5G Vision and Readiness

Innovation of New Generation Wireless Network

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Abstract

5G is a next wave of Digital Society for realizing breakthroughs in the transformation of ICT network infrastructure to drive economic and societal growth in entirely new ways. The objective is for 5G networks to be highly efficient and faster, by supporting more number of users, devices, services and new use cases without a corresponding impact on cost or carbon footprint. It targets new kinds of ultra-reliable, mission critical services to effectively connect virtually everything. Furthermore, 5G's single core network is envisioned to support existing 3G/4G and Wi-Fi access, ensuring that operators' current and future investments are fully protected. 5G will focus on the evolved versions of existing radio-access, cloud and core technologies together with some new set of technologies to cater more data traffic and upgrade massive number of equipment.

Keywords: *Frequency, ICT Player, IOT, M2M, Network Society, Spectrum*

Introduction

The current generation of mobile networks continues to transform the way people communicate with each other and access information. Further developing and implementing technologies that enable true human-centric and M2M (Machine-to-machine) connectivity will come to redefine end user mobility along with the entire landscape of the global telecoms industry.5G aims to provide unlimited access to information and the ability to share data anywhere, anytime by anyone and anything for the benefit of people, businesses and society.

Over the time, any mobile app and mobile service will be given the potential to connect to anything at any time – from people and communities to physical things, processes, content, working knowledge, timely pertinent information and goods of all sorts in entirely flexible, reliable and secure ways. The 5G promises to expand the possibilities of what mobile networks can do, and to extend upon what services they can deliver.

5G network will drive the future evolution of the internet itself by implementing the next generation ultra-broadband network infrastructure and the integration of mass-scale cloud architectures. To achieve the goals, the 5G developments will primarily focus on the right infrastructure handle massive capacity and massive connectivity.

M2M communication will be one of the bigger changes in 5G networks showing in Figure 1. Everything will be connected: houseplants, bike helmets, water systems, crops, containers, financial structures and endangered species. By connecting things, we create asnapshot of the world, from the water quality in Northern Europe to the temperature of the ice in Antarctica.

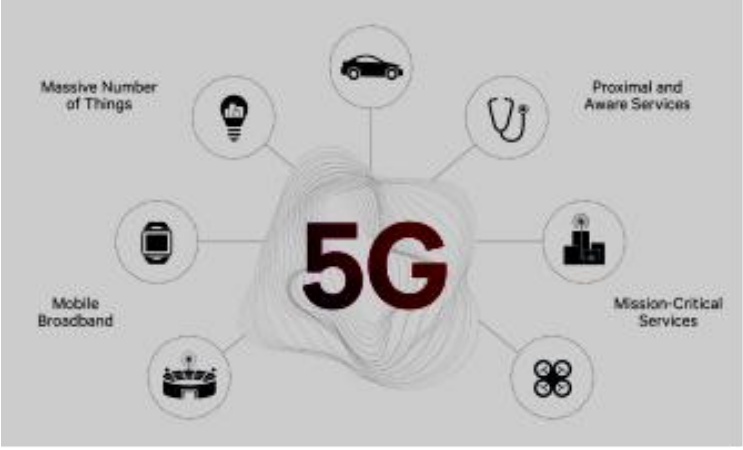

Figure 1: 5G Connectivity

In a nutshell, the 5G story will be the transformational force that enables new services, connects new industries, and empowers new user experiences for the next decade—and beyond. 5G is not just a better performance or higher flexibility; it is change of mindset and represents a new way of thinking. It encompasses innovative network design for deploying machine-type communication (MTC) and by this way 5G will be an important enabler of the Network Society.

Evolution of 5G

From the analogue to LTE, each generation of mobile technology has been motivated by the need to meet a requirement identified between that technology and its predecessor shown in Table 1.

Generation	Primary services	Key differentiator	Weakness
1G	Analogue phone calls	Mobility	Poor spectral efficiency, major security issues
2G	Digital phone calls and messaging	Secure, mass adoption	Limited data rates – high demand for internet/e-mail
3G	Phone calls, messaging, data	Better internet experience	Real performance failed to match hype, failure of WAP for internet access
3.5G	Phone calls, messaging, broadband data	Broadband internet, applications	Tied to legacy, mobile specific architecture and protocols
4G	All-IP services (including voice, messaging)	Faster broadband internet, lower latency	IOT, M2M Deployment

Table 1: Evolution of technology generations in terms of services and performance

There are two views 5G exist today.

The hyper-connected vision –In this view of 5G, mobile operators would create a blend of pre-existing technologies covering 2G, 3G, 4G, Wi-fi and others to allow higher coverage and availability, and higher network density in terms of cells and devices, with the key differentiator being greater connectivity as an enabler for Machine-to-Machine (M2M) services and the Internet of Things (IoT).

Next-generation Radio Access Technology (RAT) – This is traditional 'generation-defining' view, with specific targets for data rates and latency being identified, such that new radio interfaces can be assessed against such criteria. This in turn makes for a clear demarcation between a technology that meets the criteria for 5G, and another which does not.

Requirement of 5G Technology

Today the industry takes initiatives to progress with work on 5G by identifying a set of eight requirements:

1. 1-10Gbps connections to end points in the field (i.e. not theoretical maximum)
2. 1 millisecond end-to-end round trip delay (latency)
3. 1000x bandwidth per unit area
4. 10-100x number of connected devices
5. 99.999% availability (Perception)
6. 100% coverage (Perception)
7. 90% reduction in network energy usage
8. Up to ten year battery life for low power, machine-type devices

It is difficult to conceive a new technology that could meet all of these conditions simultaneously. The various combinations of a subset of the overall list of requirements will be supported 'when and where it matters'.

Transformation of 5G

As a technology enabler, 5G will allow businesses totransform to make the most of connectivity, but 5Gtechnologies are not being developed in isolation.Factors like security, long-term sustainability, cost,and the need to provide connectivity to the next billionsubscribers play a significant role in shaping thedirection of technology development.
The parameters that 5G technology will be developedupon include:

- traffic capacity
- data throughput
- data integrity
- latency
- energy consumption
- technology convergence
- smart communication

Such a network can be defined by three characteristics.

Scalability and Adaptability – 5G will have the ability to scale and adapt across an extreme variation of use cases showing in Fig 2, such as uniform, fiber-like broadband everywhere (not just higher peak data rates) services; ultra-reliable, mission-critical services such as controlling the power grid or remote medical procedures (where failure is not an option); and connecting everything from simple sensors to complex robots, which also means supporting billions of ultra-low energy devices needing expansive coverage, at very-low data rates and at ultra-low cost.

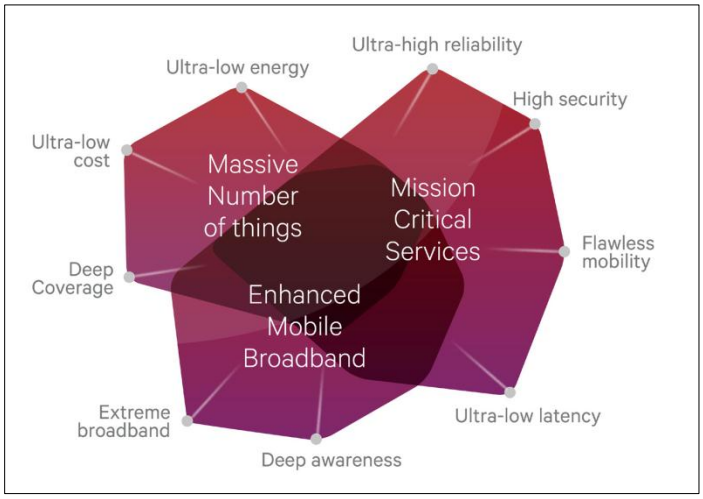

Figure 2: Variation of Different use cases

User Centric Design – The design approach for 5G is rooted in keeping the user at its center. Whether the user is a human, a device, or a "thing," it will bring content, connectivity, and computing close to the user shown in figure 3. In this approach, network intelligence and control are distributed closer to the users— sometimes referred to as the "edge" of the network.This distributed approach combined with virtualized network functions will not only reduce latency, but also significantly improve cost and energy efficiency, which are key objectives for any new-generation technology.

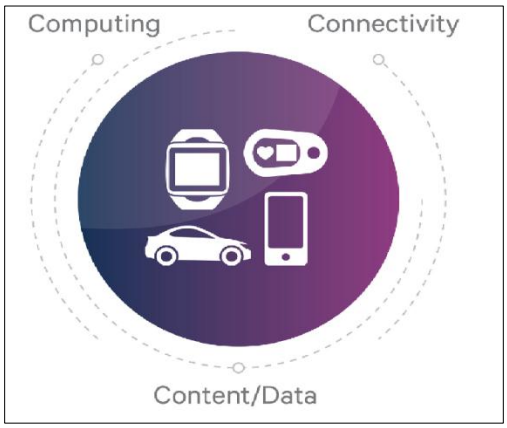

Figure 3: User centric design

Key Technology Drivers

Key 5G technology drivers are as follows:

- While previous generations of wireless networks were characterized by • fixed radio parameters and spectrum blocks, 5G will allow utilization of any spectrum and any access technology for the best delivery of services.

- Air-interface and RAN systems will need to be completely redesigned • to accommodate a new mobile access paradigm of massive capacity, huge numbers of connections, and ultra-fast network speeds.

- 5G will feature native support for new kinds of network deployments, • including ultra-dense radio networking with self-backhauling, device-to-device communications, dynamic spectrum reforming and radio access infrastructure sharing.

Necessary Breakthroughs

The development of 5G will require several new breakthroughs in the following area:

i. Multiple access and advanced waveform technologies combined with advances in coding and modulation algorithms are essential for realizing continuing improvements in spectral efficiency.

ii. The baseband and RF architecture are required to enable computationally intensive and adaptive new air interfaces

iii. Advanced RF domain processing will bring benefits to the efficient and flexible usage of spectrum; single-frequency full-duplex radio technologies will be a major contributor to increasing spectrum efficiency

iv. Integrated access node and backhaul design

v. Radio technologies for mobile devices are required to support a vast range of capabilities, from ultra-low energy sensors to ultra-fast devices with long-lasting battery life.

Spectrum and Coverage Implications

While spectrum usage and allocation varies fromcountry to country, one aspect of spectrum usage iscommon to all: as demand for connectivity rises, theneed for additional spectrum increases.Each generation of mobile technology has improveduser experience through the ability to utilize additional–typically higher – frequency bands and widertransmission bandwidths; as this increases both trafficcapacity and achievable data rates. To maximize spectrum efficiency, all-spectrum access and programmable air interface technologies will need to be capable of mapping service requirements to the best suitable combinations of frequency and radio resources. Global harmonization of spectrum and how it is used,including licensing and fees, is highly beneficial for alltelecom players.The following three topics are considered of spectrum for 5G:

1. Trends in the spectrum requirements for wireless broadband access and backhaul
2. Considerations for new wireless broadband spectrum above 6 GHz
3. Spectrum management methods

The unified air interface will, for example, need to use the time and frequency domains, orthogonal, and non-orthogonal domains, as well as synchronous and asynchronous domains to adapt and scale to different spectrum and services types are shown in Figure 4,

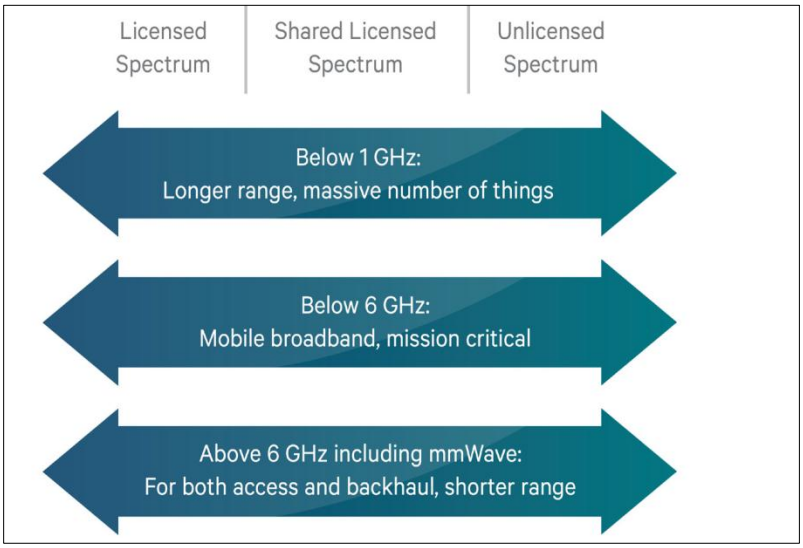

Figure 4: Unified Air Interface for all Spectrum

Timeline

5G is presently in its early research stages. New IMT spectrum is expected to be agreed upon for the World Radio Communication Conference (WRC) in 2015.The start time of commercial deployment of 5G systems is expected in years 2020+, following the R&D phase and the standardization and regulatory phases. Japan has committed to have a commercial system for the 2020 Olympics. It is too early for the European operators to commit to network rollouts but many are predicting the 5G commercial availability in 202-2025 shown in Table 2.

Years	Milestones
2014-15	Exploratory phase to understand detailed requirements on 5G future systems and identify most promising functional architectures and technology options which will meet the requirements.
2015-17	Detailed system research and development for all access means, backbone and core networks (including SDN, NFV, cloud systems etc.) by taking into account economic conditions for future deployment.
2016-18	Identification and analysis of frequency bands envisaged for all 5G communications and final system definition and optimization by means of simulations, validation of concepts and early trials.
2017-18	Investigation, prototypes, technology demos and pilots of network management and operation, cloud-based distributed computing and big data for network operation.
2018-20	Demonstrations, trials and scalability testing of different complexity depending on standard readiness and component availability.
2020	New frequency bands available and initial commercial deployment of new systems. Close to commercial systems deployment under real world conditions with selected customers to prepare economic exploitation on global basis.

Table 2: 5G Exploration to Deployment

Vision for 5G

The vision is to create a new generation of technology that is scalable and adaptable enough to support new kinds (and levels) of services and use cases ranging from connecting simple sensors to mission-critical applications like remote control medical procedures to complex robots. The goal is not only to make mobile broadband faster and better, but to provide uniform, “fiber-like” broadband everywhere.

Building such a network requires a new way of thinking. New technologies will be needed that will, for example, enable communication at higherfrequencies. Services will need to be built to minimize connectivity requirements, and flexibility will be needed to, for example, create low-latencycommunication links dynamically.

The ICT players believe that 5G is the technology evolution that will enable such flexible networks to be built and provide connectivity for the many future use cases. They need to share a common understanding of the complete network ecosystem and build toward it.

Conclusion

This is about enabling the change and change-makers; bringing benefit to people, business and society. The platform for thisvision is a flexible, reliable, fast, secure, sustainable and affordable network that provides connectivity for billions of people, industries and things, everywhere and anytime.

The user-centric approach is at the heart of 5G, where connectivity, computing, and content all come together, close to the user, be it a human, a vehicle, a machine, or a thing. From a connectivity perspective, these users will no longer be mere end-point, they will be integral parts of the network, creating “edgeless” connectivity.

5G is envisioned to be a unified platform to address the expanded connectivity needs of the next decade and beyond, not only providing the most appropriate connectivity, but also offering opportunities for new deployment models, sharing models, charging/subscription models.

5G success depends on the entire ICT ecosystem. Its growth will be built upon global LTE success. ICT ecosystem innovation will also be a major driver in creating a bigger 5G market.

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