Introducing 5G networks – Characteristics and usages

The fifth generation networks (5G) is currently under development and will hit the market at the horizon **2020**. Compared with the current 4G LTE technology, 5G is targeting to reach both **high speed (1 Gbps)**, low power and low latency (1ms or less), for massive **IoT, tactile internet and robotics**.

The following Q&As will give you a first introduction to 5G technology and its uses cases:
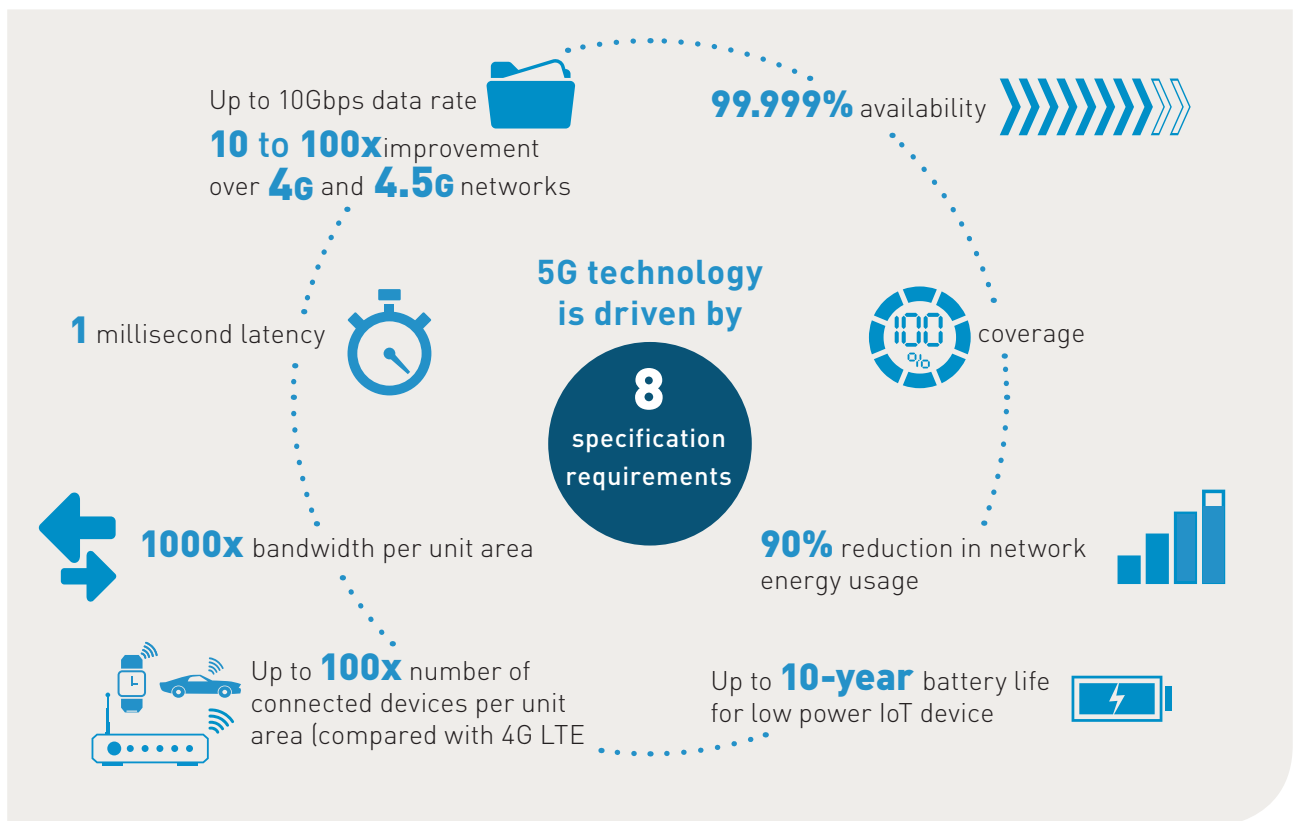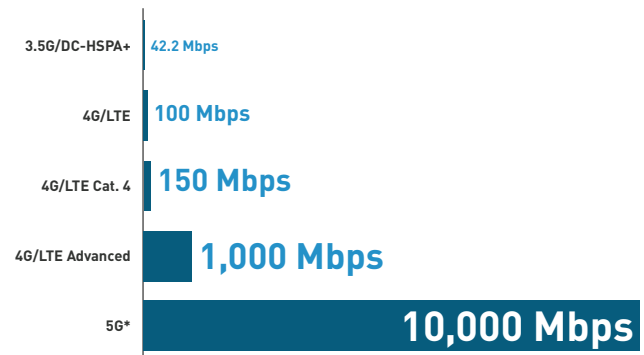
What is (and what isn't) 5G, and what is the difference between 4G / LTE and 5G?

The next (5th) generation wireless network will address the evolution beyond mobile internet to massive IoT (Internet of Things) for the horizon 2020. The main evolution compared with today's 4G and 4.5G (LTE advanced) is that beyond data speed improvements, new IoT and critical communication use cases will require new types of improved performance. For example "low latency" is what provides real-time interactivity for services using the cloud: this is key for the success of self-driving cars for example. Also, low power consumption is what will allow connected objects to operate for months or years without the need for human assistance.

Unlike current IoT services that make performance trade-offs to get the best from current wireless technologies (3G, 4G, WiFi, Bluetooth, Zigbee, etc...), 5G networks will be designed to bring the level of performance needed for massive IoT. It will enable a perceived fully ubiquitous connected world.
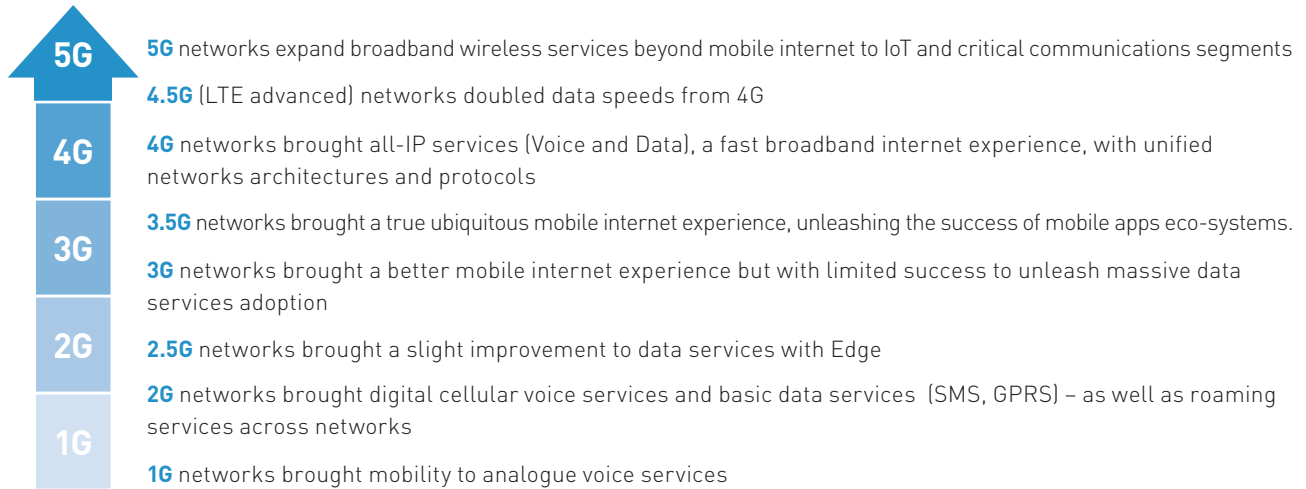
Speed-wise, the evolution of data services since 3.5G network is spectacular as shown in the following diagram:

3.5G/DC-HSPA+	42.2 Mbps
4G/LTE	100 Mbps
4G/LTE Cat. 4	150 Mbps
4G/LTE Advanced	1,000 Mbps
5G*	10,000 Mbps

Up to 10Gbps data rate
10 to **100x** improvement over **4G** and **4.5G** networks

99.999% availability

5G technology is driven by

8 specification requirements

1 millisecond latency

100% coverage

1000x bandwidth per unit area

90% reduction in network energy usage

Up to **100x** number of connected devices per unit area (compared with 4G LTE

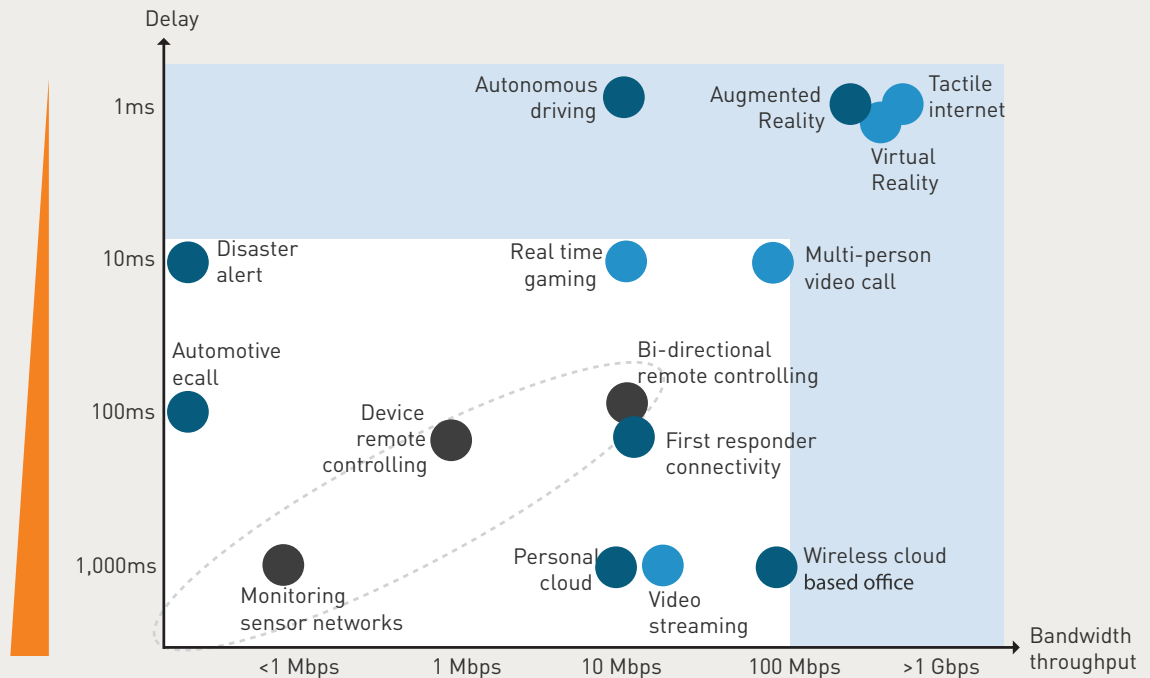Up to **10-year** battery life for low power IoT device

What are the real 5G use cases?

Each new generation wireless network came with all new set of new usages. The next coming 5G will make no exception and will be focused on IoT and critical communications applications

5G networks expand broadband wireless services beyond mobile internet to IoT and critical communications segments

4.5G (LTE advanced) networks doubled data speeds from 4G

4G networks brought all-IP services (Voice and Data), a fast broadband internet experience, with unified networks architectures and protocols

3.5G networks brought a true ubiquitous mobile internet experience, unleashing the success of mobile apps eco-systems.

3G networks brought a better mobile internet experience but with limited success to unleash massive data services adoption

2.5G networks brought a slight improvement to data services with Edge

2G networks brought digital cellular voice services and basic data services (SMS, GPRS) – as well as roaming services across networks

1G networks brought mobility to analogue voice services

The following table from GSMA maps various uses cases vs their needs for speed and for fast response time (Latency). The grey area shows which services will benefit from 5G speed improvement, or latency improvements, or both.

Delay axis:
- 1ms
- 10ms
- 100ms
- 1,000ms

Bandwidth throughput axis:
- <1 Mbps
- 1 Mbps
- 10 Mbps
- 100 Mbps
- >1 Gbps

Use cases plotted:
- Autonomous driving
- Augmented Reality
- Tactile internet
- Virtual Reality
- Disaster alert
- Real time gaming
- Multi-person video call
- Automotive ecall
- Bi-directional remote controlling
- Device remote controlling
- First responder connectivity
- Personal cloud
- Video streaming
- Wireless cloud based office
- Monitoring sensor networks

Legend:
- Services that can be delivered by legacy networks
- Services that could be enabled by 5G
- Fixed
- Nomadic
- On the go
- M2M connectivity

Some key applications like self-driving cars require very aggressive latency (fast response time) while they do not require fast data rates.

Conversely, enterprise cloud base services with massive data analysis will require speed improvements more than latency improvements.

Latency benefits example:

A car running at 100Km/h will move 27.6m every second, or 2.7cm every millisecond. If the road sensors capture an unexpected event on the road, <1ms network(s) latency means that the information will reach the car from the cloud in a time frame that corresponds to less than 1 meter motion   (between the time the event occurred and the time the car control system gets the information).

The drones use case best illustrates all 5G next coming challenges: Low latency for fast response-time, LAN and WAN combination to support fast moving drones, high speed data rates to exploit high quantities of navigation data and sensors to actuators communications for complex navigation software heuristics.

Critical Communications use cases:

5G will meet the expectation for ultra-reliable, critical decision making systems in a broad range of industrial and citizens services. For example:

Sensors to actuators real-time communication for industrial applications

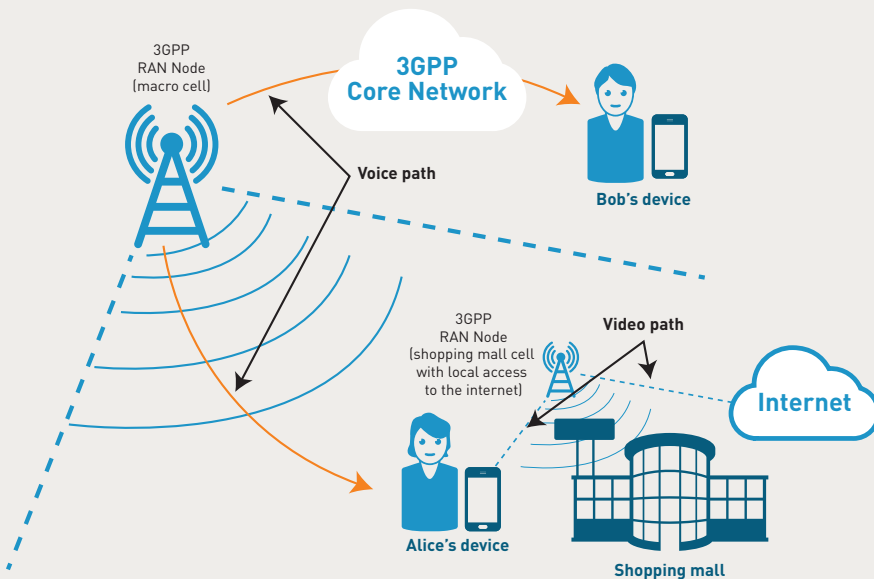Healthcare monitoring systems

Driverless cars navigation

Drones/robotics applications

Virtual networks (5G Slicing) tailored to each use case:

5G will be able to support all communication needs from low power Local Area Network (LAN) – like home networks for example, to Wide Area Networks (WAN), with the right latency/speed settings. The way this need is addressed today is by aggregating a broad variety of communication networks (WiFi, Z-Wave, LoRa, 3G, 4G, etc…) 5G is designed to allow simple virtual networks configurations to better align network costs with applications needs.   This new approach will allow 5G Mobile Network operators to catch a larger piece of the IoT market pie by being able to deliver cost effective solutions for low broadband, low power applications.

The concept of "Best Connection per traffic type" will then be achievable

3GPP
RAN Node
(macro cell)

**3GPP
Core Network**

Voice path

Bob's device

3GPP
RAN Node
(shopping mall cell
with local access
to the internet)

Video path

Internet

Alice's device

Shopping mall

Tactile Internet

As defined as super-low latency internet applications to meet human level response time. As an example, for medical nano-surgery, intra-body robotics systems will allow the surgeons to perform real-time micro-machining.

The impact of tactile internet will also revolution the gaming industry. It will also expand to the other four human senses beyond touch (hear, sight, smell, taste) to enable new virtual reality user interfaces where applications will meet human senses response time.

When is 5G coming? Where is 5G technology in terms of standardisation and how long will this take?

> ITU-R launched "IMT for 2020 and beyond" in 2012, setting the stage for 5G
> **Japan** and **Korea** started to work on 5G requirements in 2013
> NTT Docomo did first 5G experimental trials in 2014
> Samsung, Huawei and Ericsson started prototype development in 2013
> **South Korean** SK Telecom plans to demo 5G in 2018 at the Pyeongchang winter Olympics
> Ericsson and TeliaSonera plan to make commercial service available in **Stockholm** and **Talinn** by the end of 2018
> **Japan** target is to launch 5G for the 2020 **Tokyo** summer Olympics
> **AT&T** to test 5G wireless service in Austin, Texas in 2016.
> **Fujitsu** recently demonstrated speed rates at 56Gbps

LTE network coverage forecasts, as a % of population by region

Legend: 2014, 2020
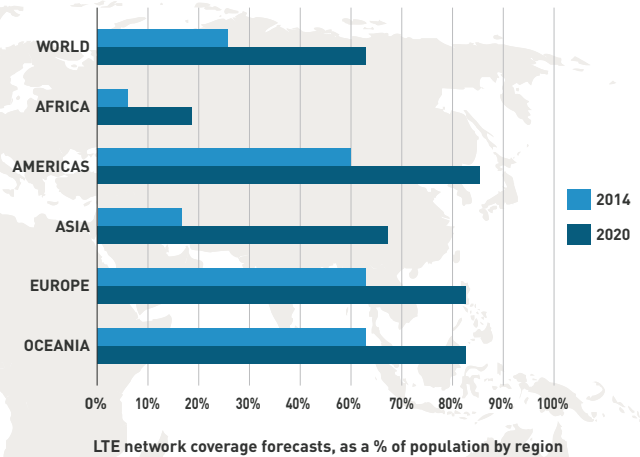
How fast will 5G take-up be?

The projected adoption rate for 5G differs drastically from all previous generation networks (3G, 4G): While previous technology where driven by mobile internet usage and the availability of "killer apps", 5G is expected to be mainly driven by new IoT usages, such as connected and self-driving cars for example.

Given that new perspectives of usage for broadband connectivity, some equipment suppliers such as Ericsson predict more than 150 Million 5G connected devices in less than 12 months after network launch

For traditional mobile internet usage, combining all LTE networks coverage, GSMA is forecasting the following penetration rate for 2020.

3G 4G

5G
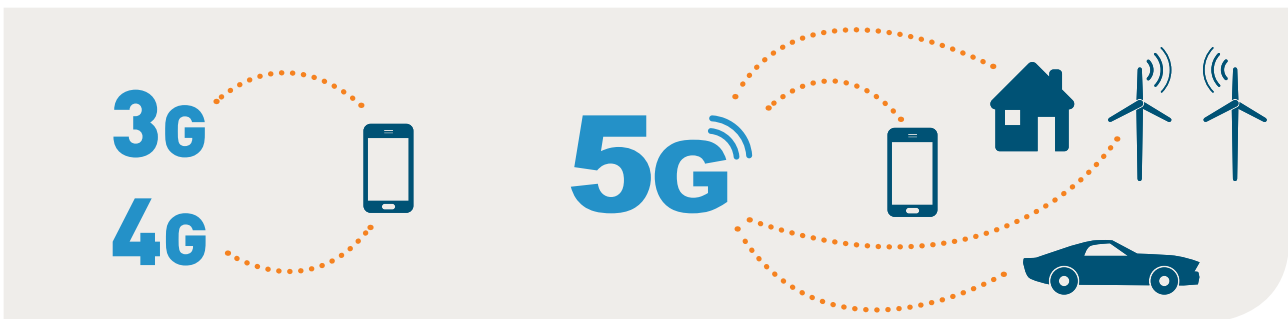
What are the implications of 5G for mobile operators?

5G is still a cellular broadband technology and is a network of networks. MNOs expertise and knowledge in building and operating networks will be key for the success of 5G.

Beyond providing network services, MNOs will be able to develop and operate new IoT services

The implementation of 5G networks while keeping 3G and 4G networks operational will likely trigger a new challenge for MNOs regarding the ability of frequencies in the spectrum (especially if the forecasted massive volume on IoT occurs). MNOs will need to require then operate new spectrum in the 6 to 300 GHz range, which means massive investments in the network infrastructure.

To reach the 1ms latency goal, 5G networks imply connectivity for the base station using optical fibers.

On the cost savings side, 5G networks are planned to be capable to support virtual networks such as low power low throughput (LPLT) networks for low cost IoT.   Unlike today where LORA networks address that need, separately from 4G.
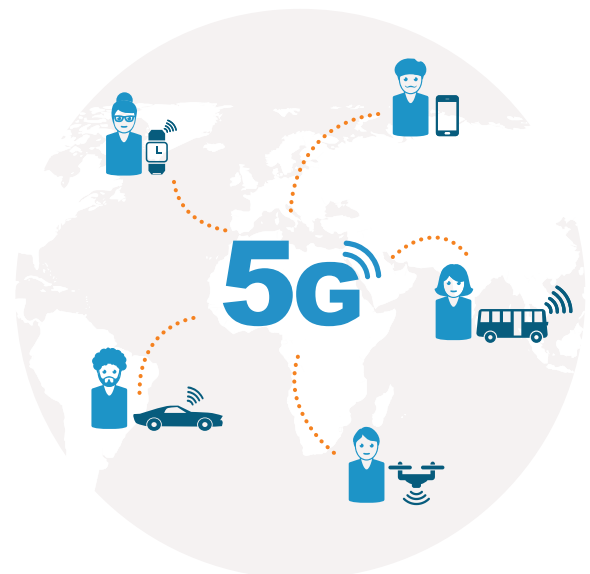
Will 5G technology be secure?

4G networks today use the USIM application to perform strong mutual authentication between the user and his/her connected device and the networks. The entity hosting the USIM application can be a removable SIM card or an embedded UICC chip. This strong mutual authentication is crucial to enable trusted services. Security solutions today are already a mix between security at the edge (device) and security at the core (network). Several security frameworks may co-exist in the future and 5G is likely to re-use existing solutions used today for 4G networks and for the cloud (SEs, HSM, certification, Over-The-Air provisioning and KMS)

The standard for strong mutual authentication for 5G networks is not finalized yet. The need for security, privacy and trust will be as strong as for 4G if not stronger with the increased impact of IoT services. Local SEs in devices can not only secure network access but also support secure services such as emergency call management and virtual networks for IoT

5G what does it mean for consumers?

5G for consumers means not just faster mobile internet, but mainly internet connectivity in many more objects than what you see today in 2016. The car and the house are two examples of the big IoT revolution coming ahead, supported by 5G networks

? How will 5G technology accelerate the commercialisation of IoT devices relying on cellular rather than Wi-Fi technology?

Wi-Fi wireless is a "Local Area Network" technology, limited in operation range and very limited in both speed and latency.   Many IoT services are demanding more ubiquity, more mobility, and more performance speed-wise and response time-wise.   5G will truly unleash a true IoT eco-system

? How will 5G networks / use cases change the world?

The "perception" of speed, instantaneous response time and performance for IoT will become a reality thanks to 5G. As an example, the well expected success of self-driving cars will only be possible when 5G networks are available.

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