

 **MNS Consulting**
Management – Technology – Engineering



**5G TECHNOLOGY:
MOBILE NETWORK EVOLUTION**

Introduction

Mobile networks were originally designed for voice traffic (2G). Progressively, the nature of the traffic has evolved towards more complex data services such as SMS, Internet access or mobile TV. Vendors and mobile operators were able to support this development by introducing new types of modulations, access technologies and network technologies. However, the evolution of mobile networks over the last ten years is undoubtedly compared to the tsunami of the need for bandwidth triggered by the reduction of the mobile data cost of subscriptions, always on customers, mobile video streaming from smartphones and especially with the use of connected objects, drones, virtual reality and very soon Autonomous Cars.

The 5G succeeds the 4G “LTE” (Long Term Evolution) radio communication standard. This one already offers very high bit rates, but the 5G will go further with a throughput up to 30 times that of 4G. Its introduction responds to the exponential growth of data traffic in mobile networks, strong increase in the use of connected objects and the growing desire to guarantee an optimized and uniform user experience across the entire radio spectrum both in the licensed frequency bands or without licensing. The 5G promises to be a catalyst in the industry of smartphones, connected objects, Virtual reality and cars autonomous.

The purpose of this document is to give an overview of the 5G technology, and share some information’s related of stakes of the 5G and different uses and fields of application

1. What is 5G?

The goal of mobile communication system is to provide improved and flexible services for a larger number of customers with a good user experience. This objective results in a big challenge for the wireless technology that is increasing system capacity and quality within the limited available frequency spectrum.

Unlike the transition from 3G to 4G, whose progress was limited due to a lack of capacity, experts describe the 5G technology as the next major proposed phase of mobile telecommunications standards beyond current standards. In addition to being 30 times faster than 4G, the future network should especially be able to connect up to a million objects per square kilometer, a fundamental element in these intelligent and ultra-connected cities that specialists dream. According to the Gartner Institute, the number of connected objects is expected to increase from 6.4 billion in 2016 to 21 billion by 2021.

In February 2017, the 3GPP SA WG1 listed the requirements on performance targets and basic capabilities for the 5G system. The specification was characterized by:

- A Support for fixed, mobile, wireless and satellite access technologies;
- A scalable and customizable network that can be tailored to requirements from multiple services and vertical markets (e.g., network slicing, Network Function Virtualization);
- An efficiency in Resource for services ranging from low data IoT services to high bitrate multimedia services;
- An efficiency in energy and battery power optimization;
- A network capability exposure to allow 3rd party Internet Service Providers and Internet Content Providers to e.g. manage network slices, and deploy applications in the operator's Service Hosting Environment;
- An indirect connectivity from a Remote UE via a Relay UE to the network, and service continuity between indirect connections and direct connections.

This specification (TS22.261) has been submitted for approval at the plenary meeting of 8-10 March 2017 to the technical specifications department (TSG SA # 75)

"5G" is the word that was on everyone's lips during the Mobile World Congress 2017 in Barcelona. And for good reasons, the International Telecommunication Union (ITU) is beginning to clarify fifth-generation standards, several operators and vendors have already started testing the new initial 3GPP 5G New Radio (NR) specification. By the second half of 2017 the focus of 3GPP work will shift to Release 15 specifications, to deliver the first phase of 5G standards in June 2018.

Finally, the 5G should be much more efficient and ecological, thanks to its capacity to adapt to different uses. It is hoped to significantly reduce the energy consumption of networks and terminals.

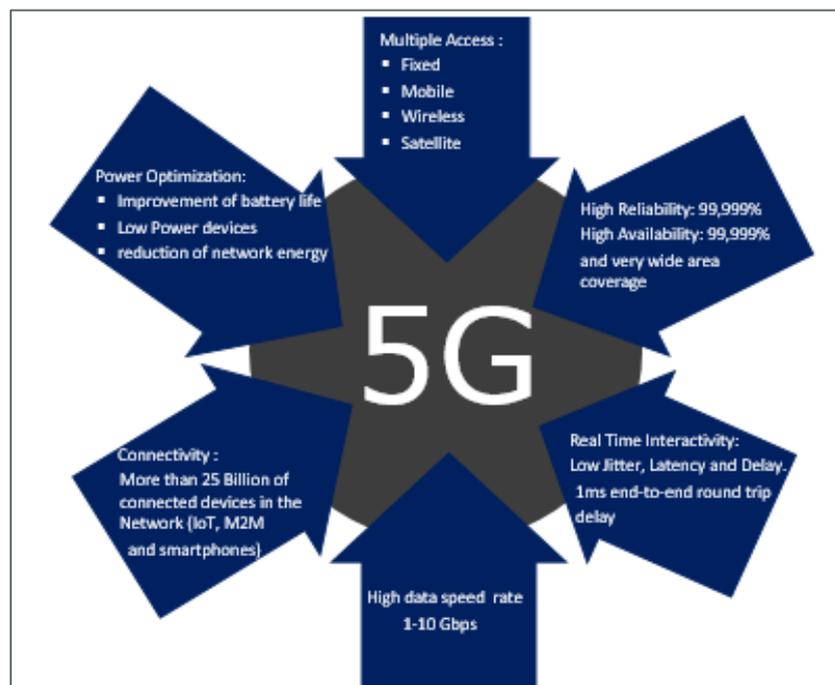


Fig 1: Criteria and requirements for 5G

2. 5G Network Architecture

For this new technology, the 3GPP has opted for a new logo and unlike the 4G network which had the official name LTE, the 5G will also be called 5G. The new logo and nomenclature will be defined in Release 15 of 3GPP.

Although there is no defined standard for the air interface and other parts of this new network, the 3GPP working groups are already discussing what might be the architecture of tomorrow's network. Below is one of the logical architecture under discussion within the group.

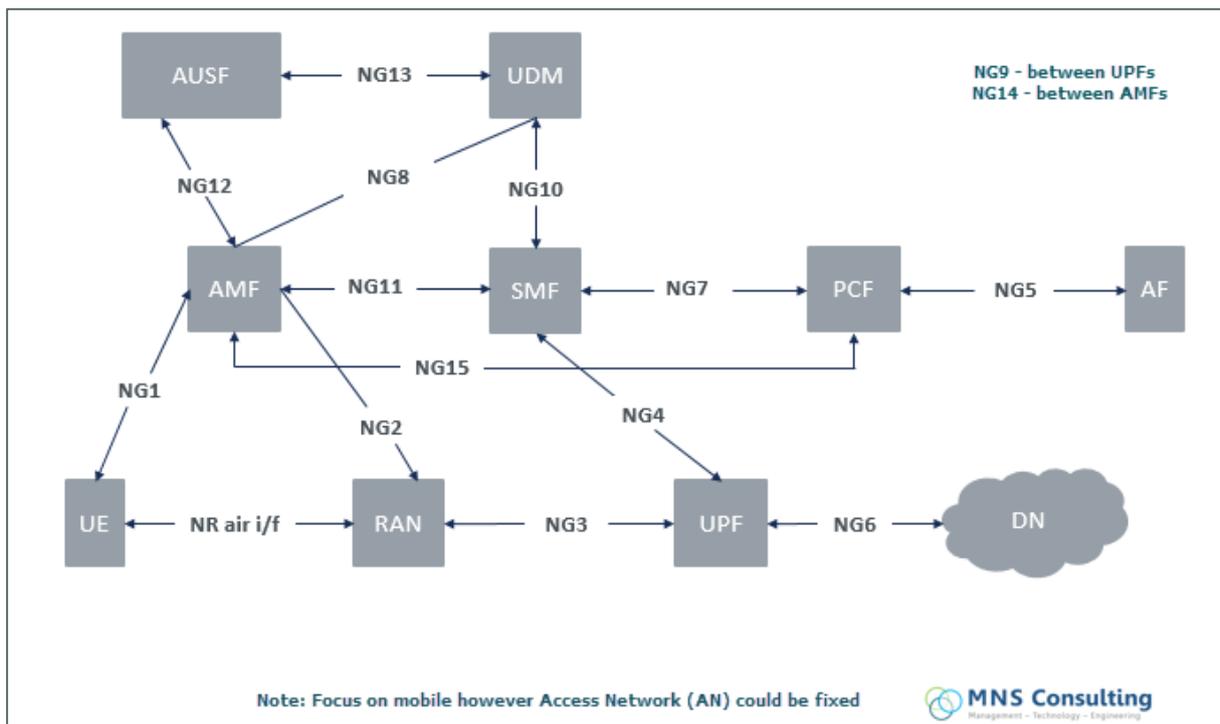


Fig 2: 5G Logical Architecture

Source: Andy Sutton, Principal Network Architect – Chief Architect's from British Telecom –
<http://www.slideshare.net/3G4GLtd/5g-network-architecture-and-design>

Find below Functional blocks signification:

- ✓ AUSF = Authentication Server Function
- ✓ UDM = Unified Data Management
- ✓ AMF = Core Access and Mobility Management Function
- ✓ SMF = Session Management Function
- ✓ PCF = Policy Control Function
- ✓ AF = Application Function
- ✓ UE = User Equipment
- ✓ RAN = Radio Access Network
- ✓ UPF = User Plane Function
- DN = Data Network, e.g. operator services, Internet or 3rd party services

3. 5G Challenges

The 5G is not an evolution of 4G, it is a brand new mobile system which aim to pool all Research & Development efforts to achieve a single standard for a global system. The concept of uniqueness for a global mobile system was tested with the 4G which was the first mobile system actually designed from the outset for global standardization.

Many promises are made around the 5G, the expectations of operators and vendors for the development of new business opportunities are many. On the side of the regulation one expects a specification more supplied than that of the preexisting technologies. While the specificities of the network of tomorrow are still being developed, it is already known that it will have to meet several major challenges:

- **Deployment:** 5G deployment will generate enormous blows (CAPEX), it will be necessary to invest enormously for the installation of the new radio nodes as well as for the modernization of the transmission links. According to *Anritsu*, 5G will be challenged to further develop CRAN as another evolution in network design, complementing the user and control plane separation in the move towards more flexible cloud based networks. In this concept, some functions of the RAN are moved from the cell site back into a consolidated baseband cloud service.
- **IoT and Connectivity:** 5G will accelerate the commercialization of IoT, in the future years we will see a strong growth of the uses of connected objects. So, one of the challenges of 5G will be to facilitate their integration, their interoperability, manage the high growth of the data traffic volume that will be generated but also their security, to obtain a fluid communication between objects from different systems.
- **Security:** This is one of the most important challenges that 5G needs to ensure the protection of personal data. 5G will have to define the uncertainties related to security threats including trust, privacy, cybersecurity, which are growing across the globe.
- **Data volumes:** In comparison to the traditional human to human traffic in cellular networks, we will discover new types of connected devices and great number of Machine to Machine (M2M) devices in a cell may cause serious system challenges i.e. radio access network (RAN) challenges, which will cause overload and congestion.
- **Smartphones:** In 2016 we recorded a 2.3% decline in sales of smartphone worldwide, a total of 1.47 billion units according to the *IDC research firm*. Only the premium smartphone of the American giant Apple and Chinese Huawei have been able to stand out in market. With the arrival of the 5G in 2020 is expected therefore an increase in sales because for several consumers wanting to take advantage of the services of the new Networks will need to be procured a new terminal.

- **Air Interface:** So far, the access and modulation technique for the 5G standard are not yet definitively known. Concerning the frequencies that will be used some evokes in particular the band from 3G to 30Gbps, the major challenge will be to harmonize the band to be used for 5G find the common usable frequencies for the countries worldwide will not be an easy task. The Member States of the European Union are given until 2020 to release the frequency band 700Mhz because it is the latter that must be attributed to the 5G at first.
- **Economy and Ecology:** 5G is expected to reduce costs for mobile data services, both for traditional uses and for professional uses. Behind this economic challenge is also a challenge for sustainable development. The automated integration of all data from disparate meters will make it possible to rationalize energy expenditure and therefore to save energy and contribute to the green. So, the 5G should prove capable of connecting equipment's with low energy consumption and with a duration of several years.

4. Real 5G use cases and areas of application

The promises of the 5G go beyond its incredible speed, with an expected throughput much greater than the bit rates offered by existing technologies. Some may wonder why so many capacity requirements. In reality, the 5G technology are much deeper. Indeed, this new standard will be the first to be designed to take into account a fully 100% connected world. It should connect not only our smartphones, tablets, computers but also connected objects as varied as our clothes, household appliances, cars, street furniture or even plants which will ensure 100% connectivity. Gartner estimates that our planet will have more than 20 billion of these intelligent objects by 2020, and we will attend a tremendous growth in the number of data to be processed, which can be very useful for decision-making in several sectors: economic, political, demography, GIS, environmental and socio cultural.

The following figure from GSMA maps various uses cases against their needs for speed and for fast response time. The sky-blue area shows which services will benefit from 5G speed improvement, or low improvements, or both.

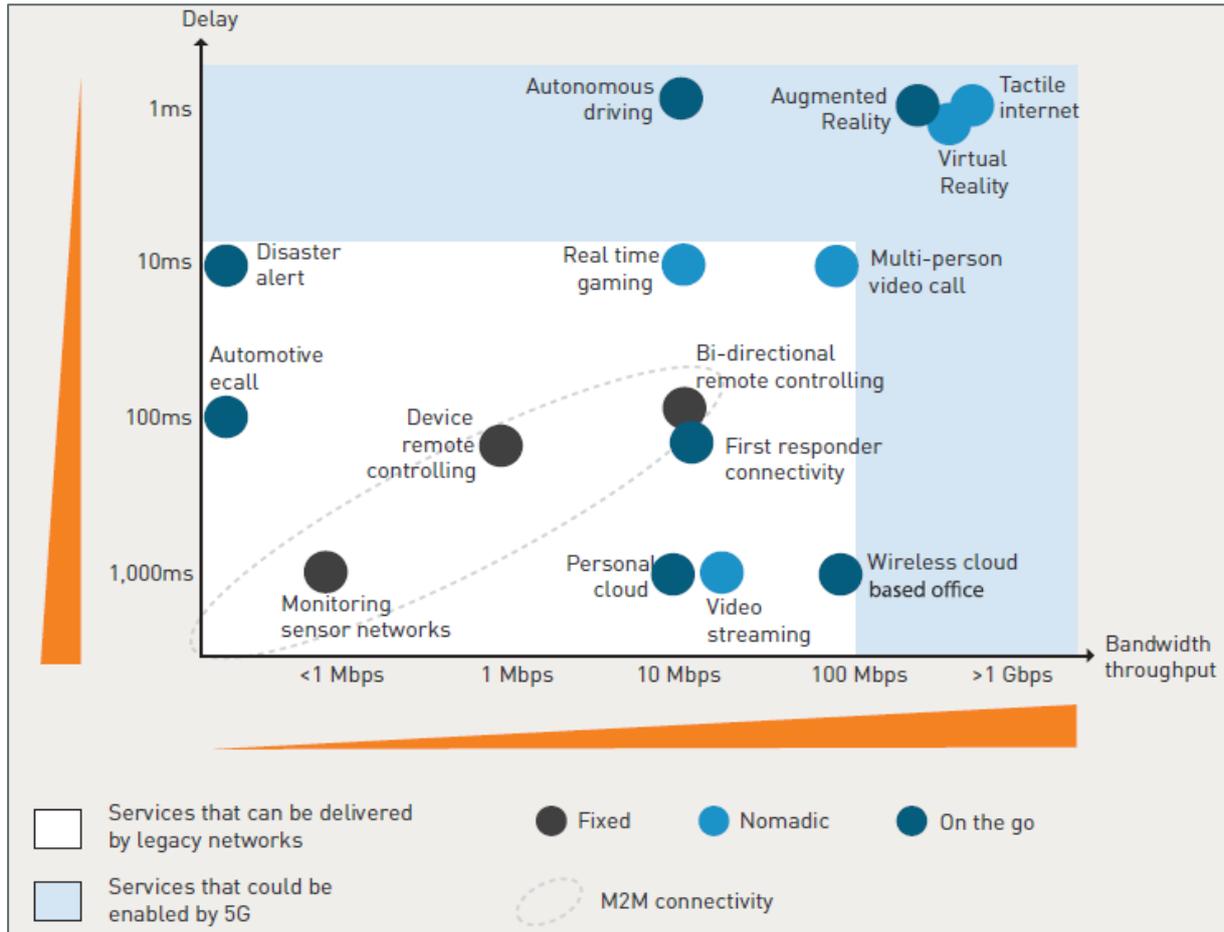


Figure 3: Bandwidth and latency requirements of potential 5G use cases

Source: GSMA Intelligence

This technology has enormous potential in several industries, and will contribute to the creation of new markets in all sectors of activity that men face in their dailies. The many applications resulting from this future network will also allow the creation of new jobs within some companies. Below are some examples of application domains:

- Transport:** The exchange of information between the vehicles communicating with each other would make it possible to set up a road traffic management system in urban areas to limit congestion but also to limit the numbers of accidents at motorways. We also announce the very next arrival of the autonomous cars which will be able thanks to the connected objects and the speed of the 5G and its latency to reduce some human errors on our roads.
- Healthcare systems:** With the advances in medicine and new technologies in sensors, IoT and mobile networks mainly expectations of 5G with high throughput, high availability and low latency, one will be able to witness operations by a remote robot controller by a surgeon located somewhere in the world, or take blood pressure, auscultate and examine in real time patients (elderly, disabled ...) who cannot move to the hospital.

- **Smart City:** With the growth of the population's density in the big cities, come the problems of resource management (energy, water, waste ...). Equipping the various urban facilities with communication capacities (taps, red lights, bus shelters, garbage bins ...) is to collect valuable data to monitor their operation and optimize the consumption of resources. If these different equipment (buses, faucets, streetlights ...) communicate with different technologies, this increases the CAPEX / OPEX and complicates the work of data collection and synchronization of the equipment between them. Adopting a single standard will produce chips / sensors in larger quantities so this will reduce costs and simplify their installation and operation. Hence the need for 5G.
- **Education:** By combining Tactile Internet and Virtual Reality, the future experience in teaching and learning could go far beyond today's experience. This can remove the physical location constraint for experimental practices, and facilitate and enable the sharing of resources between larger numbers of students irrespective of their current location. The impact would be more significant in hands-on experience with expensive equipment and facilities.

5. African Market

The development of Mobile Data has led to several changes in the telecommunications market in all African countries. The pricing of data services must therefore evolve to be sufficiently relevant and in line with the challenges that this transformation generates, but it is clear that in several countries of the continent, access to mobile data services is still a major brake the growth of these technologies.

The invasion of the mobile terminals market in Africa by Asian brands has reduced the cost of purchasing smartphones and made access to mobile data services accessible to a large proportion of the population, given that this has long Has been a barrier to adoption of mobile data technologies (3G & 4G) in some African countries. The Asian suppliers will be the solution again for 5G terminals and the connected objects still little known by a majority of the African populations who already find them a little expensive for the average consumer's portfolio.

Despite the dizzying growth rates observed in recent years in the mobile telecommunications sector in Africa, it is possible to highlight the delay experienced by some countries in sub-Saharan Africa, mainly in Francophone Africa, in the deployment of 3G / 4G technologies. According to experts, in 2022 Africa will experience a high rate of progress in mobile data networks subscriptions. 4G coverage rate will be more than 25%, Internet of things (IoT) connections will grow from 11 million in 2016 to 75 million connections and mobile broadband around 83% subscriptions. These statistics show the enormous potential of mobile data in Africa, players in the telecommunications sector needs to be ready to relieve these challenges.

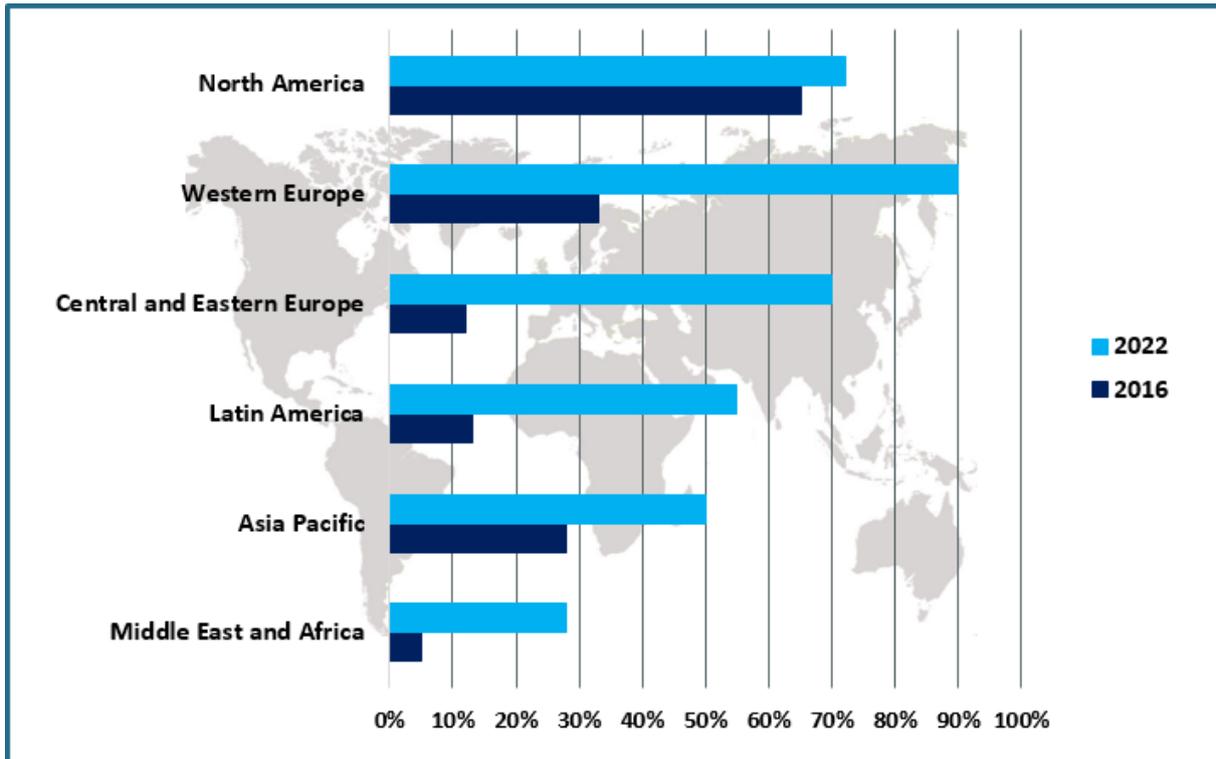


Fig 4: LTE network mobile subscriptions by region

Source: Ericsson mobility report November 2016

Several operators have already announced their interests and are already preparing for the modernization of their networks in the expectations of the network of the future, among them Tunisia Telecom which through its CEO announced the modernization of transmission capacities of its wired network waiting for the 5G while specifying that preparing for this wait would not be easy. Apart from the example of Tunisia Telecom, we can also mention the South African ISP WBS which so far relies on Vodacom to deploy its Wifi LTE-A to declare that it intends to switch to 5G in 2020 to ensure the its services and position itself as a leader in this technology.

Hamilton Telecom has announced that it would like to relaunch Uganda Telecom after its acquisition with 5G technology. Telecommunications actors in Africa therefore remain very attentive to the evolution of 5G standards and would be ready to embark on the 5G experiences which would then offer many opportunities and create a new way of doing business.

