This is 5G

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01 What is 5G?

Previous generations of mobile networks addressed consumers predominantly for voice and SMS in 2G, web-browsing in 3G and higher-speed data and video streaming in 4G. The transition from 4G to 5G will serve both consumers and multiple industries. With global mobile data traffic expected to grow eight times by the end of 2023, there is a need for a more efficient technology, higher data rates and spectrum utilization. New applications such as 4K/8K video streaming, virtual and augmented reality and emerging industrial use cases will also require higher bandwidth, greater capacity, security, and lower latency. Equipped with these capabilities, 5G will bring new opportunities for people, society, and businesses.

What will happen in the next five years?

More efficient networks will address the capacity needs from the growing mobile data traffic. Industries will be transforming by new capabilities brought on by 5G.. Examples of these capabilities include:

1. The ability to download a full-length HD movie in seconds
2. The quick reaction time (low latency) to enable remote robotics
3. The ability to spin up virtual networks on-demand with network slicing
4. Battery lifetimes beyond 10 years for remote cellular devices

Requirements of a 5G network

Up to 100 times faster data rates: instant access to services and applications

Network latency lowered by a factor of five; use cases in areas such as manufacturing, automotive, energy and utilities, healthcare

Mobile data volumes expanded by a factor of 1,000

10x better battery life: remote sensors and more sustainable networks

2G **Voice**
Massive mobile voice communication

3G **Browsing**
Feature phones and mobile broadband introduction

4G **Video**
Smartphone popularization and mobile data traffic exponentially increase

5G **Consumers and multiple industries**
More efficient networks, any device connected and new business opportunities across industries

In 2023, Ericsson forecasts:

9B
9 billion mobile subscriptions

20B
20 billion connected IoT devices

75%
Video will account for 75% of mobile data traffic

1B
1 billion 5G subscriptions

20%
20% of the global population covered by 5G

02 Why 5G

Three areas of usage and applications have been defined by the International Telecommunication Union's Radiocommunication Sector (ITU-R) as part of its program to expand and support diverse usage scenarios and applications beyond 4G:

Enhanced Mobile Broadband
Mobile broadband is the first use case for 5G. It addresses traffic growth demands and higher consumer experience needs. Fixed Wireless Access, as another use case example, can provide connectivity for households and Small Medium Enterprises (SMEs) using wireless technologies.

Usage scenarios:
Widespread connectivity is needed as the demand for mobile broadband continues to grow
Data rates, connection density, and mobility
Human-centric use cases: Access to multi-media content, such as 4k streaming on a mobile device or on-site live experiences

Massive Internet of things (IoT)

Usage scenarios:
Connectivity is required for millions of devices
Typically transmitting a low volume of non-delay-sensitive data (low bandwidth and not latency critical)
Devices must be low cost with extremely long battery lives

Critical IoT

Usage scenarios:
Ultra-reliable, resilient and instantaneous connectivity
Stringent requirements on availability, latency and throughput

Use cases:
Wireless control of industrial manufacturing and production processes, remote medical surgery, distribution and automation on a smart grid, and transportation safety.

Enhanced Mobile Broadband

Non-SIM devices

Smartphones

Home, enterprises, venues, mobile/ wireless/fixed

4K/8K, UHD, broadcasting, VR/AR

Massive Internet of things (IoT)

Smart building

Capillary network

Logistics, tracking and fleet management

Smart meter

Smart agriculture

Critical IoT

Traffic safety and control

Remote manufacturing, training, surgery

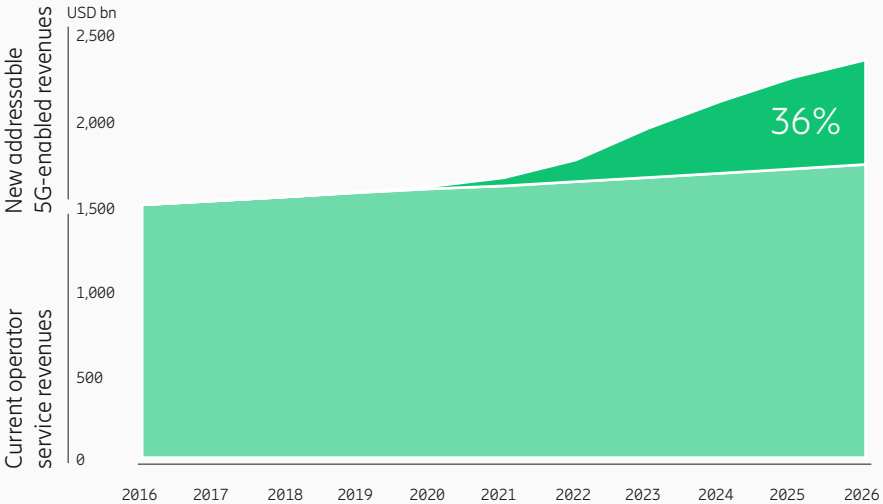
Industrial application and control

03 What will 5G mean for operators?

The introduction of 5G will bring more efficient networks, addressing the capacity needs. Evolution to 5G will enable 10 times lower cost per gigabyte than current 4G, based on Ericsson's economic study of enhanced mobile broadband.

5G will also enable new services, new ecosystems and new revenues. By digitalizing 10 industries with 5G, operators can benefit from up to USD 619 billion market opportunity globally in 2026, based on Ericsson's report The 5G business potential, representing potential of additional up to 36 percent growth in revenues. Operators will find the greatest opportunities in the manufacturing and energy/utilities sectors. Capturing this market potential requires investment in technology, as well as business development, go-to- market models, and organizational adaptation.

Figure 5: Current and 5G-addressable revenues (global)



Source: Ericsson and Arthur D. Little

The 5G value chain

Figure 4: Operator adressable 5G market in ten industries (USD billion)

Source: Ericsson and Arthur D. Little

Based on the 10 industries examined in the study, the graph above illustrates the potential revenue for operators addressing industry digitalization with 5G in 2026.

The three main roles for the operator when it comes to generating revenue through 5G industry digitalization have been identified as follows:

Network developers excel in operating network infrastructure, including access, core and transport, and apply powerful IT enablers to support consumers and businesses with uniquely tailored connectivity solutions that maximize the power of digital.

Service enablers, in addition to empowering connectivity, provide digital platforms on which businesses can easily configure and integrate value-enhancing digital capabilities into their business processes in highly automated ways.

Service creators create new digital services, build innovative businesses and collaborate beyond telecoms to set up new digital value systems, in addition to providing digital platforms and infrastructure services.

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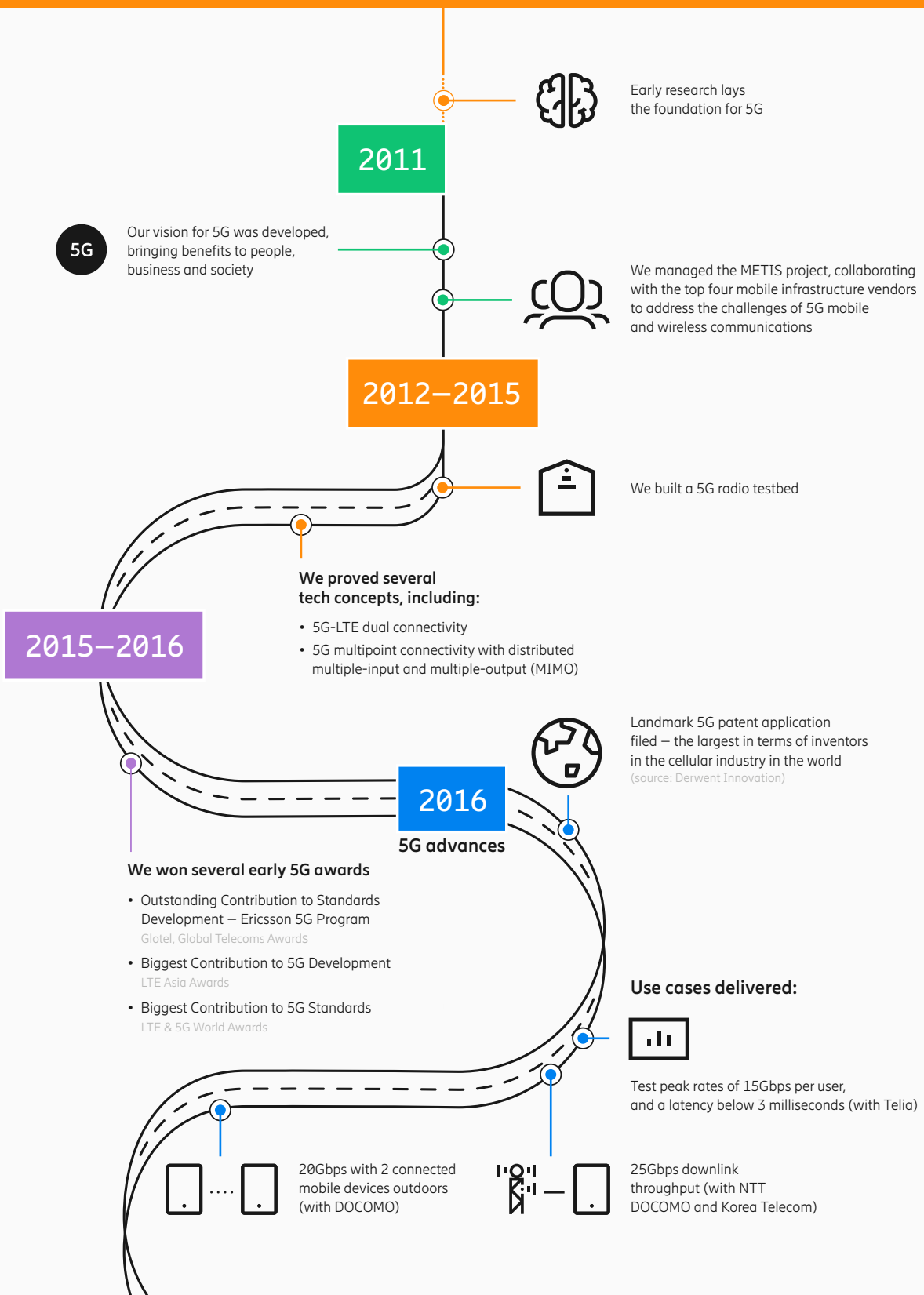
Blazing the 5G trail

From 2011 to 2020 – and beyond

Ericsson and its key industry partners have reached several important milestones on the road to global 5G standardization.



2017

The most advanced outdoor 5G field trial reached a record-breaking 3.6Gbps at 170 kmph (with SK Telecom and BMW)

5G network tested at the historic Indianapolis motor speedway (with Verizon)

Multiple 5G New Radio trials (with Qualcomm, SK Telecom, AT&T, NTT DOCOMO, Vodafone and Telstra Australia)

First public 5G live network use cases deployed in Europe (with Telia and Intel)

Ericsson performed the world's first federated network slicing live demo, providing seamless network service end-to-end between Korea and Germany (with SK Telecom and Deutsche Telekom)

38 5G Memorandums of Understanding (MoU) signed with operators, including with Vodafone, Telefónica and China Mobile, to help define industry standards, drive innovation and launch equipment demonstrations

First deals including 5G technology, with Vodafone UK, Swisscom and Verizon

Global 3GPP standard for 5G New Radio (NR) Non-standalone (NSA) approved

Technology milestone reached: Ericsson and Qualcomm, in collaboration with AT&T, NTT DOCOMO, Orange, SK Telecom, Sprint, Telstra, T-Mobile US, Verizon, and Vodafone, showcased 5G NR multi-vendor interoperability

TODAY

Our partnerships are growing

TOMORROW

We will see 5G in action

There will be even more use cases and applications deployed, such as remote-controlled robots and fixed wireless access, ready for 5G subscription uptake in 2020

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05 Technologies at the heart of 5G

Whereas 2G, 3G and 4G were primarily radio focused, 5G will represent an entire system with radio, a telecom core, and OSS all transformed to support new requirements. This process will involve new radio technologies, a virtualized cloud-based core, and end-to-end management and orchestration to facilitate automation and new concepts like network slicing. The system will not be standardized – instead many technology areas and interfaces will be standardized in different environments.

● **5G core network technologies**
● **5G radio network technologies**

Artificial Intelligence (AI) is the ability of machines to learn processes.

Automation makes all configurations of services and network connections, which are mainly manual today, automated. This reduces time to market for new services and improves the quality with less risk of error.

● **Baseband** provides switching, traffic management, timing, baseband processing, and interfaces towards the radio units.

● **Beam tracking** is used to follow the position and movements of a given device. 5G Radio points one or more beams in the best direction for that device in real-time, to ensure consistently reliable connections.

● **Cloudification** is the conversion and/or migration of data and application programs to make better use of cloud computing.

● **Cross-domain orchestration** manages provision, end-to-end services and connectivity across 5G system domains like radio, transport and core.

● **Edge computing** is the technology to move the execution applications closer to the users. This will enable latency sensitive applications e.g AR/VR or mission critical use cases. This is done by having cloud platforms distributed further out in the radio network.

● **Dynamic Time-Division Duplexing (TDD)** enables adjustments of uplink and downlink resources flexibly according to the instantaneous traffic load.

● **eCPRI interface** is an evolved front-haul standard agreed by industry leaders, which makes it possible to move the beamforming processing from the baseband to the radio. This simplifies Massive MIMO deployment and offers the flexibility needed in real-life site environments.

● **Federated network slicing** is designed to enable the provision of network slices globally, making sure that customers do not need individual agreements with different operators for a global service experience.

- **5G core network technologies**
- **5G radio network technologies**

- **Gigabit LTE** offers LTE-based download speeds of up to one gigabit per second.
- **Massive Multiple-Input and Multiple-Output (MIMO)** is the combination of MIMO and beamforming with large number of antenna elements – to improve both throughput and energy efficiency.
- **Multi-User MIMO** uses techniques to transmit data to several user terminals using the same time and frequency resources, thus increasing the efficiency of the system's radio spectrum.
- **Network Function Virtualization (NFV)** enables the on-demand instantiation of functions in a format easier to load-balance, scale up/down, and allow for the movement of functions dynamically across distributed hardware resources in the network.
- **Network slicing** enables mobile network operators to provide dedicated virtual networks with functionality specific to the service or customer over a common network.
- **Network slice management** automates the setup of service connections to secure service quality, save costs and gain fast time to service.
- **Radio Access Network (RAN)** connects individual devices to other parts of a network through radio connections.
- **Software-Defined Networking (SDN)** centrally configures and manages physical and virtual network devices in datacenters, such as routers, switches, and gateways.
- **Virtual Network Functions (VNF)** describes telecom core functions like packet core, IP Multimedia Subsystem and Subscriber data management when implemented as software on cloud-based hardware platforms. The software will be optimized for the cloud environment. This evolution has started and will be applicable also for LTE networks.
- **Virtualization** combines hardware and software network resources and functionality into a single, software-based administrative entity – a virtual network.
- **5G New Radio (NR)** is the radio access interface that will become the foundation for the next generation of mobile networks.
- **5G policy and user data** for Network Slices ensure users get the right service quality with data integrity.
- **5G transformation services** ensure the migration of the network and operation from legacy to 5G core, virtualized and based on an automated operational model.

Internet of things (IoT) describes the enablement of connectivity of physical devices, vehicles, and appliances to connect, exchange and store data.

Technical expectations of 5G

Peak rate data

1-20 Gbps

User experience data rate

10-100 Mbps

Spectral efficieny

x1-x3

Mobility

300-350 km/h

Latency

10-10 ms

Connection density

10k-10m devices/km^2

Security

Stronger subscriber authentication, user provacy and network security

Area traffic capacity

0.1-10 Mbps/m^2

Availability

99.999% (of time)

Battery life

10 years*

Reliability

99.999% (of packets)

Position accuracy

10m ‹ 1m

Network energy efficiency

x10-x100

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Ericsson is a world leader in communications technology and services with headquarters in Stockholm, Sweden. Our organization consists of more than 100,000 experts who provide customers in 180 countries with innovative solutions and services. Together we are building a more connected future where anyone and any industry is empowered to reach their full potential.

Net sales in 2017 were SEK 201.3 billion (USD 23.5 billion). The Ericsson stock is listed on Nasdaq Stockholm and on NASDAQ in New York.

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