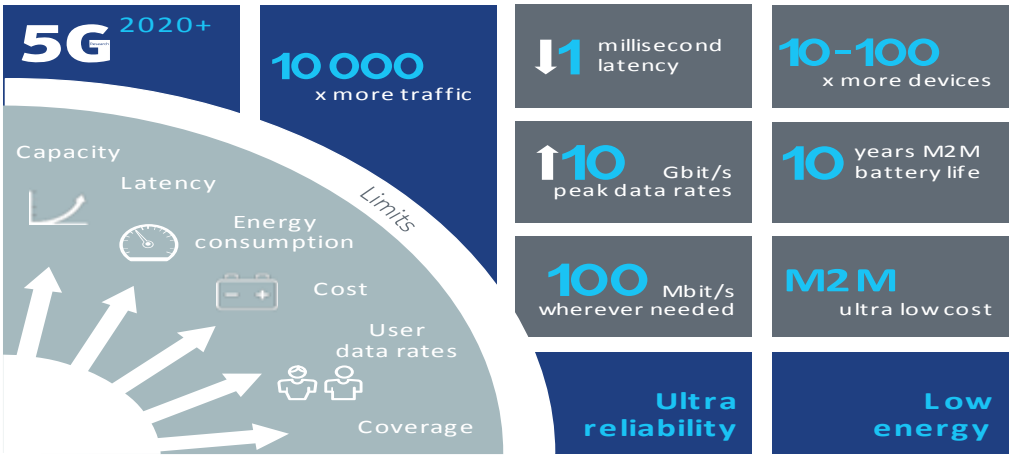
5th generation (5G) of communication networks

Background

The United States has been an early adopter in each generation of wireless technology, a major driver of innovation, and remains among the most vibrant wireless markets in the world. In the current generation of technology, called 4G or Long-Term Evolution (LTE), the U.S. benefits from substantial investment by each of the four large national wireless carriers. By most measures, however, the U.S. trails other regions in LTE performance. The U.S. can improve upon 4G results and be a driving force in the next generation of mobile networks called 5G, which will arrive after 2020. For this to occur, work needs to start now.

What is at stake for the United States?

- **Jobs & growth:** 5G is a key technology for many growing U.S. business sectors including software, video, gaming, data analytics, and machine to machine (M2M) communications.
- **Investments:** significant early investment in 5G would help close the gap in ultrafast mobile broadband between the U.S. and other countries.
- **Research:** sustained investment in 5G research would begin to address limitations in mobile broadband availability in rural areas.



Why 5G matters for citizens?

Demand: Consumers generate an increasing amount of mobile traffic, which necessitates more capacity and lower latency. 5G will offer an expected peak data rate higher than 10 Gbit/s compared to the 300 Mbit/s LTE can offer today, combined with virtually zero latency, i.e. less than 1 ms, meaning that the radio interface will not be the bottleneck even for the most challenging use cases.

Societal innovations. 5G will support applications and industries of the future such as innovative health care services, self-driving cars and next generation of industry automation. 5G will mean stepping away from best effort towards truly reliable communication. Flexible integration of existing access technologies such as LTE and Wi-Fi with new technologies creates a design that is future proof at least until 2030.

Internet of things. 5G will be designed for use cases expanding from humans to machines requiring more of networks. 5G supports the huge growth of machine-to-machine type communication, also called Internet of Things, through flexibility, low costs and low consumption of energy. At the same time, 5G will be reliable and quick enough for even mission-critical wireless control and automation tasks such as self-driving cars.

Energy and cost. 5G will lower costs and consumption of energy. Energy efficiency is an integral part of the design paradigm of 5G, not an afterthought. Virtualized and scalable technologies will further facilitate global adoption. Taking all of these factors together, 5G could bring Internet access to a larger group of people and things.

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Challenges

Harmonization. Various 5G initiatives compete to lead definition of 5G: EU's 5GPPP (or 5G Public-Private-Partnership), the flagship initiative under Horizon 2020; China's IMT-2020 (5G) Promotion Group and the 2020 and Beyond Ad-Hoc Group; Korea's national research program supported by 5G Forum; Russia's, 5GRUS program; and USA's 5G programs by the National Science Foundation.

Spectrum needs: Additional radio spectrum for mobile networks needs to be allocated and put into use quickly to meet the increased capacity and coverage demands of 5G. This means looking at new spectrum bands such as millimeter wave and centimeter wave, and using available spectrum efficiently.

Density: 5G we will need to use many more base stations to meet the performance needs of future applications. These dense networks will be deployed as heterogeneous networks, combining macro sites with smaller base stations and using a range of radio access technologies including LTE-A, Wi-Fi and any future 5G technologies. These technologies will be used in macro, small and super small cells and will integrate various radio technologies flexibly and in various combinations.

Performance: In 5G the best possible network performance will not be just about peak speed. There will be a wide range of performance measures to meet individual requirements imposed by each use case. Some real-time applications, such as driverless cars, will require virtually zero latency, while others, such as 3D video capture, will be more tolerant to latency but will require high capacity upload instead.

Net Neutrality regulation: Regulations in the U.S. should permit operators to innovate by offering prioritized or specialized services subject to transparency requirements and other appropriate safeguards.

Virtualization, telco cloud, big data and analytics are emerging key technologies enabling service agility, scalability, and efficiency of mobile networks. 5G networks will need to take full advantage of these technologies in order to deliver on the expectations towards 5G.

Recommendations for policy makers

- Continue to support investment in 5G research and coordinate through standardization and other initiatives to create a 5G ecosystem driven by investment and standardization activities including negotiating internationally for common definitions of 5G.
- Allocate more spectrum quickly and put a plan in place for spectrum for mobile broadband between 3.5 and 100 GHz.
- Any overhaul of telecommunications legislation should have the goal of increasing investment and reducing regulatory barriers to innovation. Clear, stable, and predictable rules of conduct backed by enforcement are preferable to ongoing rulemakings that regularly change the regulatory environment.
- Possible regulation on Net Neutrality should allow innovation in all stages of the value chain by offering higher speeds, guaranteed quality and specialized services, many of which have not been invented yet. At the same time blocking and throttling of traffic at any stage of the value chain should not be allowed.
- 5G necessitate a strong and vibrant standardization system that incentivizes companies to continue sharing innovations for inclusion in standards. For this to occur, access to injunctive relief for standard essential patents (SEPs) cannot be eliminated without having an alternative mechanism in place to facilitate licensing and consequently provide an adequate return on investment.

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