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Ericsson Mobility Report

Special edition
World Economic Forum

January 2019

The power of 5G

Since it launched in 2011 the Ericsson Mobility Report has earned a reputation of providing trusted insights into future network trends and needs, and has become a heavily cited source.

The latest edition is published at a truly landmark moment – the commercial introduction of 5G. No previous generation of mobile technology has had the potential to drive economic growth in the way that 5G promises. It goes beyond connecting people to the possibility of making the Internet of Things (IoT) and the Fourth Industrial Revolution a reality.

5G has the ability to drive a digital society where everything that can benefit from being connected will be connected. All-digital infrastructure can be a catalyst for competitiveness, driving new and sustainable business models and use cases, and changing industries and society as we know them. It has the potential to level the playing field within and between countries as well as around the world.

5G will not discriminate between industries, or enterprises within industries, based on scale. It has the potential to benefit all sizes of industry: from one-person operations to multinationals, and from community-based initiatives to global brands.

Digital infrastructure can make distance less relevant than ever. 5G is the backbone that can make it all work – driving economic value from enhanced mobile broadband to digital industry. That in turn will require an ecosystem of technology, regulatory, security and industry partners to deliver on the potential. Smart cities, Industrial IoT, virtual reality, autonomous transport and digital health are just some of the exciting prospects that can be made real with the support of the 5G ecosystem.

ICT is also expected to play a significant role in realizing the UN Sustainable Development Goals to foster sustainable social and financial inclusion.

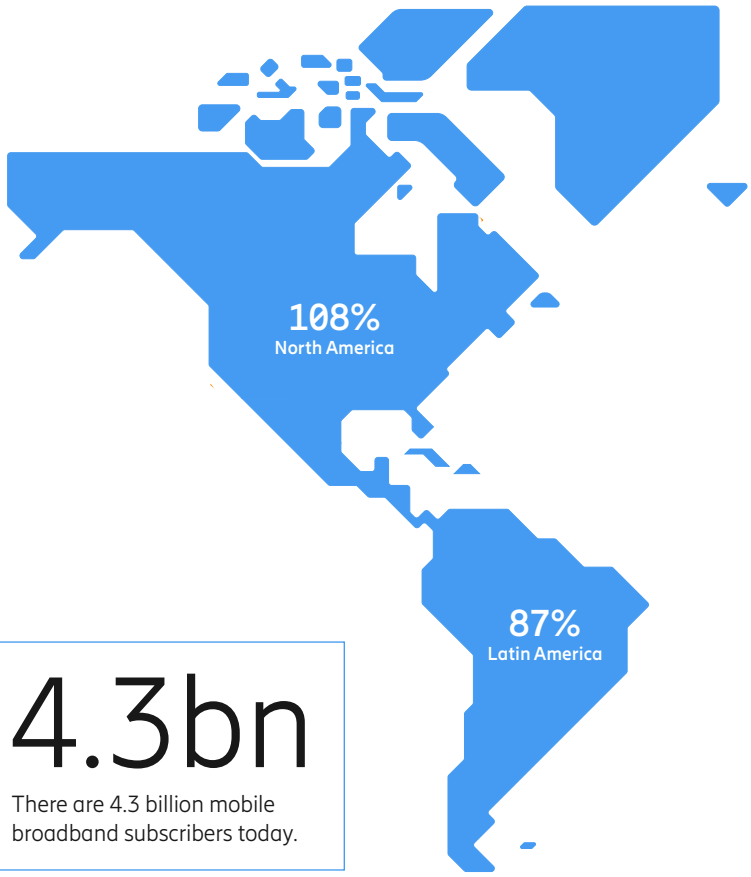
5G momentum is already building and commercialization is underway. However, the full benefits will only be realized through an engaged and driven 5G ecosystem.

I hope you find the report engaging and useful.

Börje Ekholm

President and CEO

Mobile broadband subscriptions penetration 2018



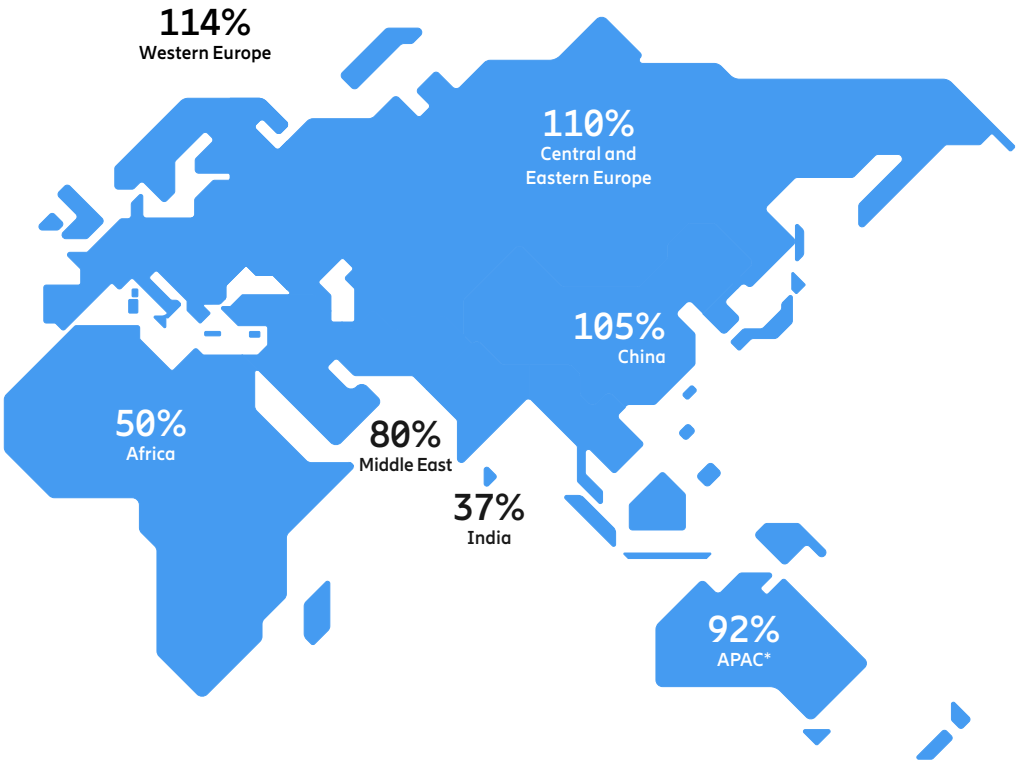
4.3bn

There are 4.3 billion mobile broadband subscribers today.

Over 40 percent of the world's population lacks broadband internet access

Global spectrum harmonization is crucial for 5G economics

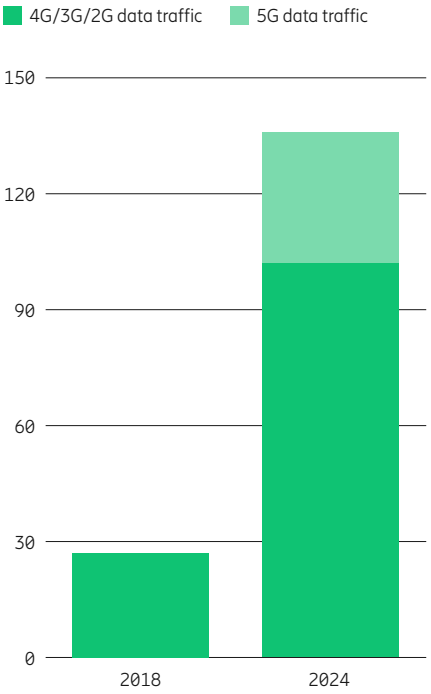
Contents



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

* excluding China and India

Global mobile data traffic (EB/month)



5x

Total mobile data traffic is expected to be 5 times higher in 2024.

5G use cases are expected across industries

Smart manufacturing can require one connected device per square meter of a factory floor

First 5G smartphones expected in Q2 2019

Mobile data traffic grew 80 percent in 2018

Crunching the numbers

1.5bn

In 2024, 5G subscriptions are expected to reach 1.5 billion.

>40%

In 2024, 5G networks are set to cover over 40 percent of the world's population.

22bn

More than 22 billion Internet of Things connections are forecast in 2024.

Mobile subscription growth dominated by Asia

The total number of mobile subscriptions was around 7.9 billion in Q3 2018, with 120 million new subscriptions added during the quarter.

The number of mobile subscriptions grew at 3 percent year-on-year and totaled 7.9 billion in Q3 2018. China had the most net additions during the quarter (+37 million), followed by India (+31 million) and Indonesia (+13 million). The high subscription growth in China continues from Q1 and Q2, and is likely the result of intense competition among communications service providers.

The number of mobile broadband subscriptions[1] grew at 15 percent year-on-year, increasing by 240 million in Q3 2018 to reach 5.7 billion.

The number of 4G subscriptions increased by 200 million during the quarter to reach a total of 3.3 billion. The net addition for 3G was around 60 million subscriptions.

Over the same period, 2G subscriptions declined by 110 million. Other technologies declined by around 30 million.

Subscriptions associated with smartphones accounted for more than 60 percent of all mobile phone subscriptions in Q3 2018. Around 360 million smartphones were sold in the quarter, which equates to 86 percent of all mobile phones sold.

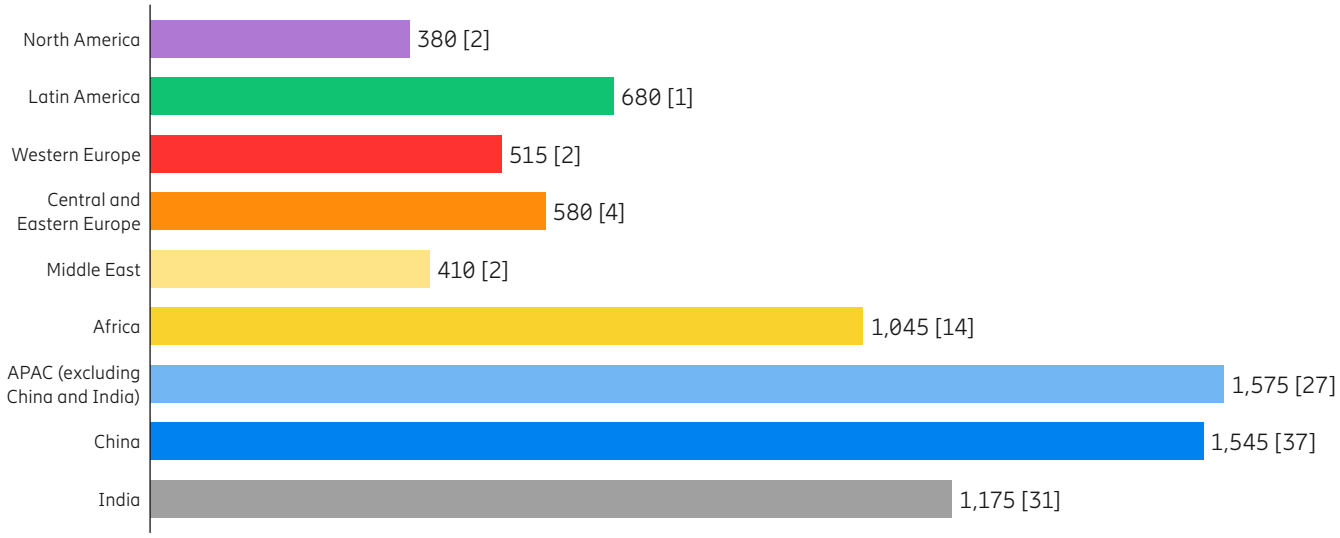
5.7bn

There are now 5.7 billion mobile broadband subscriptions.

120m

There were 120 million new mobile subscriptions globally in Q3 2018.

Total and new mobile subscriptions in Q3 2018 (million)



Key = Total mobile subscriptions [New mobile subscriptions in Q3 2018]

[1] Mobile broadband includes radio access technologies 3G, 4G, 5G, CDMA2000 EV-DO, TD-SCDMA and Mobile WiMAX

Mobile broadband drives subscriptions uptake

5G has been commercially launched.

There is strong momentum in the global 5G market. In the US, one of the major communications service providers launched a 5G fixed wireless access broadband service at the beginning of October last year, and all four of the country's major service providers have publicly announced that they will begin providing 5G services between late 2018 and mid-2019. Other markets expecting significant 5G subscription volumes early include South Korea, Japan and China. In Europe, some spectrum auctions have already been held, and others will take place over the next few years. The first commercial 5G subscriptions in the region are expected in 2019.

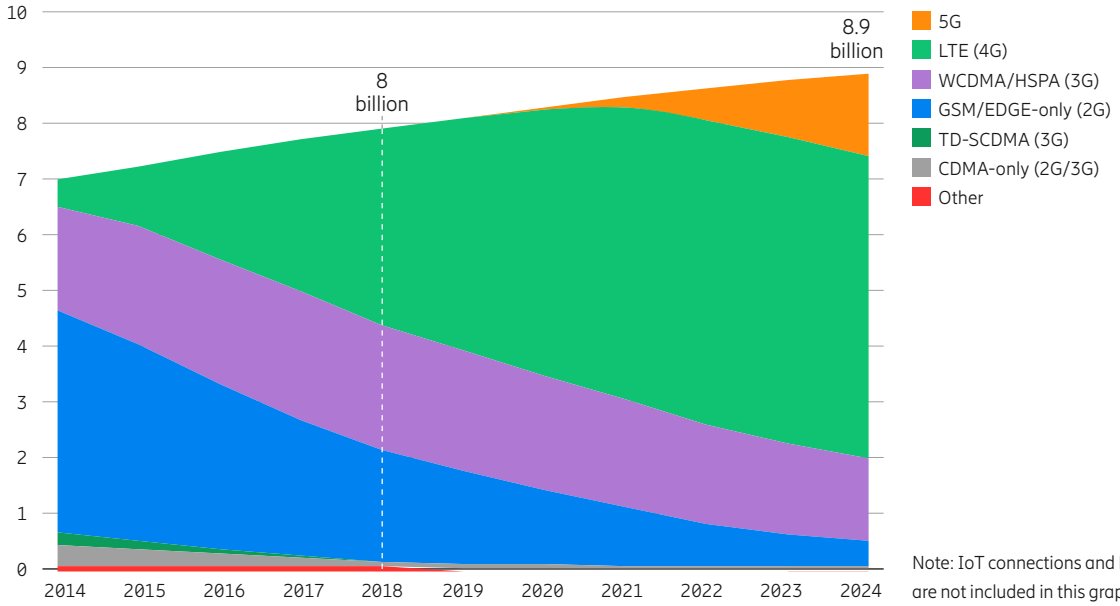
On a global level, major 5G network deployments are anticipated from 2020, and by the end of 2024 we project 1.5 billion 5G subscriptions for enhanced mobile broadband. This will account for close to 17 percent of all mobile subscriptions at that time. With global mobile data traffic forecast to increase by a factor of 5 between 2018 and 2024, key drivers for 5G deployment include increased network capacity and decreased cost per byte. 5G subscription uptake is expected to be faster than that of 4G during the corresponding period of its lifecycle, which in turn is the mobile communication technology with the fastest subscription uptake so far.

4G has been the dominant mobile access technology since the end of 2017. The number of 4G subscriptions continues to grow strongly and is forecast to reach 5.4 billion by the end of 2024, when it will make up more than 60 percent of all mobile subscriptions. The number of 3G subscriptions has declined slightly during 2018, though the technology is still estimated to account for close to 17 percent of all subscriptions in 2024.

Cellular IoT connections and fixed wireless access (FWA) subscriptions supporting new use cases will come on top of the mobile subscriptions shown in the graph below.

A 5G subscription is counted as such when associated with a device that supports New Radio (NR) as specified in 3GPP Release 15, and connected to a 5G-enabled network.

Mobile subscriptions by technology (billion)



Note: IoT connections and FWA subscriptions are not included in this graph

Technology transformation across regions

Mobile broadband[1] drives subscription growth across all regions.

Mobile subscriptions by region and technology (percent)

Note: Technologies with less than 1 percent of subscriptions are not shown in the graph

In India, 2G has remained the dominant technology during 2018, accounting for around 56 percent of total mobile subscriptions at the end of the year. However, the country has experienced strong growth in the number of 4G subscriptions over the last couple of years, and at the end of 2018 4G accounted for close to 30 percent of all mobile subscriptions.

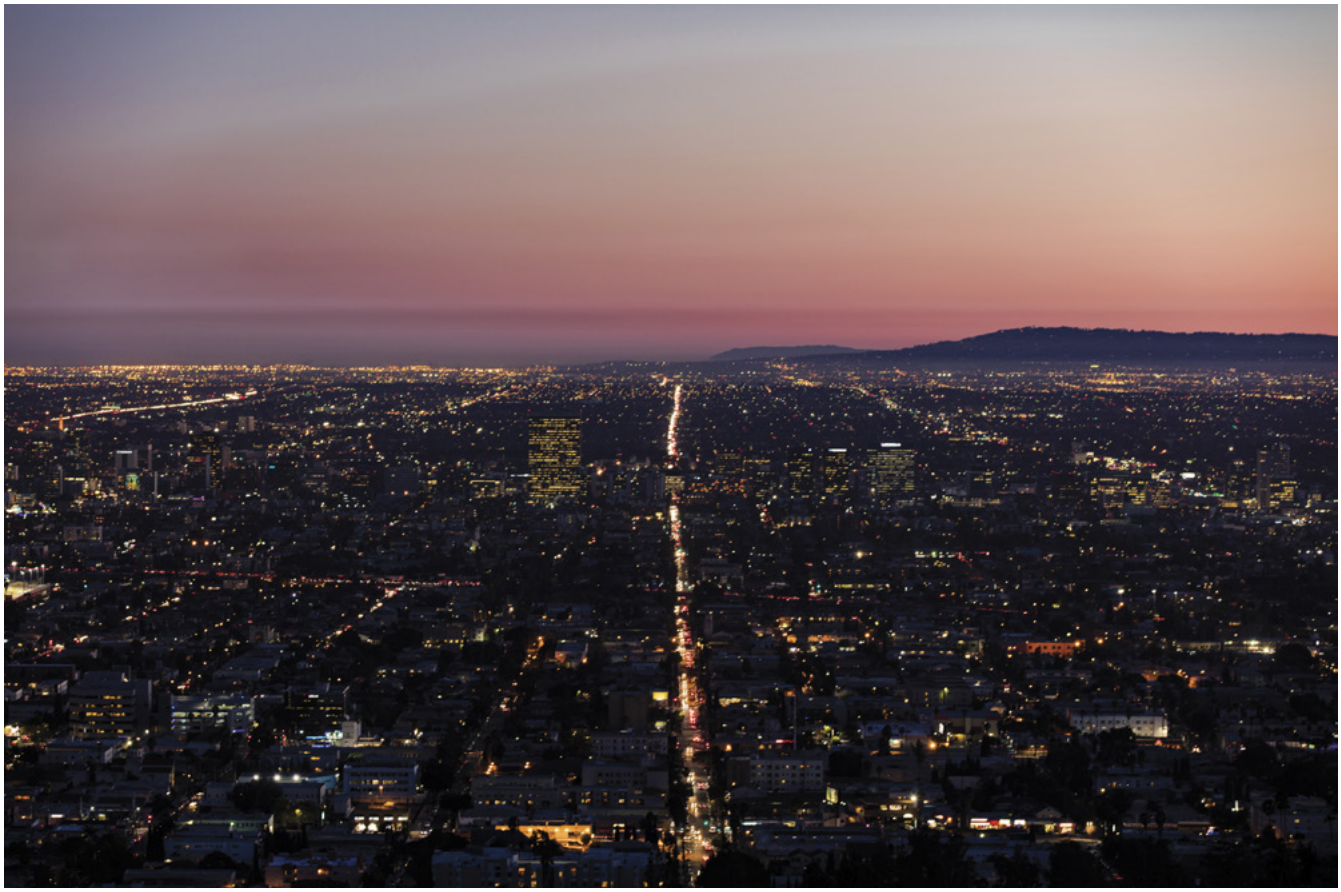
As the transformation toward more advanced technologies continues in India, 4G is forecast to represent 81 percent of all mobile subscriptions at the end of 2024. 5G subscriptions are expected to become available in 2022.

The Middle East and Africa comprises over 70 countries and is a diverse region. It varies from advanced markets which have mobile broadband subscription penetration of 100 percent, and emerging markets where around 40 percent of mobile subscriptions are for mobile broadband. At the end of 2018, more than 20 percent of all mobile subscriptions were for 4G in the Middle East and North Africa, while in Sub-Saharan Africa, 4G accounted for just over 7 percent of subscriptions. The region is anticipated to evolve over the forecast period and, by 2024, 90 percent of subscriptions are expected to be for mobile broadband. Driving factors behind this shift include a young and growing population with increasing digital skills, as well as more affordable smartphones. In the Middle East and North Africa, we anticipate commercial 5G deployments with leading communications service providers by 2019, and significant volumes in 2021. In Sub-Saharan Africa, 5G subscriptions in discernible volumes are expected from 2022.

74%

Globally, mobile broadband subscriptions now make up 74 percent of all mobile subscriptions.

[1] Mobile broadband includes radio access technologies 3G, 4G, 5G, CDMA2000 EV-DO, TD-SCDMA and Mobile WiMAX



A connected world: mobile broadband subscription levels globally are rising

South East Asia and Oceania includes developed markets with some of the most advanced networks in the world, as well as developing economies that have only recently launched 4G. 3G is still the dominant technology, at 48 percent of all subscriptions. However, 4G subscriptions grew by 70 percent during 2018, taking a share of 26 percent. This transformation is expected to continue over the forecast period and, in 2024, 4G is projected to account for 63 percent of all mobile subscriptions in the region. 5G subscriptions are expected to become available in 2021.

In Central and Eastern Europe, the transition from 3G to 4G is continuing. 4G is forecast to become the dominant technology in 2019 and to account for around 86 percent of all mobile subscriptions in 2024. The first 5G subscriptions are expected in 2019, and will make up close to 10 percent of total subscriptions in 2024.

In Latin America, 4G became the dominant radio access technology in 2018, accounting for 42 percent of all subscriptions – just above 3G, with a share of 39 percent. The distribution of technology is expected to change dramatically over the forecast period, with 4G projected to represent three-quarters of all subscriptions in 2024. The first 5G deployments will be possible in the 3.5GHz band during 2019. Argentina, Brazil, Chile, Colombia and Mexico are anticipated to be the first countries in the region to deploy 5G, with increased subscription uptake forecast from 2020.

North America, North East Asia and Western Europe have high shares of mobile broadband subscriptions. Countries within these regions have developed economies, enabling a high adoption rate of information and communications technology.

In North America, 5G commercialization is moving at a rapid pace, and the region is the first to launch commercial 5G services. In the US, one of the four major service providers deployed a 5G fixed wireless internet service at the beginning of October 2018, and another announced plans to deploy 5G based on the 3GPP 5G standard by the end of 2018. The other two major service providers are expected to launch 5G services in early 2019. 4G penetration is currently 87 percent in North America, which is the highest share globally. By the end of 2024, we anticipate more than 250 million 5G subscriptions in the region, accounting for over 55 percent of all mobile subscriptions.

55%

55 percent of mobile subscriptions in North America are expected to be for 5G in 2024.

In North East Asia, the share of 4G subscriptions is high at 82 percent. China alone had more than 1.3 billion 4G subscriptions at the end of 2018. 5G is expected to be deployed early in South Korea, Japan and China and, by the end of the forecast period, 5G subscription penetration is projected to exceed 43 percent in North East Asia.

In Western Europe, 4G is the dominant access technology, accounting for 57 percent of all subscriptions. 3G continues to decline and will represent only 2 percent of subscriptions in 2024. The region is preparing for 5G, with many operators planning commercial launches during 2019. By the end of 2024, 5G is forecast to account for around 30 percent of all mobile subscriptions.

Video drives mobile traffic growth

Mobile video traffic continues to grow, driven by increased viewing time, online embedded video and streaming services, plus the evolution toward higher resolutions.

Video traffic in mobile networks is forecast to grow by around 35 percent annually through 2024 to account for 74 percent of all mobile data traffic. Traffic from social networking is also expected to rise – increasing by 24 percent annually over the next 6 years. However, its relative share of traffic will decline from 11 percent in 2018 to around 8 percent in 2024, because of the stronger growth of video.[1]

Video is everywhere

Increasing video usage is the main driver behind the growth in mobile data traffic. Users spend increasing amounts of time both streaming and sharing video. This trend is expected to continue, as video is increasingly embedded in all types of online content. In addition, emerging media formats and applications, such as streaming high-quality video and augmented/virtual reality, will continue to drive traffic growth while enhancing the user experience.

Main drivers for video traffic growth

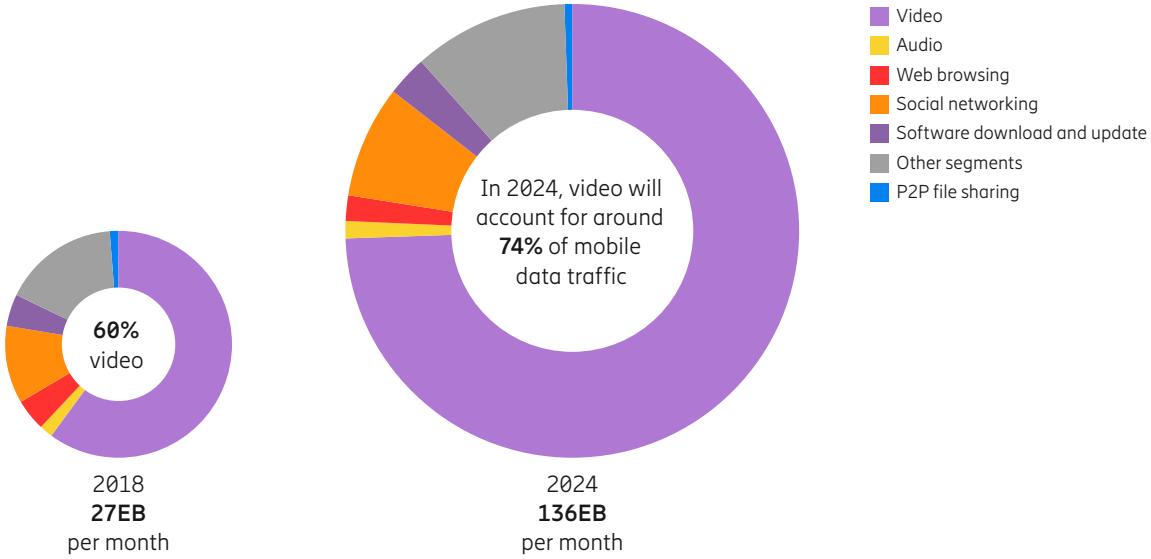
- Video part of most online content (news, ads, social media, etc.)
- Video sharing services
- Video streaming services
- Changing user behavior, with video being consumed anywhere, any time
- Increased segment penetration, not just early adopters
- Evolving devices with larger screens and higher resolutions
- Increased network performance through evolved 4G deployments
- Emerging immersive media formats and applications (HD/UHD, 360-degree video, AR, VR)

Calculate the traffic impact of different application categories

www.ericsson.com/mobility-report/mobility-calculator

Explore the relationship between the usage of various app types and monthly traffic per subscription. Fill in your app usage figures and benchmark the resulting data consumption against six pre-set data consumption profiles.

Mobile data traffic by application category per month (percent)



[1] Traffic from embedded video in web browsing and social media is included in the application category "Video"

Smartphone usage dominates mobile data traffic

In 2024, 5G networks will carry 25 percent of global mobile data traffic.

Monthly mobile data traffic per smartphone continues to increase in all regions, driven by improved device capabilities and more affordable data plans, as well as an increase in data-intensive content.

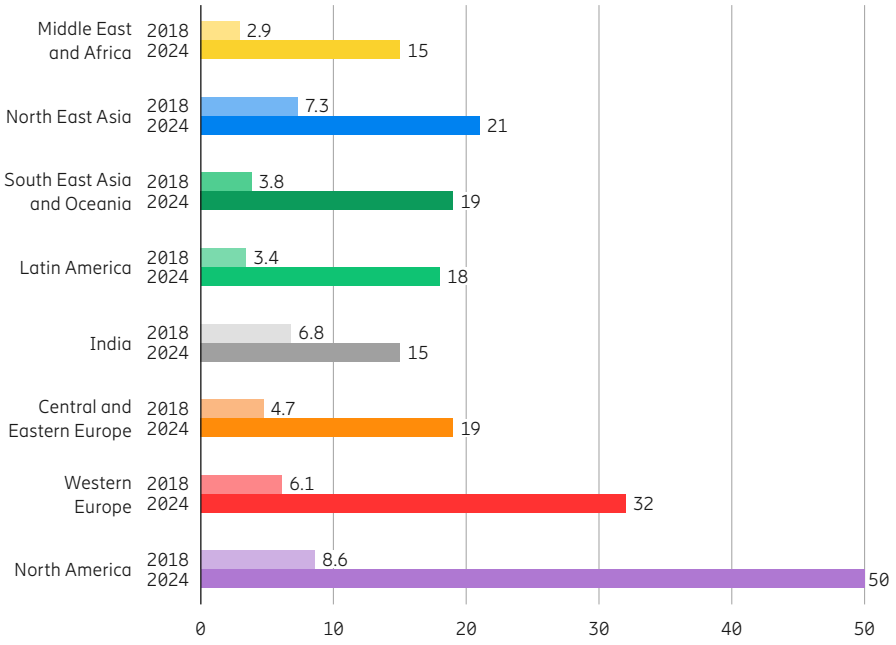
North America has the highest monthly usage, reaching 8.6 gigabytes (GB) at the end of 2018, and is set to reach 50GB by the end of 2024. In North East Asia, traffic per smartphone has grown strongly during 2018 – increasing by around 140 percent year-on-year. The region now has the second-highest monthly usage at 7.3GB and is projected to reach 21GB at the end of the forecast period. Attractive data plans as well as innovative mobile apps and content are driving growth in China.

Total mobile data traffic is expected to be higher by a factor of five

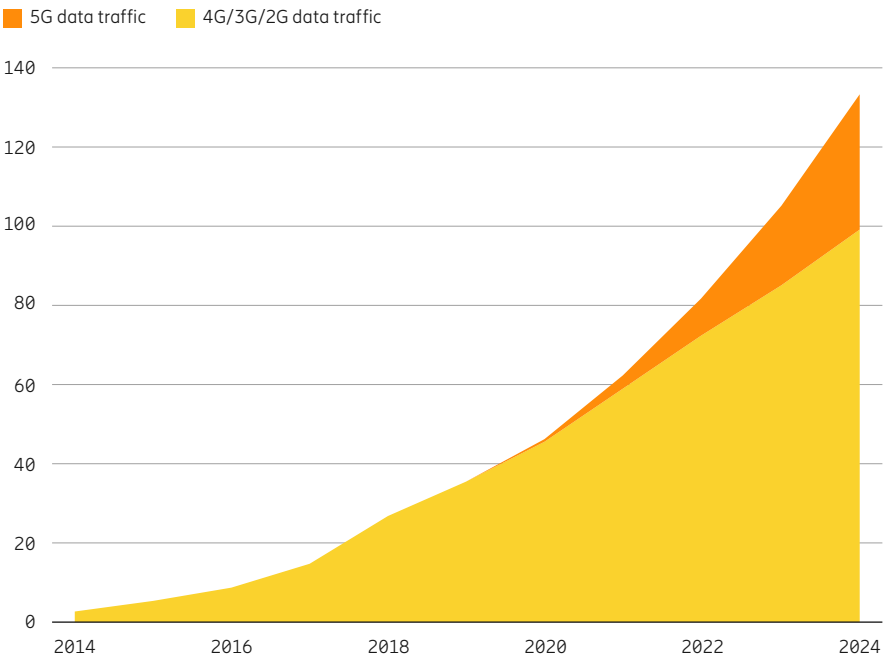
Close to 90 percent of total mobile data traffic is generated by smartphones today – a figure which is projected to reach 95 percent at the end of 2024. As monthly usage per smartphone continues to increase, total mobile data traffic is predicted to rise at a compound annual growth rate (CAGR) of 31 percent over the forecast period, reaching 136 exabytes (EB) per month by the end of 2024. It is expected that 25 percent of mobile data traffic worldwide will be carried by 5G networks at that time. This is 1.3 times more than the total traffic today.

Currently, the 5G traffic forecast does not include traffic generated by fixed wireless access (FWA) services. However, as FWA is one of the early use cases planned for 5G in some regions, it could have a significant impact on the forecast figures, depending on market uptake of the service.

Mobile data traffic per active smartphone (GB per month)



Global mobile data traffic (EB per month)



2019: the year that will put 5G on the map

5G is projected to cover more than 40 percent of the world's population in 2024.

2019 will be the year that 5G takes off
5G networks are currently being deployed in several regions worldwide and commercial launches are already taking place. One of the first 5G use cases will be fixed wireless access, as devices with form factors suitable for customer premises equipment will be early to the market, and will not have the stringent size, weight and power consumption requirements that come with smartphones.

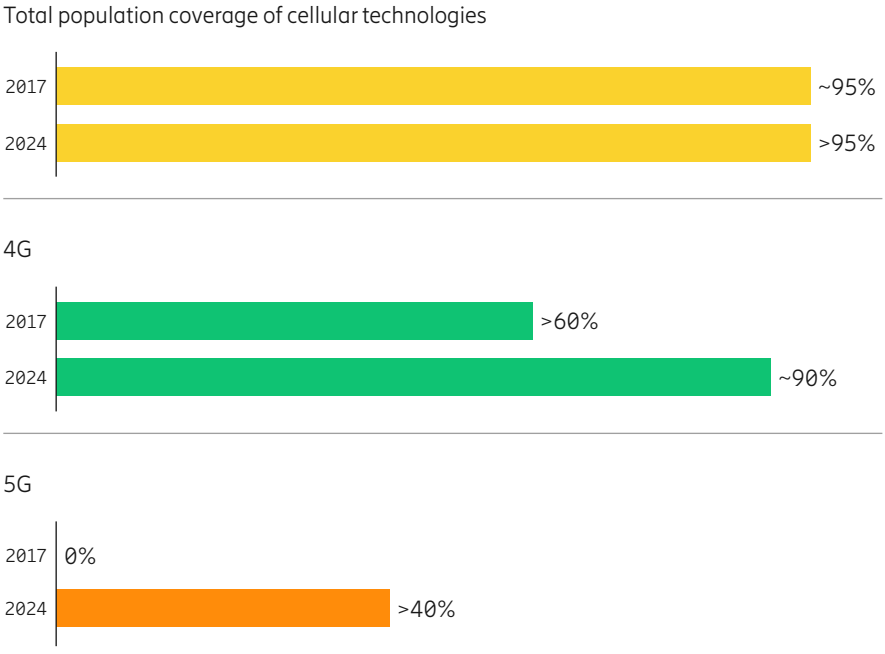
As 5G smartphones become available during 2019, several service providers are expected to commercially launch 5G. In North America and North East Asia, significant 5G subscription volumes are expected early.

5G population coverage build-out is expected to be faster than 4G
In terms of build-out and subscription uptake, 4G has been the fastest-deployed mobile communication technology to date. Initial 4G build-out was led by Western Europe, North America, Japan and South Korea. These areas, along with China, are expected to also lead the 5G population coverage build-out.

5G coverage build-out can be divided into three broad categories: radio deployments in new bands in the sub-6GHz range, deployments in millimeter wave frequency bands and deployments in existing 4G bands. Deployments in existing 4G bands can be rapidly upgraded to support 5G services in many networks by installing new software; for example, spectrum sharing between 4G and 5G in low to mid-bands.

More than 40 percent of the world's population is forecast to be covered by 5G in 2024.

World population coverage by technology[1]



[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

Internet of Things on the rise

The number of cellular IoT connections is expected to reach 4.1 billion in 2024 – increasing with a compound annual growth rate of 27 percent.

More advanced IoT use cases emerging
As the IoT application market is widening, more advanced use cases requiring enhanced network capabilities are emerging. Examples of such capabilities are support for optimized voice quality, more accurate device positioning and support for device mobility at high speed. Worldwide, service providers have announced the deployment of 85 cellular IoT networks using Cat-M1 and/or NB-IoT.[1] In both Europe and Asia, deployments of Cat-M1 have commenced, while NB-IoT is now also being deployed in North America, in addition to Cat-M1 technology. The technologies are being deployed to complement each other across regions worldwide.

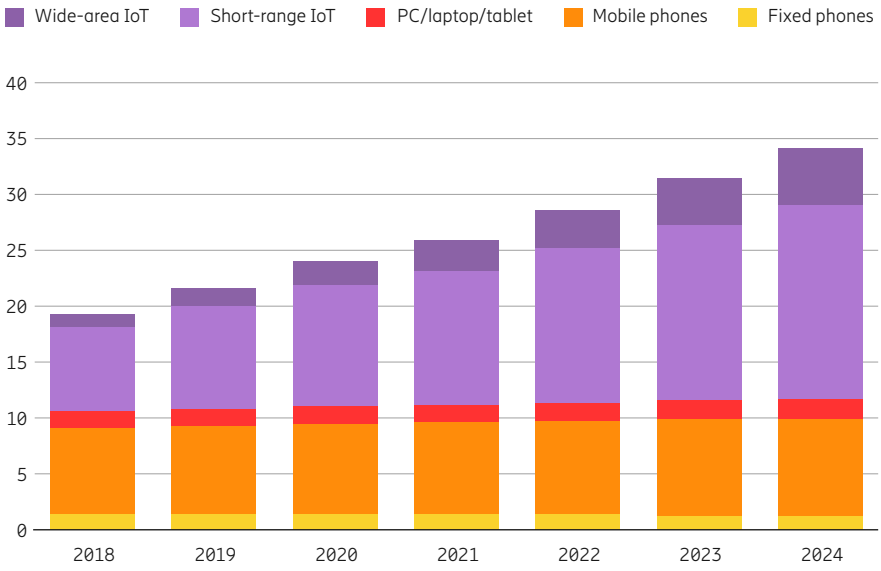
Large-scale deployments, and the resulting high-volume chipsets, are expected to continue to reduce chipset prices. This is leading to further acceleration of the growth in cellular IoT connections.

New IoT technologies driving cellular connections growth
There is an emerging trend toward communications service providers deploying one IoT network that supports both Cat-M1 and NB-IoT over a common LTE network. This enables them to address the diverse and evolving requirements across a wide range of use cases in different verticals, such as utilities, smart cities, logistics, agriculture, manufacturing and wearables.

Massive IoT cellular technologies such as NB-IoT and Cat-M1 are taking off and driving growth in the number of cellular IoT connections worldwide. Of the 4.1 billion cellular IoT connections forecast for 2024, North East Asia is anticipated to account for 2.7 billion – a figure reflecting both the ambitions and size of the cellular IoT market in this region.

These complementary technologies support diverse low-power wide-area (LPWA) use cases over the same underlying 4G network. The table below shows the IoT connections forecast, where the cellular IoT connections category is part of the wide-area IoT segment.

Connected devices (billion)



IoT connections (billion)

IoT	2018	2024	CAGR
Wide-area IoT	1.1	4.5	27%
Cellular IoT[2]	1.0	4.1	27%
Short-range IoT	7.5	17.8	15%
Total	**8.6**	**22.3**	**17%**

[1] GSA (October 2018)
[2] These figures are also included in the figures for wide-area IoT

Industries' expectations for 5G

5G will make an impact far beyond the consumer-based mobile broadband market.

Approximately 100 senior decision-makers from large companies globally across 10 key industries were interviewed.[1] They were selected for their focus on their company's 5G activities. Each respondent was presented with 12 to 15 use cases specific to their industry and was asked to pick the top 4 most important and pressing business-focused cases.

When asked which capabilities they thought will be critical to their business in the future, we uncovered interesting similarities. For example, the manufacturing, public transport, retail and agriculture industries all highlighted the ability to receive input from a large network of low-cost sensors, as well as the ability to accurately control remote equipment with no delay, to be important. Furthermore, across all sectors the respondents indicated that 5G technology will improve issues that center around data security, connectivity and process automation.

While companies are increasingly aware of how they will exploit advanced cellular technologies across their organizations, they still have a way to go to meet the challenges inherent in implementing new technology.

Based on the wide range of use cases over the 10 industries as outlined in the figure, 5G will make an impact far beyond the consumer-based mobile broadband market. While the consumer is well represented even here – in the media and entertainment, retail and financial services industries – the impact of 5G will be much deeper as more industry use cases are implemented.

Most important use cases according to industry decision-makers

Energy and utilities

- Connect and monitor remote sites, such as wind farms
- Distributed energy resource management
- Advanced Metering Infrastructure (AMI) and smart meters
- Integration sensors in micro grid and distributed generation

Public safety

- Quickly transfer more data and higher resolution imagery to/from first responders
- Multi-angle high resolution video streaming with smart analytics and alerts
- Real-time smart video surveillance
- Visor/helmet computer with augmented reality (AR) or virtual reality (VR)

Manufacturing

- Large network of sensors for predictive maintenance of machines/robots on the factory floor
- Cloud robotics (processing in the cloud for smaller, cheaper robots that can be centrally controlled and untethered in any environment)
- Identification and tracking of goods in the end-to-end value chain
- Remote quality inspection/ diagnostics with high-resolution/ 3D video or haptic feedback, thermal and other sensors

Healthcare

- Real-time mobile delivery of rich medical data sets
- Cloud robotics (processing in the cloud for smaller, cheaper robots that can be centrally controlled) for assisted living or rehabilitation
- Ambulance drones
- Smart objects, such as syringes, cabinets and beds

[1] Ericsson, "The Industry Impact of 5G: Insights from 10 sectors into the role of 5G" (2017), www.ericsson.com/en/networks/trending/insights-and-reports/industry-business-impact-of-5g

Media and entertainment

- Broadband to the home through high-density gigabit wireless fixed internet
- High-quality streaming to mobile devices
- Live personal 3D broadcast from mobile services
- 4K streaming to mobile devices

Automotive

- Better customer experience during the sales process, such as a mobile app with 4K, 360-degree images of vehicles
- VR/AR to assist or train service technicians
- Infotainment
- AR dashboards

Agriculture

- Autonomous vehicles performing tasks in the field, such as harvesting
- Predictive maintenance for farming equipment based on analysis of data from sensors
- In-field AR support for e-learning and expert advice in remote areas
- Optimize agriculture logistics chains with sensors, tracking and analytics

Public transport

- High-speed internet access on public transport
- Connected traffic cloud – aggregates and analyzes real-time data from connected vehicles, infrastructure and devices to assist operational decision making
- Real-time high-resolution vehicle video surveillance
- AR way-finding applications

Financial services

- Next-generation user-based insurance (sensors in connected cars, for example)
- High-security cloud-based services
- Real-time mobile trading
- Secure, remote sessions with financial advisors

Retail

- AR/VR shopping from anywhere
- AR/VR to visualize a product in a specific setting
- In-store AR-enabled customer care, with access to graphic-rich product information
- Automated warehouses

Making manufacturing wireless and smarter

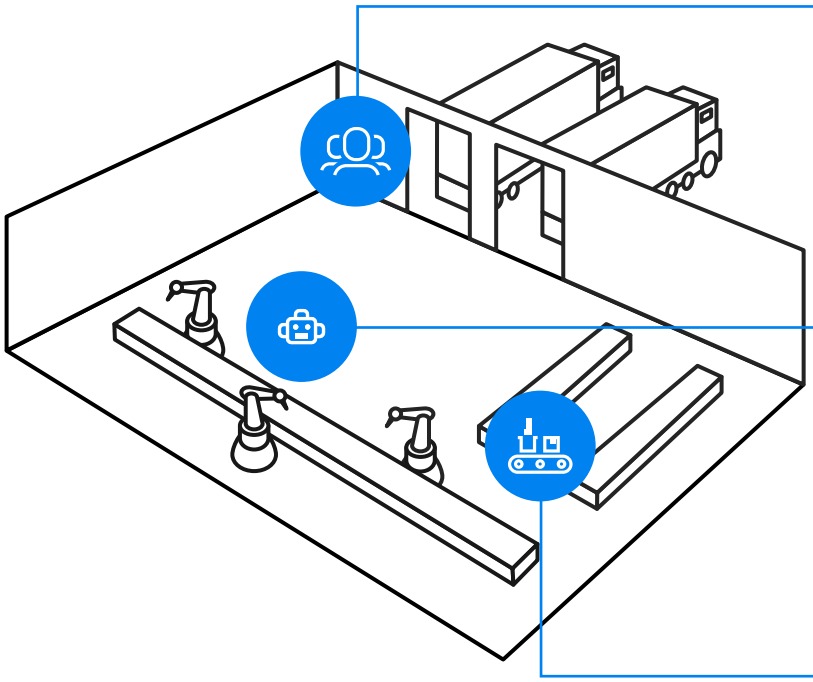
With the new cellular connectivity standards, almost every factory asset can be connected and managed to realize the benefits of smart manufacturing.

The traditional connectivity paradigm is being challenged by flexible production and wireless Industrial IoT (IIoT). Currently, production and most use cases in IIoT on manufacturing sites are based on wired connections. However, as the evolving cellular capabilities are challenging industrial ethernet solutions, wires will in many cases become redundant, introducing opportunities for more flexible production and faster line changes. The new 5G standard will further enable expansion of digital operations, addressing the challenges of manufacturing while exploiting the potential of Industry 4.0.

Realizing Industry 4.0 and unlocking value with cellular connectivity

To be competitive, manufacturers seek efficiencies in production and the ability to deliver a broader mix of customized products. This requires operational processes and production lines to be integrated and adaptable for fast configuration changes and reduced lead times, without compromising on safety or quality. But this is affected by limitations of present legacy network connectivity. Choice of connectivity determines the quality and flexibility of a manufacturer's digital foundation, as well as the possibilities and ultimately the operational value it will bring. It affects which equipment and operations can be connected, how many assets and processes can run simultaneously, and how well it scales beyond one geographical site.

Example of use cases enabled by cellular networks in a digital factory



Location use cases
- Asset management
- Warehouse management
- Workforce safety and utilization

Automation use cases
- Supply chain automation and assembly control
- Overview of entire production line and value chain processes for operational efficiency and quality
- Robot controller as cloud-based application
- Artificial intelligence automated quality testing
- Flexible production with cloud robotics

Monitoring use cases
- Remote plant monitoring
- Traffic management and route optimization (internal logistics, automated guided vehicles)
- Preventive and prescriptive maintenance
- Environmental compliance and regulations
- Workforce efficiency and manufacturing quality

Note: Based on articles published in Ericsson Mobility Report, June and November 2018

Connectivity with reach limited to the factory premises will not be sufficient to meet future operational challenges, as external flows and resource logistics also contribute to total cost and lead times of final products.

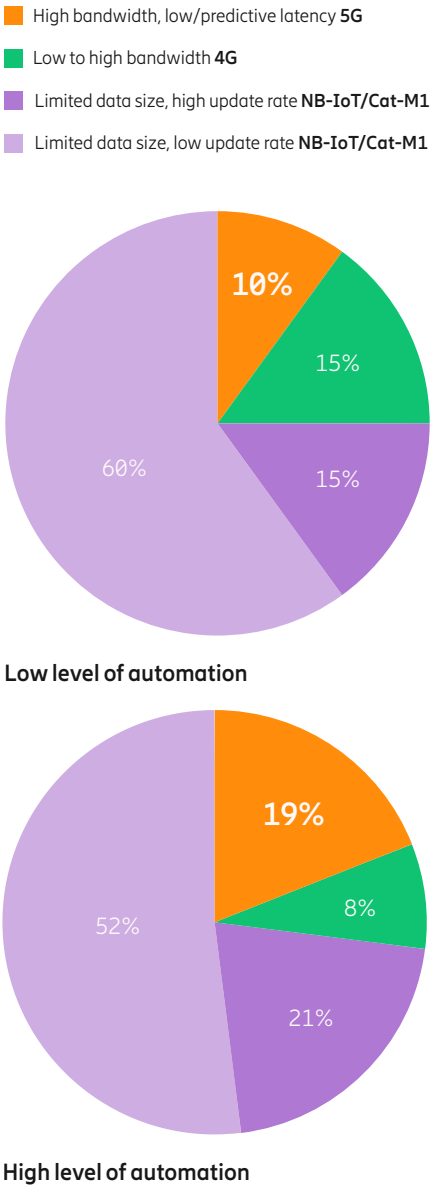
Cellular networks uniquely meet requirements to support different manufacturing use cases, locally and globally. Therefore, it is possible to securely and efficiently optimize all manufacturing variables within one communication system, connecting the factory with its surrounding ecosystem.

The connected factory and cellular use cases

As manufacturers seek to optimize utilization of every variable in production, the current connectivity paradigm is challenged. Today, most factories rely on fixed cabled networks to support critical and real-time applications for stationary machines and often complement with Wi-Fi to support non-critical (massive) applications like sensors and handheld tools. In both cases, scaling and expanding connected operations is difficult, as wires are very costly to install, maintain and retrofit, and Wi-Fi cannot sustain high network performance.

Variables cannot be managed with only a fixed cabled network, as a manufacturing site includes rotating, moving machines and portable items like tools, materials, phones and tablets. By connecting infrastructure, equipment and workers on one platform, cellular technology can be used to maximize data collection and provide actionable insights from different workflow processes. Operational challenges are addressed by three main use case categories (see the figure on the previous page).

Estimated share of different types of connected devices required to support use cases at a typical smart manufacturing site



To realize these, highly diverse assets must be connected on a large scale through a cost-effective and automated onboarding process, plus effective management of the network to secure all use cases. The characteristics of cellular networks make this possible.

Growing device, data and network demands

By 2024, the number of cellular Internet of Things (IoT) connections is forecast to reach 4.1 billion worldwide. Digitization of factory assets, equipment, vehicles and processes means the number of connected devices will increase exponentially. The estimated number of connected devices needed in a typical smart factory is 0.5 per square meter.[1] This calculation is based on potential use cases and assets benefitting from a connection.

The figure to the left illustrates distribution of cellular connectivity requirements (supporting the previously mentioned use cases) in a fully deployed smart factory. The share of each type of connected device[2] depends on whether the site has low- or high-level automation.[3] Evolving to higher automation will lead to a greater share of 5G connected devices. Both high bandwidth and consistently low latency are necessary to support large data volumes and real-time critical data, as well as consistent and secure communication.

[1] Average number based on data from different manufacturing sites. In dense areas, the connection density could be up to one connected device per square meter

[2] The exact distribution figures for a specific manufacturing site depends on the communication needs

[3] The level of automation is a continuum from manual to fully automatic operations (Parasuraman et al., 2000)

Bridging the gap between factory challenges and cellular capabilities

Eventually the installed fixed network technologies will be incapable of managing effectively the use case requirements in advanced manufacturing. Identifying and mitigating factory pain points with cellular network capabilities will more than offset the switching costs, proving the new networks' practical and business value.

Manufacturers will gradually adopt supportive applications to increase efficiency and quality in their activities, from augmented reality (AR) to digital twins. As an example, in Ericsson's factory in Estonia, inspection of assets and products with contextual information (AR) has resulted in consistently improved product quality with reduced lead time and cost.

Cellular networks have superior capabilities in, for example, mobility, security, availability and reliability. However, there is currently a disconnect between three perspectives among manufacturers: understanding cellular capabilities; the different digital solutions they enable; and how these solutions address manufacturers' pain points. The figure above starts with the manufacturing perspective, illustrating typical factory pain points. It then gives examples of digital solutions, use case categories and enabling cellular capabilities.[4]

Processes benefit from cellular capabilities, supporting Industry 4.0

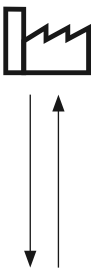
With expected growth in demand for digital twins, and automated, customized, remote and even mobile production, the need for supporting cellular network capabilities will increase. Examples include:

- processes requiring mobility, such as shop floors with automated vehicles and assembly warehouses, which need secure and precise management as well as tracking of traffic, data flows and assets
- low-volume and high-variance manufacturing cases, where wireless machine line configuration is simple and flexible compared to cabled machine lines
- processes that cannot be monitored and controlled via cables but require wireless, real-time critical data transmission and a stable, deterministic network performance (bandwidth and latency) to operate
- processes susceptible to human error, or advanced manufacturing that requires tacit knowledge and skills transfer, with widespread digital tools to mitigate for errors and encourage faster learning
- processes where coordination of factories, resources and components is time-sensitive or crucial (e.g. product quality and timely delivery)

Manufacturing companies that exploit the full value of cellular networks' capabilities beyond a single manufacturing site can also explore increased internal and external collaboration and create tighter ecosystems with partners, stakeholders and customers for optimized manufacturing, and increasingly customized products.

The future connected manufacturing industry

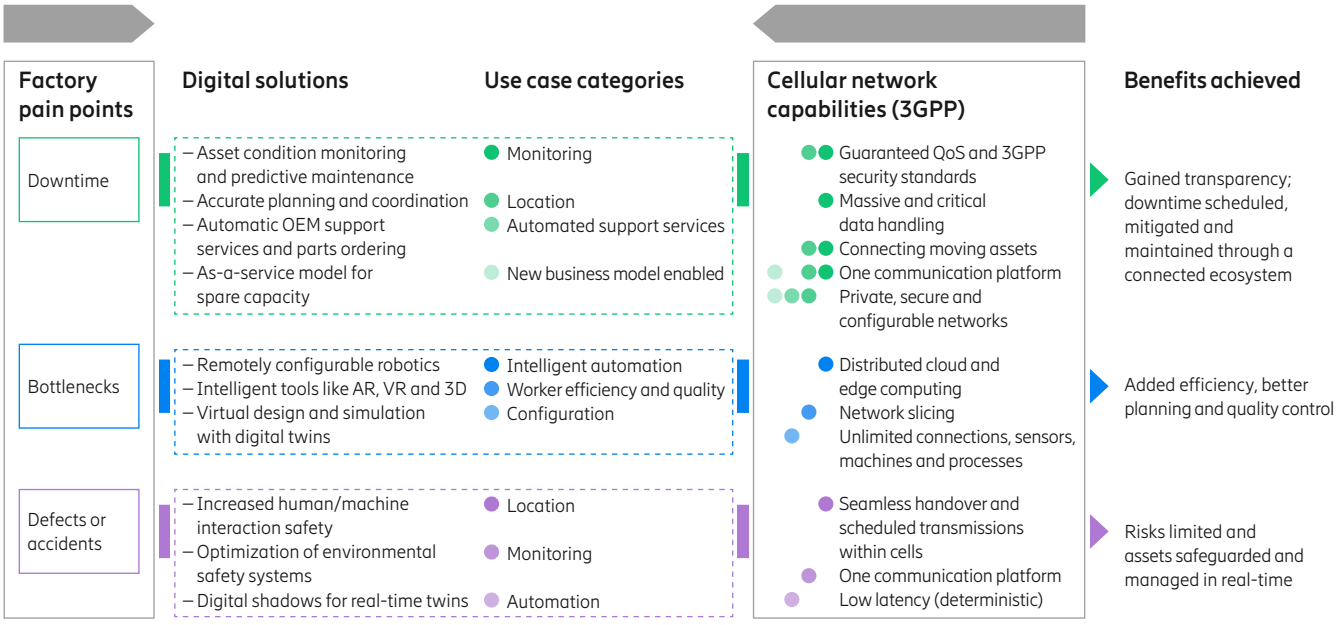
Connected flows
The factory is integrated with wider networks, other factories and logistics.
- Logistics securely tracked throughout manufacturing process
- Awareness of precise location of vehicles



Connected site
The factory floor is a highly specialized environment with diverse needs.
- Extreme reliability and low latency
- Secure, high reliability, high availability network

Globally connected company and products
The factory-shipped, installed and delivered goods are globally connected and serviced.
- New forms of customer engagement
- New services and partner ecosystems enabled

Bridging the gap: linking factory pain points to cellular capabilities



[4] A complete mapping of the solutions needed to address the pain points is substantial and complex. Accordingly, the mentioned actions and enablers are just some highlighted examples

Enabling internet for all

Over 40 percent of the world's population lacks broadband internet access. The most cost-efficient way to bring people online is to leverage existing mobile network infrastructure.

Digitalization is a fundamental means to achieve the United Nations Sustainable Development Goals (SDGs).

The 2030 Agenda for Sustainable Development, containing the 17 SDGs, was adopted in September 2015 by all United Nations member states. Digitalization by leveraging existing and widely deployed technologies, such as mobile broadband, will play a vital role in achieving this. Through continued network upgrades and deployments, along with government-funded international development, service providers can help accelerate global digitalization and the fulfillment of Agenda 2030.

Globally, the main way of accessing the internet is through mobile networks and a mobile device; however, more than 40 percent of the world's population still has no broadband internet access. Most of this population lives in locations with mobile broadband coverage but has no mobile broadband device or is not using internet due to issues including illiteracy, very young age, disinterest and affordability. However, lack of mobile broadband coverage is also a substantial barrier to internet access for many. An overwhelming majority of the population without internet access lives in developing countries. Internet access is a fundamental enabler for economic growth and a critical factor in fulfilling the SDGs. Recent research[1] shows there is a significant effect from mobile broadband on macroeconomic development in terms of gross domestic product (GDP), both when mobile broadband is first introduced, and gradually as it diffuses throughout different economies. On average, a 10 percent increase in mobile broadband penetration causes a 0.8 percent increase in GDP.[2]

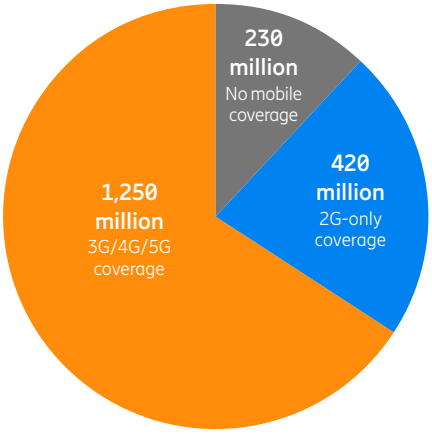
Through selective investment in mature mobile broadband technologies, communications service providers can sustainably expand coverage by upgrading existing 2G (GSM) sites, as well as targeting uncovered areas with new 4G (LTE) and 5G deployments.

Despite strong growth, 1.9 billion people still expected to have no mobile broadband connection by 2024

At the end of 2018, around 4.3 billion subscribers out of the world's total population of 7.6 billion had internet access via mobile broadband technology. It is forecast that an additional 1.9 billion subscribers will have mobile broadband internet access by 2024.

However, this means there will still be around 1.9 billion people[3] without a mobile broadband connection by 2024. Of those, 1.2 billion will be within a mobile broadband coverage area but will have no subscription to such a service.

Estimated number of people without a mobile broadband connection in 2024



1/4

One-quarter (1.9 billion) of the world´s population will still not have a mobile broadband connection in 2024.

Note: Update of an article published in Ericsson Mobility Report, June 2017

[1] Edquist, Harald; Goodridge, Peter; Haskel, Jonathan; Li, Xuan; and Lindquist, Edward (2018), "How important are mobile broadband networks for the global economic development?", Information Economics and Policy, vol. 45, pp. 16–29: https://www.sciencedirect.com/science/article/pii/S0167624517301695

[2] The economic effect gradually decreases over time

[3] According to UN world population estimates, there will be 700 million people under the age of 5 in 2024. Most of these are assumed not to have a mobile broadband connection

Connecting the unconnected

As more radio base stations are deployed, the world's mobile network population coverage[4] continues to increase. At the current trajectory, mobile broadband will provide network coverage to around 92 percent of the world's population by 2024. But to address the very low average revenue per user (ARPU) customer segments, network coverage expansion requires cost-efficient solutions, enabling positive business cases for communications service providers. Service providers, vendors, governments, regulators and international organizations must continue to address digital development and enable internet access for the unconnected. Amongst other areas, cost/benefit-based business models, encouragement of local application services and ICT literacy development are of importance. In this context, international development organizations' role is vital to develop financial ecosystems and enable the expansion of digitalization to connect the unconnected.

Mobile broadband network upgrades and deployment scenarios

The majority of those connected to the internet are 3G and 4G subscribers on mobile broadband networks. Many subscribers remain on 2G, which provides significant value to everyday life – including the possibility to use basic data services – but does not offer the full benefits of mobile broadband, or access to a wider range of services.

In areas with existing 2G coverage, upgrading the sites to 3G, 4G or 5G New Radio (NR) will provide mobile broadband network coverage. This would require a low incremental investment as most of the costly items – including towers, power, security and backhaul – are already available at the existing site.

In areas with moderate traffic demands, service providers can cover significantly larger geographical areas with mobile broadband solutions designed for cost-efficient coverage, based on traffic predictions indicating the best sites for expansion.

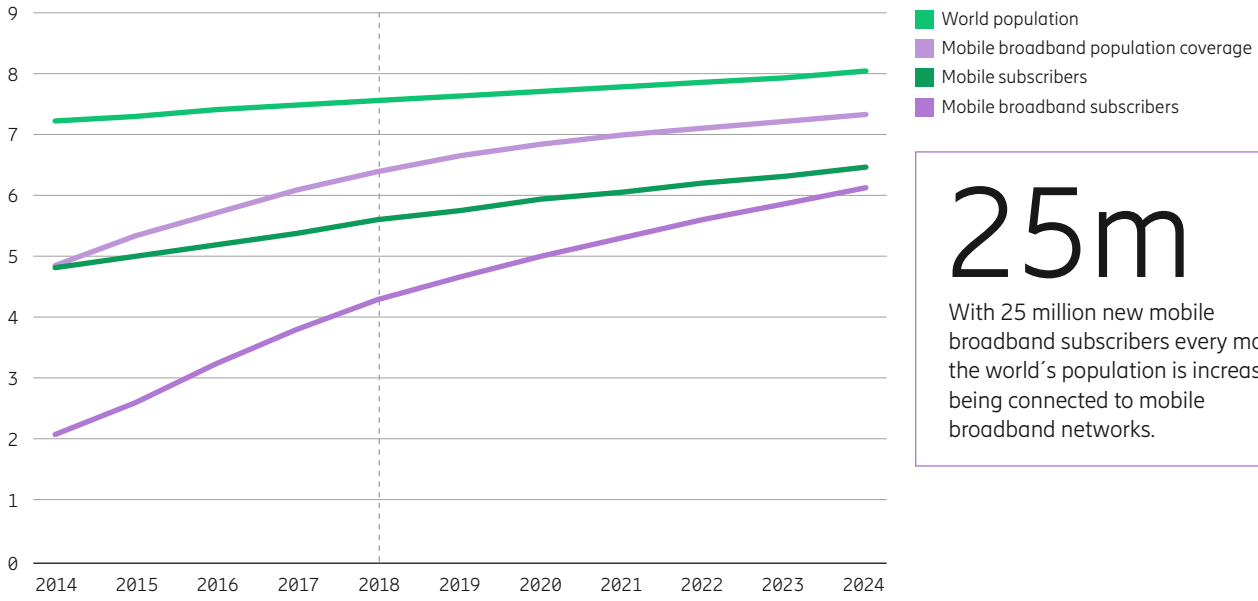
Upgrading existing 2G sites to 3G or 4G operating at low bands is possible on the existing network grid, and there is potential to utilize larger antennas and beamforming to increase 4G coverage and capacity even further. Today, there are hundreds of thousands of legacy 2G sites suitable for a cost-efficient 3G/4G technology upgrade.

5G NR for rural broadband

Upgrading sites with 5G technology will also be feasible. 5G NR can be configured to perform better or on a par with 4G, even in rural scenarios. For example, combining 5G NR 3.5GHz and LTE 800MHz on a 2G grid can provide vastly superior capacity compared to a 4G standalone network. When used together in an effective way, the high band offloads the traffic from lower band, resulting in significantly improved coverage as well as capacity. On an existing 2G grid it is possible to reach downlink data rates exceeding 100Mbps at cell edge with 5G NR using conventional terminals and normal base station equipment. By enhancing the network and terminal hardware, more than 350Mbps in the downlink and more than 30Mbps in the uplink can be achieved.

International development organizations' involvement is vital to connect the unconnected.

Mobile broadband networks – population coverage and subscribers (billion)



25m

With 25 million new mobile broadband subscribers every month, the world´s population is increasingly being connected to mobile broadband networks.

[4] Population coverage is here displayed as the population that has sufficient radio signal to connect to a mobile network. The ability to connect to the network is subject to factors such as access to devices and subscriptions

Providing mobile broadband coverage in remote rural areas
Imagine a scenario where several villages have access to 2G coverage and others are outside any mobile coverage. Extending mobile broadband coverage to populations that reside outside any existing mobile coverage area is more challenging, as they are typically spread over large areas in different, mostly rural locations, without any reliant power infrastructure. Different solutions to provide mobile broadband coverage can be applied in those cases.

Areas within existing 2G coverage area:
These areas can easily be provided with mobile broadband coverage by site upgrade to 3G, 4G or 5G. Comparing 2G cell coverage with 3G or 4G on the same frequency band, a doubling of the cell range could be achieved.[5] Using 4G with beamforming has the potential to double this extended cell range again, i.e. achieving a fourfold extension[6] compared to the base case with 2G.

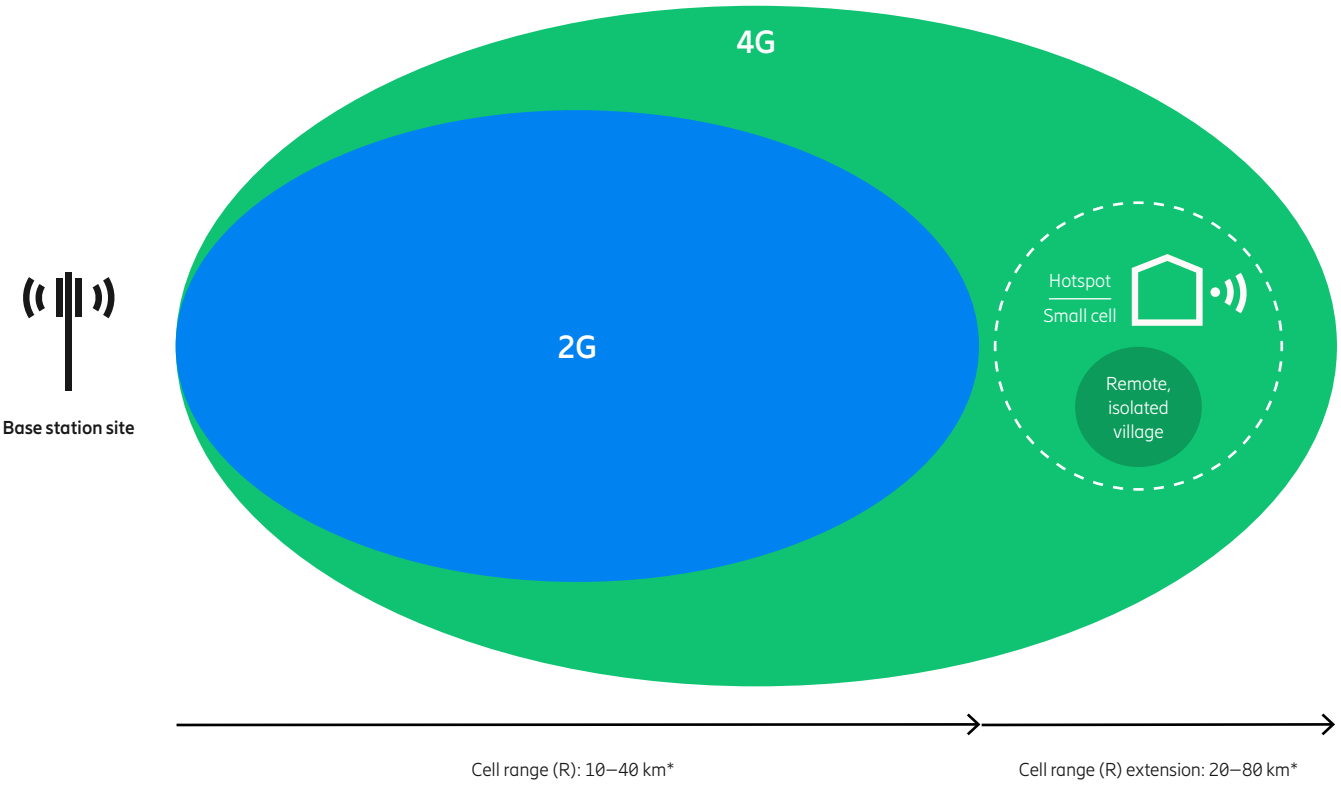
Areas outside existing 2G coverage area:
For important hotspots in, for example, a village, such as schools or a healthcare clinic, an outdoor high-gain antenna can be used to provide broadband access to the premises (fixed wireless). This solution requires low investment and the 4G site can serve a hotspot that is located 20–80km outside the 2G coverage range. An alternative solution could be to install a small cell network utilizing microwave or satellite as a backhaul solution.

> Mobile broadband technology to connect the unconnected is an enabler for digitalization.

Deploying scalable mobile broadband technologies to achieve Agenda 2030 goals
By deploying cost-effective mobile coverage solutions, it is possible to connect low-income subscriber groups with low-cost, energy-efficient solutions where needed, in presently uncovered areas. The technology is scalable as the demand for performance grows, providing economies of scale decreasing the cost per unit of output. Furthermore, by addressing affordability, digital literacy skills and local applications in languages that users understand, the uptake of people utilizing the internet through mobile broadband services can further expand.

Mobile broadband technology to connect the unconnected is an enabler for digitalization, playing a fundamental role in achieving the UN sustainability development goals. Service providers' continued business case-driven network upgrades and deployments, as well as deployments in conjunction with government funding and international development, to connect the unconnected is a means to accelerate global digitalization and the fulfillment of Agenda 2030.

Example of solutions for providing mobile broadband coverage in remote rural areas



* Depending on area and base station height

[5] Assuming free-space propagation loss
[6] Calculation based on using eight antenna elements

Connecting things in the city

Cities are embracing a wide range of Internet of Things (IoT) services, and for many of these services deep indoor connectivity is a requirement.

Simulation of a realistic large-scale IoT service scenario in a city showed that up to 99 percent of devices located deep indoors could be reached with new cellular IoT technologies.

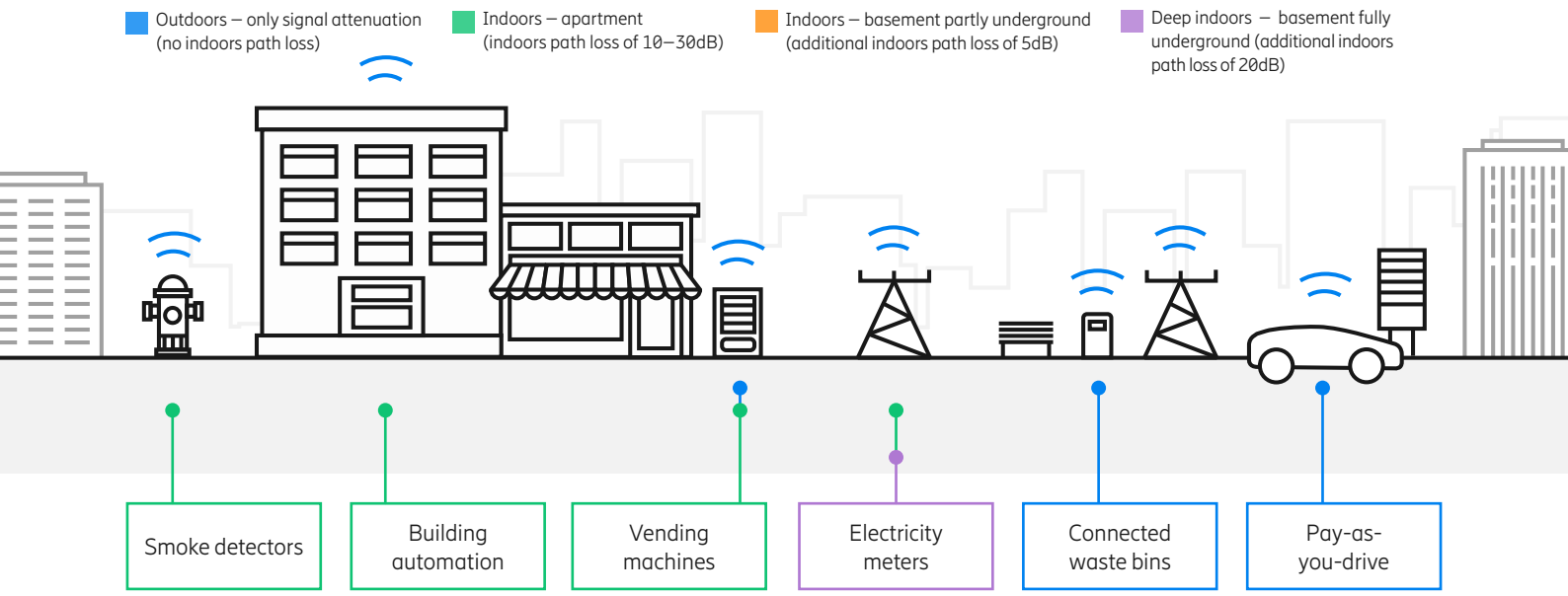
Cellular networks are well-suited to providing connectivity for emerging IoT applications due to their ubiquitous deployments, as well as their inherent characteristics, which include security and reliability. Currently, cellular networks' main role is to provide mobile broadband coverage. Connectivity for IoT devices poses new coverage challenges for various use cases. The 3GPP Low-Power Wide-Area (LPWA) cellular technologies, Cat-M1 and NB-IoT, supporting a wide range of low cost devices, can be deployed on existing LTE (4G) networks to overcome these challenges. Both technologies are currently being deployed worldwide, enabling a range of new IoT services.

IoT technologies supporting diverse use cases

Cat-M1 is designed to support a wide range of IoT applications, including connected waste bins, alarms incorporating emergency voice assistance and fleet management. Cat-M1 provides theoretical peak uplink data throughput of around 1Mbps. However, there is a compromise between data throughput and coverage: the lower the bitrate the application requires, the further the coverage is extended for the application. The minimum connectivity target has been set to a maximum coupling loss (MCL)[1] of 160dB where the achievable uplink data rate is around 1Kbps.[2] This can be compared to an MCL of 144dB for broadband LTE with up to 1Mbps in downlink and a few 10s of Kbps in uplink.

NB-IoT is a narrowband solution designed to provide even better coverage and enables deployment of devices with an even lower cost than Cat-M1. It targets ultra-low-throughput IoT applications, such as smoke detectors and utility meters. The minimum connectivity target has been set to an MCL of 164dB where the achievable uplink data rate is around 300–400bps.[3] Both technologies support the IoT use cases exemplified in the figure below.

IoT connected devices in a city scenario[4]



Note: Update of an article published in Ericsson Mobility Report, June 2017

[1] Maximum coupling loss (MCL): Coupling loss is a measure of the attenuation of the radio signal between the transmitter and receiver. MCL is the largest attenuation the system can support with a defined level of service. This can also be used to define the coverage of the service

[2] An MCL of 159.7dB is a 3GPP target that has been evaluated and exceeded by the industry. See also industry white paper "Coverage Analysis of LTE-M Category-M1, Version 1.0, January 2017"

[3] An MCL of 164dB is a 3GPP target that has been evaluated and exceeded by the industry

Percentage of devices reached in the IoT city scenario

	800MHz band			2.6GHz band		
	LTE MBB (144dB)	Cat-M1 (160dB)	NB-IoT (164dB)	LTE MBB (144dB)	Cat-M1 (160dB)	NB-IoT (164dB)
Outdoors	100	100	100	100	100	100
Indoors – apartment	100	100	100	97	100	100
Indoors – basement partly underground	99	100	100	83	99	99
Deep indoors – basement fully underground	77	99	99	32	86	92

Network coverage for IoT applications in a city

Network coverage for IoT applications with limited demands on throughput, such as metering and monitoring use cases in a metropolitan area, was analyzed. Measurements from a commercially deployed LTE network[5] for broadband services were used to calibrate a model for simulating broadband LTE, Cat-M1 and NB-IoT coverage. A three-dimensional model of a city was used, with close to 1,000 buildings per square kilometer with an average of 5 floors per building. Both line-of-sight and non-line-of-sight characteristics, including outdoor-to-indoor and indoor radio propagation models, were considered. Typical radio base station site characteristics were assumed, with inter-site distances of approximately 500 meters.

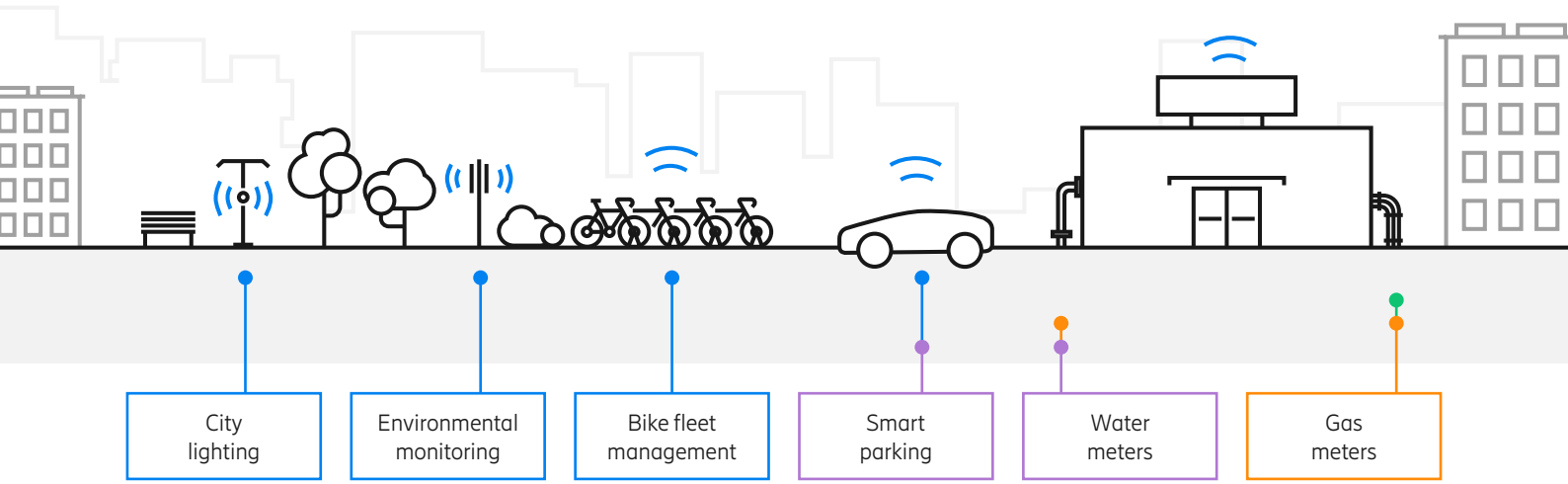
IoT devices, with a density of around 20,000 per square kilometer, were uniformly distributed across the city, both outdoors and indoors, and corresponding signal strength attributed to the different environments. For example, basements located partly underground were modelled with an additional path loss[6] of 5dB in addition to the signal attenuation indoors (10–30dB) and those fully underground (deep indoors) with 20dB.

The coverage was simulated for an IoT application on broadband LTE, Cat-M1 and NB-IoT. The same cell layout was used to calculate coverage for each technology. Network coverage was analyzed in two frequency bands: one lower band (800MHz) that has the advantage of stronger signal propagation for further coverage, and one higher band (2.6GHz) offering greater capacity. The table above shows the percentage of devices reached for each technology.

Extending the LTE coverage for IoT applications

The 800MHz band modelling showed that in challenging radio signal propagation environments, such as deep indoors, both Cat-M1 and NB-IoT can reach up to 99 percent of devices. This can be compared to broadband LTE, which would reach 77 percent of mobile broadband devices. In the 2.6GHz capacity band, the coverage of both Cat-M1 and NB-IoT is also substantially better than the broadband LTE coverage of only 32 percent.

Coverage is enhanced for low-data-rate IoT devices by reducing the data rate to provide additional coverage. With 3GPP targets already exceeded in evaluations, the enhancements will enable IoT city deployments with up to 99 percent coverage of devices using cellular networks for connectivity.



[4] In this city scenario, only IoT services with limited demands on throughput, such as metering and monitoring use cases, are included. IoT services with stringent requirements on availability, reliability, delay and higher demand on throughput, for example traffic safety, automated vehicles and industrial applications, are also expected to be deployed in city environments

[5] Mobile network of a major European operator in a metropolitan area

[6] Path loss is the signal decrease that occurs as the radio waves travel through the air or through obstacles

The need for 5G spectrum harmonization

Licensing of the right spectrum in sufficient amounts is fundamental to build momentum for 5G services.

Significant efforts are still needed to align allocations between countries to secure the right spectrum. This is an urgent matter, as 5G networks are already being deployed in new frequency bands. Alignment is crucial for the economics of the emerging 5G ecosystem, as it directly affects costs of devices and infrastructure.

Mobile data traffic is projected to increase by around five times over the next six years.

Advanced 5G services are expected to provide significantly higher peak data rates and capacity at very high quality, requiring spectrum resources to be allocated in very wide bandwidths. Aggregate bandwidth of 10GHz to 15GHz or more (implemented over time) will need to be allocated, requiring gigahertz-wide channel blocks in bands in the 24.25GHz to 86GHz range. Resolving the coverage-capacity challenge also requires access to spectrum resources in both the mid- and low bands.

The 5G spectrum bands

As radio wave propagation properties differ by spectrum band, it will be important to secure a combination of bands to meet the coverage, quality and capacity requirements.

There are a number of bands already in use by service providers for earlier access technology generations that are expected to be shared with 5G. In general, all current 3GPP bands including low and mid-bands are being considered for 5G services now or in the future.

Combinations of these bands will be central to delivering 5G coverage and capacity for enhanced mobile broadband, IoT, industrial automation and mission-critical business cases, as well as for Public Protection and Disaster Relief (PPDR) services.

ITU and the World Radiocommunication Conferences (WRC-15 and WRC-19)

For 5G services to meet the demands on data speeds and capacities, ITU member states will need to agree on enough spectrum bandwidth in the right bands with the right conditions. (Conditions include requirements of use within a specific frequency band, e.g. the radio signal characteristics.)

At WRC-19 (November 2019) the member states of the ITU are expected to agree on new 5G spectrum allocations within the high bands (agenda item 1.13 concerning the 24.25GHz to 86GHz range). These are often referred to as the "millimeter wave" (mmWave) bands and are central to supporting a wide range of new industry applications using 5G New Radio (NR) technology specified by the 3GPP industry organization. 3GPP is also studying the use of the 6.5GHz band (5925MHz to 7125MHz) for 5G services.

The 5G spectrum bands

Low

Below 1GHz

Low bands provide favorable radio wave propagation characteristics – useful for coverage in remote areas and into buildings.

Mid

Between 1GHz and 6GHz

Mid-bands are particularly beneficial as they offer a favorable "middle ground" between propagation characteristics (coverage) and bandwidth (capacity). Mid-bands within the 3.3GHz to 5GHz range should be made available in 2019 to 2020.

High

From 24.25GHz to 86GHz

High bands have wide bandwidths essential to serve rapidly growing traffic demands. The high bands expected to be deployed early for 5G include the 26GHz, 28GHz, 37GHz and 39GHz bands.

Note: Update of an article published in Ericsson Mobility Report, June 2018

Early deployments
Many countries have taken actions to allocate certain bands – both before WRC-19 and outside the scope of the WRC-19 agenda item 1.13. They are taking steps toward commercial 5G NR, focusing on 26.5GHz to 29.5GHz (the 28GHz band). This has allowed for quicker deployments of 5G services but also requires dedicated efforts to harmonize the allocations between those countries.
Examples include:

- In the US, the Federal Communications Commission (FCC) has adopted regulations governing mobile use in the 28GHz range (suggesting that satellite use will be secondary). The 37GHz and 39GHz bands are also being prepared for early use.
- South Korea has carried out a successful pre-commercial 5G trial using the range 26.5GHz to 29.5GHz during the Pyeongchang 2018 winter sports event. This activity was followed by a spectrum auction and commercial deployment by all service providers using the 28GHz band.
- Japan will be deploying commercial 5G networks well before the 2020 summer sports event in Tokyo. In addition, large-scale pre-commercial field trials are taking place within the 3.7GHz, 4.5GHz and 28GHz frequency ranges.
- Regulators in Europe and China aim to deploy commercial 5G networks in the 26GHz range by 2020. In addition, they have expressed interest in subsequent deployments in the 42GHz range.
- India is considering the range 24.5GHz to 29.5GHz (26GHz and 28 GHz) for commercial 5G networks, as well as the bands 37GHz, 39GHz and 42GHz.

Local licenses for private networks
A number of countries are considering awarding (or enabling service providers to lease) spectrum for local use. Countries wishing to make spectrum available to entities on a more local basis could limit those allocations to real-estate defined areas, such as factories. This is a national decision and it is still unclear if and how countries will realize possible allocations for private mobile networks.

Realizing the full potential of 5G deployments
To realize the full potential of early terrestrial 5G network deployments and meet growing demands on network performance, significant efforts are required worldwide to reassign spectrum from underutilized applications to 5G services. This process will be most beneficial to service providers, industries and consumers if:

- enough bandwidth to meet 5G access performance demands is awarded
- appropriate regulatory conditions for spectrum use and coexistence are applied
- internationally harmonized high-band arrangements are applied

National licensing of the right spectrum, in sufficient amounts, to terrestrial mobile broadband providers is fundamental to initiate and build momentum for 5G service deployments to support society, national markets and consumers.

Methodology

Forecast methodology
Ericsson makes forecasts on a regular basis to support internal decisions and planning, as well as market communication. The forecast time horizon in the Mobility Report is six years and is moved forward one year in the November report each year. The subscription and traffic forecast baseline in this report uses historical data from various sources, validated with Ericsson internal data, including measurements in customer networks. Future developments are estimated based on macroeconomic trends, user trends, market maturity and technological advances. Other sources include industry analyst reports, 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
Mobile subscriptions include all mobile technologies. Subscriptions are defined by the most advanced technology that the mobile phone and network are capable of. Our mobile subscriptions by technology findings divide subscriptions according to the highest-enabled technology they can be used for. LTE subscriptions, in most cases, also include the possibility for the subscription to access 3G (WCDMA/HSPA) and 2G (GSM or CDMA in some markets) networks. A 5G subscription is counted as such when associated with a device that supports New Radio as specified in 3GPP Release 15, and connected to a 5G-enabled network.

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

Rounding of figures
As figures are rounded, summing up data may result in slight differences from the actual totals. In the key figures tables, subscriptions have been rounded to the nearest 10th of a million. However, when used in highlights in the articles, subscriptions are usually expressed in full billions or to one decimal place. Compound annual growth rate (CAGR) is calculated on the underlying, unrounded numbers and is then rounded to the nearest full percentage figure. Traffic volumes are expressed in two or three significant figures.

Subscribers
There is a large difference between the numbers of subscriptions and subscribers. This is because many subscribers have several subscriptions. Reasons for this could include users lowering traffic costs by using optimized subscriptions for different types of calls, maximizing coverage and having different subscriptions for mobile PCs/tablets and mobile phones. In addition, it takes time before inactive subscriptions are removed from operator databases. Consequently, subscription penetration can be above 100 percent, which is the case in many countries today. However, in some developing regions, it is common for several people to share one subscription, for example via a family- or community-shared phone.

Mobile data traffic
Ericsson regularly performs traffic measurements in over 100 live networks covering all major regions of the world. These measurements form a representative base for calculating worldwide total mobile traffic. More detailed measurements are made in a selected number of commercial WCDMA/HSPA and LTE networks with the purpose of understanding how mobile data traffic evolves. No subscriber data is included in these measurements.

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.

Population coverage
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), together 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)

4K: In video, a horizontal display resolution of approximately 4,000 pixels. A resolution of 3840 × 2160 (4K UHD) is used in television and consumer media. In the movie projection industry, 4096 × 2160 (DCI 4K) is dominant

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

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

AR: Augmented reality. An interactive experience of a real-world environment whereby the objects that reside in the real world are "augmented" by computer-generated perceptual information

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

EB: Exabyte, 10^{18} bytes

EDGE: Enhanced Data Rates for Global Evolution

EPC: Evolved Packet Core

FDD: Frequency Division Duplex

GB: Gigabyte, 10^{9} bytes

Gbps: Gigabits per second

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

GSA: Global mobile Suppliers Association

GSM: Global System for Mobile Communications

GSMA: GSM Association

HSPA: High Speed Packet Access

IMS: IP Multimedia Subsystem

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

mmWave: Millimeter waves are radio frequency waves in the extremely high frequency range (30–300GHz) with wavelengths between 10mm and 1mm. In a 5G context, millimeter waves refer to frequencies between 24 and 71GHz (the two frequency ranges 26GHz and 28GHz are included in millimeter range by convention)

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

Short-range IoT: Segment that 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

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

WCDMA: Wideband Code Division Multiple Access

Wide-area IoT: Segment made up of devices using cellular connections or unlicensed low-power technologies like Sigfox and LoRa

Global and regional key figures

Ericsson Mobility Visualizer
Explore actual and forecast data from the Mobility Report in our new interactive web application. It contains a range of data types, including mobile subscriptions, mobile broadband subscriptions, mobile data traffic, traffic per application type, VoLTE statistics, monthly data usage per device and an IoT connected device forecast. Data can be exported and charts generated for publication subject to the inclusion of an Ericsson source attribution.

Find out more
Scan the QR code, or visit
www.ericsson.com/mobility-report/mobility-visualizer

Global key figures

Mobile subscriptions	2017	2018	Forecast 2024	CAGR** 2018–2024	Unit
Worldwide mobile subscriptions	7,720	7,980	8,920	2%	million
– Smartphone subscriptions	4,350	5,010	7,210	6%	million
– Mobile PC, tablet and mobile router subscriptions	250	260	330	4%	million
– Mobile broadband subscriptions	5,250	5,930	8,420	6%	million
– Mobile subscriptions, GSM/EDGE-only (2G)	2,410	2,000	470	-21%	million
– Mobile subscriptions, WCDMA/HSPA (3G)	2,330	2,270	1,480	-7%	million
– Mobile subscriptions, LTE (4G)	2,750	3,580	5,440	7%	million
– Mobile subscriptions, 5G			1,500		million
Mobile data traffic*					
– Data traffic per smartphone	3.4	5.6	21	24%	GB/month
– Data traffic per mobile PC	9.8	12	30	17%	GB/month
– Data traffic per tablet	4.6	5.8	14	16%	GB/month
Total data traffic***					
Total mobile data traffic	15	27	136	31%	EB/month
– Smartphones	13	24	128	32%	EB/month
– Mobile PCs and routers	1.7	2.1	5.2	17%	EB/month
– Tablets	0.5	0.7	2.0	20%	EB/month
Total fixed data traffic	80	100	280	18%	EB/month
Fixed broadband connections	930	990	1,120	2%	million

Regional key figures

Mobile subscriptions	2017	2018	Forecast 2024	CAGR** 2018–2024	Unit
North America	390	400	460	2%	million
Latin America	690	700	740	1%	million
Western Europe	510	520	540	1%	million
Central and Eastern Europe	580	580	590	0%	million
North East Asia	1,800	1,960	2,060	1%	million
China[1]	1,420	1,550	1,630	1%	million
South East Asia and Oceania	1,120	1,160	1,290	2%	million
India	1,200	1,200	1,420	3%	million
Middle East and Africa	1,410	1,450	1,810	4%	million
Sub-Saharan Africa[2]	680	710	940	5%	million

* 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

Smartphone subscriptions	2017	2018	Forecast 2024	CAGR** 2018–2024	Unit
North America	320	330	390	3%	million
Latin America	480	510	610	3%	million
Western Europe	380	390	480	4%	million
Central and Eastern Europe	310	340	540	8%	million
North East Asia	1,310	1,550	1,900	3%	million
China[1]	990	1,280	1,540	3%	million
South East Asia and Oceania	600	680	1,030	7%	million
India	420	560	1,000	10%	million
Middle East and Africa	560	640	1,260	12%	million
Sub-Saharan Africa[2]	280	340	690	13%	million
Mobile broadband subscriptions					
North America	380	390	460	3%	million
Latin America	510	570	690	3%	million
Western Europe	460	480	540	2%	million
Central and Eastern Europe	400	450	590	5%	million
North East Asia	1,610	1,820	2,050	2%	million
China[1]	1,270	1,460	1,630	2%	million
South East Asia and Oceania	740	860	1,290	7%	million
India	440	510	1,180	15%	million
Middle East and Africa	700	850	1,630	11%	million
Sub-Saharan Africa[2]	340	410	820	12%	million
LTE subscriptions					
North America	300	350	190	-9%	million
Latin America	210	290	550	11%	million
Western Europe	240	290	370	4%	million
Central and Eastern Europe	140	190	510	17%	million
North East Asia	1,290	1,600	1,090	-6%	million
China[1]	1,030	1,320	880	-6%	million
South East Asia and Oceania	200	300	820	18%	million
India	250	350	1,150	22%	million
Middle East and Africa	130	200	770	25%	million
Sub-Saharan Africa[2]	30	50	310	34%	million
Data traffic per smartphone*					
North America	6.6	8.6	50	34%	GB/month
Latin America	2.4	3.4	18	32%	GB/month
Western Europe	4.0	6.1	32	32%	GB/month
Central and Eastern Europe	3.6	4.7	19	26%	GB/month
North East Asia	3.0	7.3	21	19%	GB/month
China[1]	2.7	7.2	19	18%	GB/month
South East Asia and Oceania	2.7	3.8	19	31%	GB/month
India	5.4	6.8	15	14%	GB/month
Middle East and Africa	2.0	2.9	15	32%	GB/month
Sub-Saharan Africa[2]	1.4	1.8	9.0	31%	GB/month
Total mobile data traffic					
North America	2.5	3.2	19	35%	EB/month
Latin America	1.0	1.6	9.5	35%	EB/month
Western Europe	1.8	2.6	14	33%	EB/month
Central and Eastern Europe	1.1	1.5	9.2	35%	EB/month
North East Asia	4.2	11	39	23%	EB/month
China[1]	2.7	8.6	29	22%	EB/month
South East Asia and Oceania	1.4	2.2	16	39%	EB/month
India	1.8	3.0	12	26%	EB/month
Middle East and Africa	1.1	1.8	17	45%	EB/month
Sub-Saharan Africa[2]	0.36	0.54	5.2	46%	EB/month

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

Ericsson enables communications service providers to capture the full value of connectivity. The company's portfolio spans Networks, Digital Services, Managed Services, and Emerging Business and is designed to help our customers go digital, increase efficiency and find new revenue streams. Ericsson's investments in innovation have delivered the benefits of telephony and mobile broadband to billions of people around the world. The Ericsson stock is listed on Nasdaq Stockholm and on Nasdaq New York.

www.ericsson.com

Ericsson
SE-164 80 Stockholm, Sweden
Telephone +46 10 719 0000
www.ericsson.com

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