDS to one cell per floor yields even higher supported traffic – 21 GB per month. This evolution meets the targets of supporting a user throughput of 10 Mbps and a many-fold traffic increase over today's levels.<sup>3</sup>

## Improving indoor app coverage and capacity



To conclude, the demand for increasing capacity and app coverage puts requirements on network evolution. A radio network toolbox, including options to improve the macro, densify the macro and add coordinated small cells is able to meet these demands in an efficient way. Tight integration of small cells with the macro network provides substantial gains over the uncoordinated case, while DAS and in particular RDS can improve indoor app coverage and support a manifold increase in traffic volumes.

<sup>1</sup> All references to Radio Dot System, RDS and RD refer to the Ericsson Radio Dot System.

<sup>2</sup> Assumptions: The building has a footprint of 50x50 m, resulting in a floor area of 2500 m<sup>2</sup>, and is 24 floors or 72 m tall. The subscriber density in the building is one subscriber per 10 m<sup>2</sup>. The monthly traffic per subscriber is distributed over 20 working days and 10 working hours per working day. Different DAS and RDS configurations are evaluated. In all cases there are four antenna points per floor (each covering some 625 m<sup>2</sup>), and the output power per antenna point is 0.1 W. LTE with 20 MHz FDD at 2.6 GHz.

<sup>3</sup> 10 Mbps is a minimum speed requirement today for enterprise offices which typically have Wi-Fi.



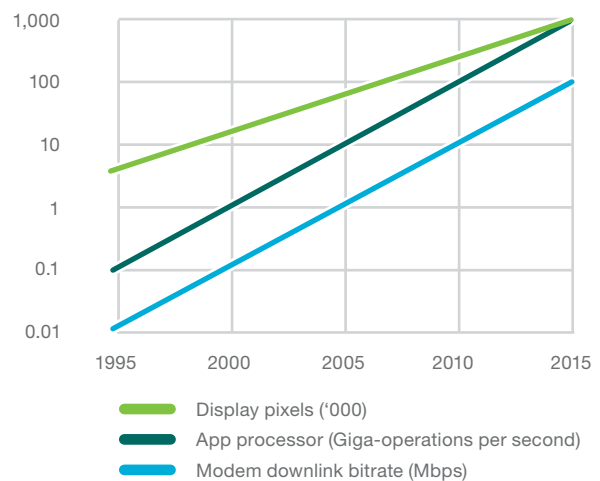
# SMART MOBILE DEVICES AND APP COVERAGE

Mobile radio network capabilities increase with each new technology generation. There are also incremental improvements between generations as system software features and radio modulation improve over time, increasing both spectral efficiency (bits transmitted per hertz of radio spectrum) and the possibility to add more cells into the radio access network. Yet, the network is only one part of the mobile broadband story. It plays a role in an ecosystem, interacting with user devices and the apps that run on them.

The remarkable growth of mobile data traffic in the last few years has largely been driven by the use of smartphones and tablets. These smart mobile devices affect network performance in a number of ways, for instance older and less capable devices can use more radio network resources to accomplish what a newer device can with less. At the same time, newer and more advanced devices offer the subscriber an improved experience which correlates with higher data traffic per subscriber. Therefore, the distribution of device categories connected to the radio access network, together with their respective capabilities, has an effect on network resource usage, user experience, and ultimately operator revenue generation and profitability.

Smart devices are rapidly evolving and taking on new capabilities. Three of the major functional components in these devices are the modem, the application processor, and the device screen. Their evolution is illustrated in the figure top right. It shows that the performance of both modem and application processing has been increasing by roughly an order of magnitude every five years. Display resolutions and sizes have also been increasing rapidly.

Increases in mobile device capabilities



## The modem

The modem handles communications with the radio base stations. The maximum bitrate that modems in the newest devices can handle follows network capability as new cellular generations are rolled out and new features are deployed. Successive device categories have been released to handle the various HSPA stages in WCDMA and new LTE advances. In the last few years, the downlink bitrate capability has improved from 3.6 Mbps to 42 Mbps in HSPA devices and from 100 Mbps to 150 Mbps in LTE devices. By the end of this year, devices capable of 300 Mbps over LTE-Advanced will be available. As devices are upgraded to take advantage of the new network capabilities, data transfer over the air interface becomes more efficient.

To assess the relative performance of HSPA and LTE smart devices, data traffic was measured over the course of one week in one network. The network is in a developed market and has a high penetration of smart devices, with over 70 percent running either iOS or Android. As would be expected, the median downlink throughput for these devices varied depending on their capability, from 400 Kbps for the low-end (HS 3.6) models to 2.75 Mbps for the high-end (HS 42 and LTE) devices. These measurements are made from data traffic generated by actual app usage.

In the same network, measurements of cell-edge performance indicated that downlink throughput for the high-end devices was 150 percent better than for the low-end devices. Clearly, devices with higher bitrate capabilities should outperform those with lower limits. It is interesting that they outperform them at any speed – even well below the limits of the older devices.

### The application processor

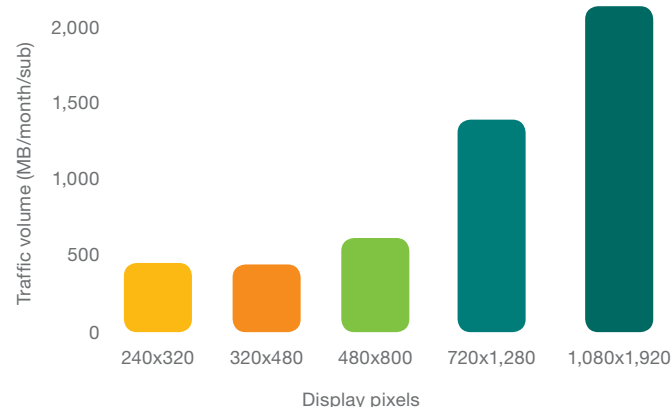
An application processor runs the operating system and apps in smart mobile devices. Its scope is continually being enlarged, as peripheral functions such as data handling from sensors and graphics processing are integrated. Performance has been increasing in successive generations of application processors (measured in giga-operations per second, or GOPS). The performance gains have come with architectural complexity as the number of cores in processors multiplies, and power-saving innovations such as asymmetrical cores appear, giving the ability to run intensive operations on larger cores and basic functions on smaller cores during periods of low usage.

As the app processor gains capability, it allows ever larger and more data-intensive apps to be used, creating a demand for higher performance and more capacity in the network. This influences network dimensioning as networks are built out to accommodate the new demands.

### The display

The screen is important both as part of the user interface as well as a primary way to display content. The top right figure shows the results of data consumption analysis for Android device users in a representative sample of networks worldwide. It illustrates that increasing numbers of pixels on device displays (driven by increases in both size and resolution) is connected with more data traffic per subscriber.

### Display pixels and average data consumption



Display size also correlates with other factors such as radio capability and data plan.

There is a large variance in traffic per display size for individual operators.

### Streaming video and app coverage

With improvements in modems, application processors and displays, each new generation of devices is able to handle more data-intensive apps. An illustration of this is video streaming, which accounts for about 40 percent of all mobile data traffic due to its data intensity. While a large part of the video streamed today is coded into 360p format (see table below) or smaller, 480p and 720p usage is growing and it is clear that higher resolution formats will be used. Bigger and higher resolution screens, the increasing use of tablets, the emergence of phablets (or mini-tablets) as well as more capable cameras in smart devices all point to continued video traffic growth.

### Digital video formats with estimated media rates

Format	Codec	Pixel dimensions	Media rate (Mbps)
240p	H.264	360x240	0.400
360p	H.264	480x360	0.750
480p	H.264	640x480	1.2
720p	H.264	1280x720	2.5–3.5
1080p	H.264	1920x1080	5–6
2160p (4K)	H.265	3840x2160	10–15

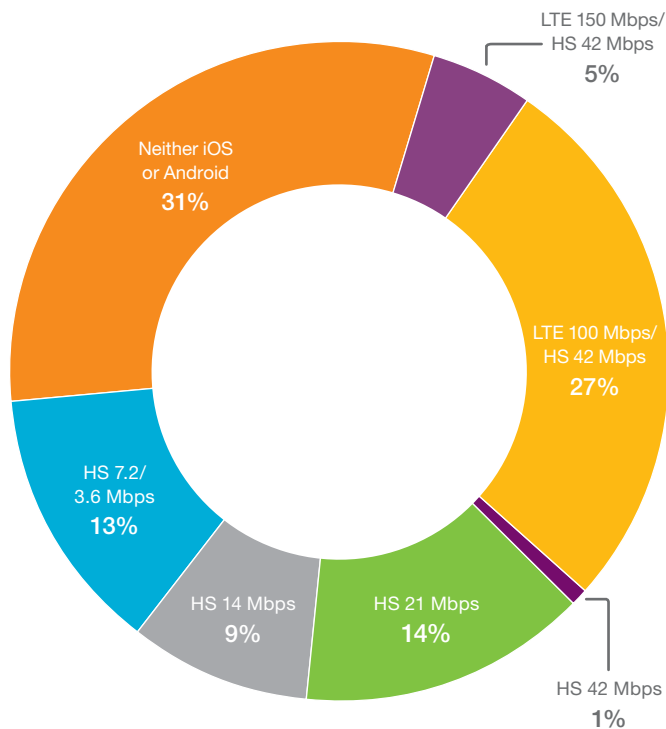
An extreme example of the emergence of larger video formats and higher bit rates can be seen in the introduction of smart devices offering the ability to capture and process 4K (ultra-high definition) video.

Using the higher compression available from High Efficiency Video Coding (H.265 codec), 4K video can be streamed at bit rates of 10–15 Mbps. To assess the viability of streaming media, app coverage can be used to measure the probability of getting the necessary uplink data rate. While this is possible today in advanced WCDMA/HSPA and LTE networks, the area with enough performance to achieve it is only a small portion of the network’s total coverage. A subscriber would have a low probability of being able to stream 4K video with current network dimensioning.

Closer to the realities of today, the H.265 high efficiency video codec – beyond enabling ultra-high definition video – can also be used to encode smaller format video streams at nearly twice the compression of the H.264 codec. It was designed to reduce the bitrate requirements by half with similar image quality, at the cost of increased processing complexity. In the context of transmitting video streams in mobile networks, this can be seen as a trade-off between network resource utilization and device application processor computational power.

The graph below illustrates the distribution of smart mobile devices (iOS and Android) in the same cellular network in which the device performance measurements were made as previously described. These devices represent

**Distribution of devices by radio capability in a developed market**



Source: Measurements from a single network over one week

around 70 percent of all mobile devices in use. There are significant proportions of the device park that are older and have modems with maximum bitrates associated with previous network limitations (3.6, 7.2, 14.4 and 21 Mbps versions of HSPA). On the other hand, the low percentage of devices shown as capable of bitrates of 42 Mbps is due to the fact that this HSPA network feature emerged around the same time that LTE began to be deployed. So the majority of devices capable of 100 Mbps over LTE are also capable of 42 Mbps over WCDMA.

Mobile broadband networks, smart devices and apps form an ecosystem. All three are advancing quickly and are interdependent in delivering the best user experience. By understanding these trends, operators can influence the distribution of devices in their network to get more out of their network investments. This can take the form of promoting new models, or special offerings to trade in older models that cannot take full advantage of newer network features.

While a subscriber’s experience is impacted by the age of their smart mobile device, it is also important to note that a network with a high proportion of older devices is less efficient than it could be, ultimately affecting all users. On the other hand, devices with the capability to capture, process and transmit ultra-high resolution video are emerging. Networks are already capable of handling such high demands in limited areas, and over time, continuous coverage for increasingly higher resolution video streaming will be built out.

**App coverage**  
 The coverage area for any given app is related to the performance (uplink, downlink and latency) needed for an acceptable user experience. App coverage describes this area in terms of probability of being able run a given application, e.g. video streaming, web browsing or uploading data. Smart devices and apps continually evolve and encompass newer capabilities, requiring more network performance to provide a good user experience. App coverage offers an integrated view of network coverage, capacity and quality relative to a specific app.

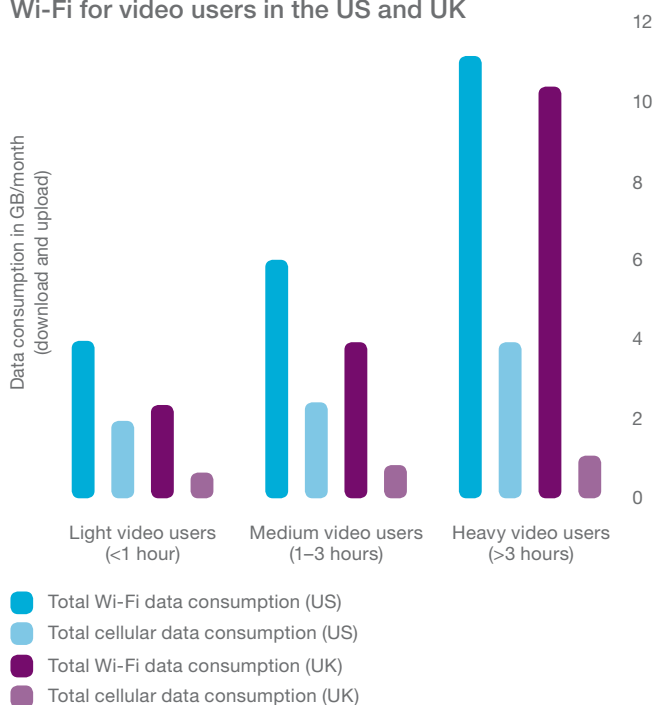
# VIDEO USE OVER CELLULAR AND WI-FI

Video is the largest and fastest growing category of mobile data traffic, with Ericsson predicting that it will account for over 50 percent of the total data traffic on cellular networks in 2019. Smartphone users consume video in various forms, including streaming videos, movies, and TV programs, as well as user-generated clips and video telephony over both cellular and Wi-Fi networks. An Ericsson ConsumerLab analysis of smartphone users in the US and UK found that cost and network performance are important factors in determining why consumers may prefer to watch video over Wi-Fi rather than via cellular networks.

In this study, smartphone users were segmented into six different user groups based on what type of applications and services they used on their phones. Based on 23 different application usage frequency questions, the 6 user groups were categorized as: light data users, social networking-centric users, utility application users, browsing-centric users, video-centric users and power users. The two groups with the highest levels of video usage were the power users and video-centric users. Although high video usage was the common denominator for these two groups, power users were characterized by the highest frequency usage of all applications, whereas video-centric users had average usage of applications other than video. Some 10 percent of all smartphone users in the US were power users, whereas this group represented 6 percent in the UK. Six percent of users in the US were video-centric users, while the UK figure was seven percent.

A comparative analysis of monthly mobile video traffic consumption on Wi-Fi and cellular network for smartphone users in the US and UK shows that heavy and medium video users consume proportionally more video over Wi-Fi than cellular networks compared to light video users. This holds true not only for smartphone users in the US and the UK, but also for other mature markets such as South Korea and Japan.

Monthly data consumption over cellular and Wi-Fi for video users in the US and UK



Source: Ericsson ConsumerLab analytical platform 2013, Nielsen on-device metering data (5,000 respondents in US, 1,500 respondents in UK)  
Base: Smartphone users who run video apps on their mobile phone

According to the data gathered from the surveys of smartphone users in the US and UK, there are two main barriers to video consumption over cellular networks – the first being the performance of the networks and the second being the limitations of mobile data caps and costs. The most cited reasons among smartphone users in the US and UK for why they may prefer Wi-Fi to cellular networks were better network speed, cost and reliability. Among those who preferred Wi-Fi, the strongest concerns over limited data plans were among power users and video-centric users.

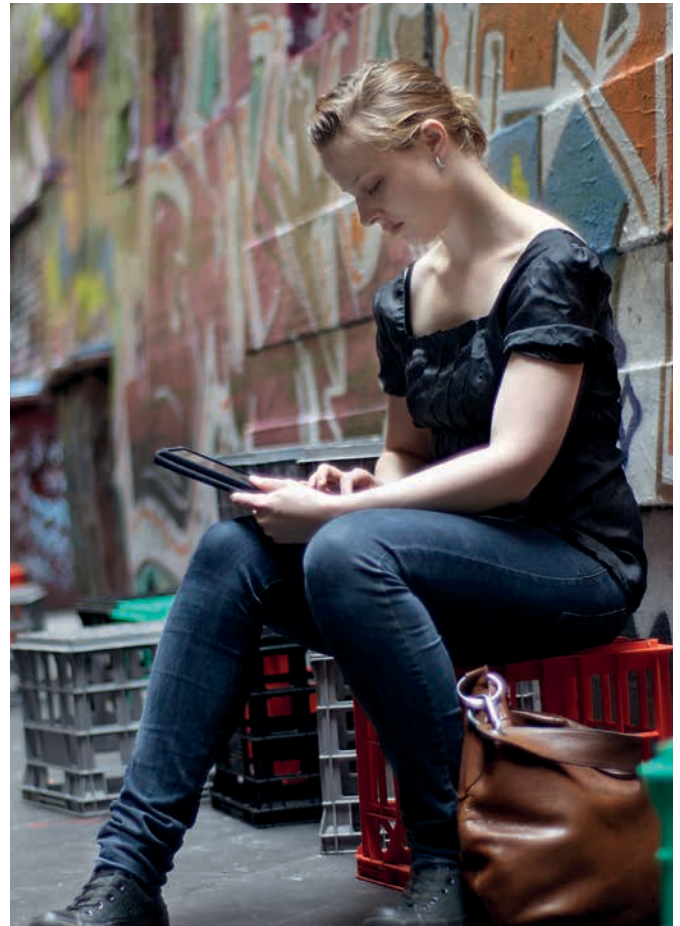
## Data plans vs mobile video use

Comparing US smartphone video users who stated that they have unlimited data plans to those who stated that they have a tiered data subscription shows that the former consume 64 percent more cellular data.

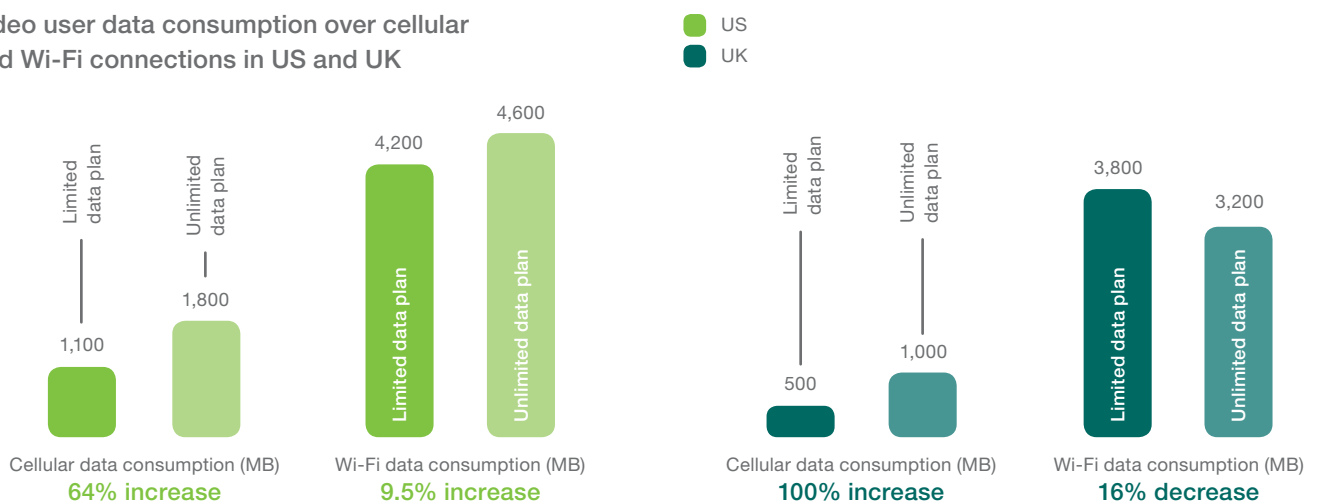
The difference in data consumption over Wi-Fi networks between these 2 groups is only 9.5 percent, showing the impact that data plan limitations have on cellular data consumption. We see similar relative differences in levels of data consumption over cellular and Wi-Fi networks with respect to consumers with unlimited or limited data plans in the UK. This is shown in the graphs below.

In most markets, mobile subscriptions with data plans which are unlimited – or perceived as unlimited – typically comes at a high price for the user. In reality, most operators already have or are implementing data plans which include tiered pricing. There is still room for innovative tariff structures designed to attract more traffic volume with discounted unit prices.

This study indicates that mobile broadband operators are essentially faced with a source of untapped demand for data traffic over their networks. Mobile/cellular network performance, in terms of data throughput rates and latency, is increasing worldwide. This leaves more optimal subscriber offerings as a path to increased growth.



## Video user data consumption over cellular and Wi-Fi connections in US and UK



Source: Ericsson ConsumerLab analytical platform 2013, Nielsen on-device metering data (5,000 respondents in US, 1,500 respondents in UK)

Base: Smartphone users who run video apps on their mobile phones





# M2M IN TRANSFORMATION

Machine-to-Machine (M2M) communication is taking off, driven by declining costs, improved coverage, more capable radio technologies, regulatory mandates and a growing range of successful applications and business models.

At the end of 2013 there were around 200 million cellular M2M devices in active use, and this number is expected to grow 3–4 times by 2019. Average M2M device penetration is around 2 percent of data subscriptions among measured networks, while it can reach 20 percent for those operators that focus on M2M. A closer look at the characteristics of M2M devices is required in order to better understand their impact on networks.

Securing cost-effective and seamless transfer between networks is a key concern for the global M2M roaming alliances being formed. Average M2M penetration is much higher as a percentage of data roaming devices – around 15 percent – which is explained in part by M2M roaming traffic from vehicle tracking and fleet management systems.

Contrary to other device types, a majority of M2M devices in active use are still GSM-only. Currently in North America, almost all devices are 3G or 4G and the only 2G devices that are left are M2M. This will also be the case in Western Europe in 2–3 years' time. One reason for this is that the cheapest M2M modules are still GSM-only, which is needed for low ARPU M2M subscriptions. Another reason is that many current M2M applications do not require high network speeds. A third explanation is that M2M applications often have long lifecycles. A smart meter device, for example, may be intended to last for up to 20 years, in contrast to smartphones which are typically replaced every 2–3 years. Given the long lifecycle of M2M applications, investment in the latest available radio technology may support future needs. Such measures depend on the module's price feasibility.

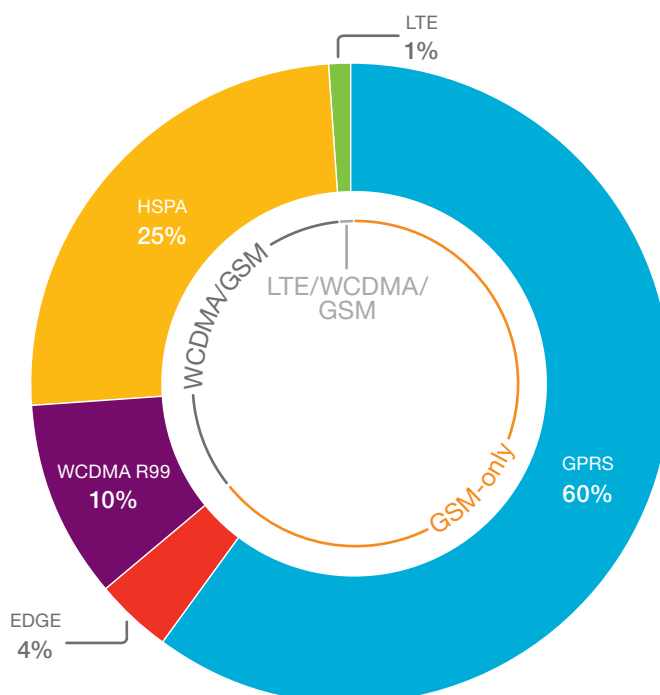
The graph to the right shows that globally, around 64 percent of M2M devices are still GSM-only. It is based on measurements of all device types,

taken over the past year from mobile networks<sup>1</sup> all over the world. M2M data subscriptions with 2G, 3G or 4G devices<sup>2</sup> are included in the analysis.

Although the number of M2M devices on GSM will increase in absolute terms, the share of these devices on this technology will reduce to around 30 percent in 2019. In 2016, it is expected that 3G/4G will be the dominant technologies of all active M2M subscriptions. LTE M2M device penetration is expected to reach more than 20 percent in 2019, up from today's 1 percent, and will represent more than 40 percent of shipments in the same year.

M2M communication represents a small share – around 0.1 percent – of total cellular traffic in terms of bytes. This traffic share will go up as LTE M2M devices and more powerful processors are included in high bandwidth and low latency-demanding applications such as consumer electronics, vehicles and billboards.

Radio capability distribution of M2M devices in measured mobile networks



<sup>1</sup> CDMA networks not covered

<sup>2</sup> SMS or circuit switched-only devices not included (packet switched measurements)



# KEY FIGURES

Mobile subscription essentials	2012	2013	2019 forecast	CAGR 2013–2019	Unit
Worldwide mobile subscriptions*	6,300	6,700	9,200	5%	millions
> Smartphone subscriptions	1,300	1,900	5,600	20%	millions
> Mobile PC, tablet and mobile router subscriptions	250	300	700	15%	millions
> Mobile broadband subscriptions	1,600	2,200	7,600	25%	millions
> Mobile subscriptions, GSM/EDGE-only	4,300	4,200	1,500	-15%	millions
> Mobile subscriptions, WCDMA/HSPA	1,300	1,600	4,500	20%	millions
> Mobile subscriptions, LTE	80	200	2,600	55%	millions

Traffic essentials**	2012	2013	2019 forecast	CAGR 2013–2019	Unit
> Monthly data traffic per smartphone***	500	650	2,500	25%	MB/month
> Monthly data traffic per mobile PC***	2,400	3,300	13,000	25%	MB/month
> Monthly data traffic per tablet***	1,000	1,400	6,300	30%	MB/month
Total monthly mobile data traffic	1.1	2.0	20	45%	EB/month
Total monthly fixed data traffic	30	40	140	25%	EB/month

Mobile traffic growth	Multiplier 2013–2019	CAGR 2013–2019
All mobile data	10	45%
> Smartphones	10	50%
> Mobile PC	3	20%
> Tablets	23	70%

\*Using active VLR subscriptions for India

\*\*Monthly data traffic volumes by year end

\*\*\*Active devices

## Traffic exploration tool

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

To find out more, scan the QR code, or visit [www.ericsson.com/ericsson-mobility-report](http://www.ericsson.com/ericsson-mobility-report)



# METHODOLOGY

## Forecast methodology

Ericsson performs 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 a national or regional level, together with internal assumptions and analysis. Historical data may be revised if the underlying data changes – for example, if operators report updated subscription figures.

Mobile subscriptions include all mobile technologies. M2M subscriptions are not included. Subscriptions are defined by the most advanced technology that

the mobile phone and network are capable of. Figures are rounded and hence summing up rounded data may result in slight differences from the actual total.

Traffic refers to aggregated traffic in mobile access networks and does not include DVB-H, Wi-Fi or Mobile WiMax traffic. Voice traffic does not include VoIP.

## 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 in 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.

# GLOSSARY

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

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

APAC: Asia Pacific

ARPU: Average Revenue Per User, a measure of the revenue generated per user or unit

Basic phone: non-smartphone

CAGR: Compound Annual Growth Rate

CDMA: Code Division Multiple Access

CEE: Central and Eastern Europe

CEMA: Central and Eastern Europe, Middle East and Africa

DL: Downlink

EB: ExaByte,  $10^{18}$  bytes

EDGE: Enhanced Data Rates for Global Evolution

GB: GigaByte,  $10^9$  bytes

GSA: Global Supplier Association

GSM: Global System for Mobile Communications

HSPA: High Speed Packet Access

IMEI-TAC: International Mobile Equipment Identity – Type Approval Code

LA: Latin America

LTE: Long-Term Evolution

M2M: Machine-to-Machine

MB: MegaByte,  $10^6$  bytes

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

Mbps: Megabits per second

MEA: Middle East and Africa

MMS: Multimedia Messaging Service

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)

NA: North America

OS: Operating System

P2P: Peer-to-Peer

PetaByte:  $10^{15}$  bytes

Smartphone: mobile phones with open OS, e.g. iPhones, Android OS phones, Windows phones but also Symbian and Blackberry OS

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

VLR: Visitor Location Register

VoIP: Voice over IP (Internet Protocol)

UL: Uplink

WCDMA: Wideband Code Division Multiple Access

WE: Western Europe

Ericsson is the driving force behind the Networked Society – a world leader in communications technology and services. Our long-term relationships with every major telecom operator in the world allow people, businesses and societies to fulfill their potential and create a more sustainable future.

Our services, software and infrastructure – especially in mobility, broadband and the cloud – are enabling the telecom industry and other sectors to do better business, increase efficiency, improve the user experience and capture new opportunities.

With more than 110,000 professionals and customers in 180 countries, we combine global scale with technology and services leadership. We support networks that connect more than 2.5 billion subscribers. Forty percent of the world's mobile traffic is carried over Ericsson networks. And our investments in research and development ensure that our solutions – and our customers – stay in front.

Founded in 1876, Ericsson has its headquarters in Stockholm, Sweden. Net sales in 2013 were SEK 227.4 billion (USD 34.9 billion). Ericsson is listed on NASDAQ OMX stock exchange in Stockholm and the NASDAQ in New York.