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 mobile data cost, 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, to the 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 and unlicensed frequency bands. The 5G promises to be a catalyst in the industry of smartphones, connected objects, Virtual reality and autonomous cars.

The purpose of this document is to give an overview of the 5G technology, and share some information on the stakes and different use cases 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 continuously increasing system capacity and quality within a 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 of. 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 evolutive 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 capability to adapt to different use cases. It is hoped to significantly reduce the energy consumption of networks and terminals.

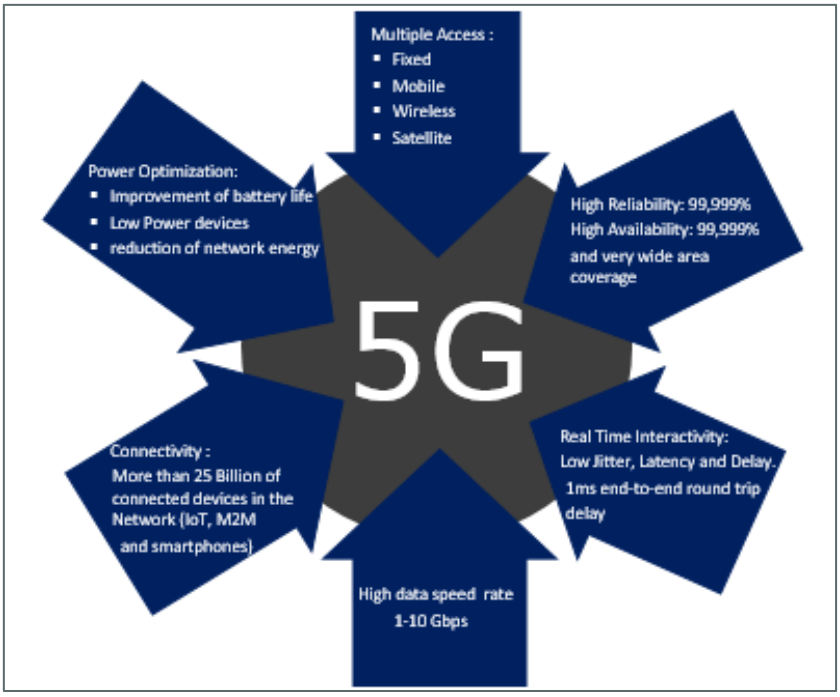

Fig 1: Criteria and requirements for 5G

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.

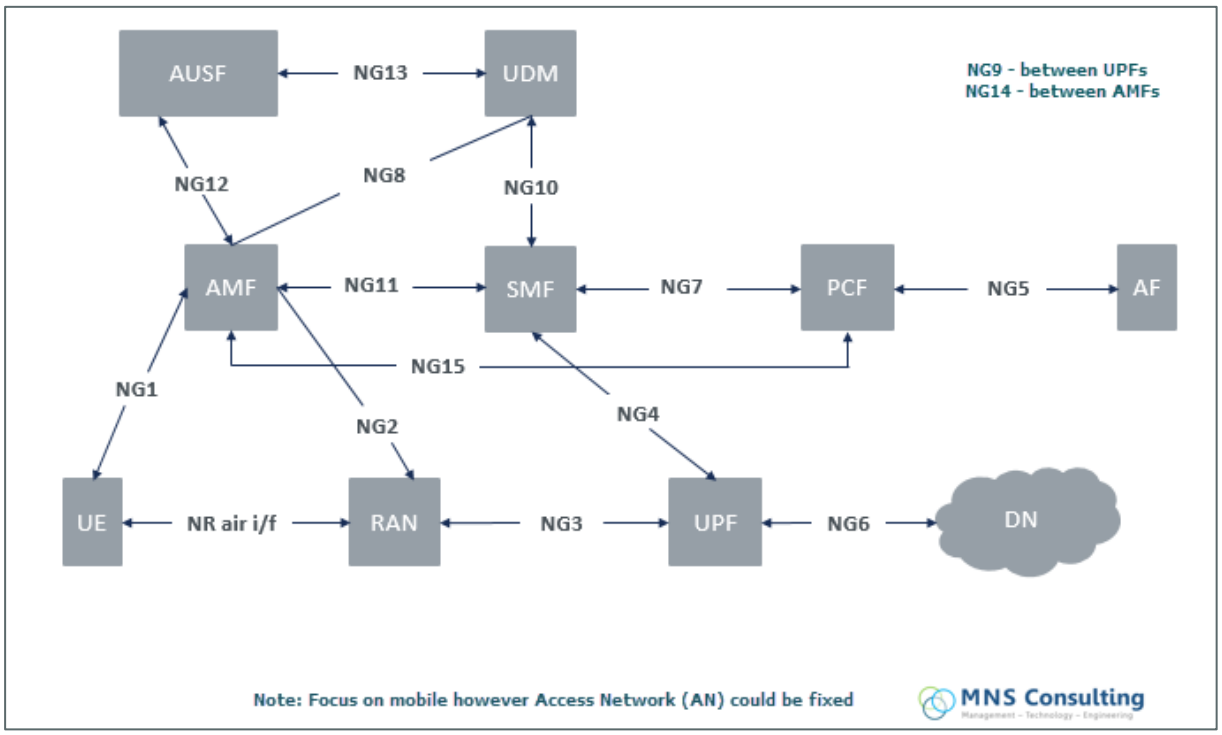

Fig 2: 5G Logical Architecture

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 aims at pooling 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 high. While the reality of the network of tomorrow is still being developed, it is already known that it will have to meet several major challenges:

- **Deployment:** 5G deployment will generate important expenses (CAPEX) as 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 (Cloud-RAN) 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 roll-out of IoT and in the future years we will see a strong growth of connected objects use cases. Key challenges of 5G will be to facilitate their integration, interoperability, growth management of the data traffic volume but also their security in order to obtain a fluid communication between objects from different systems.

- **Security**: Personal data protection is one of the most important challenges that 5G needs to address. 5G will have to deal with different security threats including trust, privacy, cybersecurity, which are growing across the globe.

- **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 we expected an increase in the smartphone sales as consumers will want to take advantage of the new network.

- **Air Interface:** So far, the access and modulation technique for the 5G standard are not yet definitely known. One of the major challenge will be to harmonize the bands to be used for 5G for the countries worldwide and this will not be an easy task. The Member States of the European Union for instance are given until 2020 to release the 700Mhz frequency band as it is the one to be dedicated to 5G at first.

- **Economy and Ecology:** 5G is expected to reduce costs for mobile data services, both for personal and for professional usage. Behind this economic challenge is also a challenge for sustainable development. The automated integration of all data from diverse meters will make it possible to rationalize energy expenditure and therefore to save energy and contribute to the green transformation endeavor. So, the 5G should prove itself capable of connecting equipment with low energy consumption for a duration of several years.

4. Real 5G use cases and areas of application

The promises of the 5G go beyond its incredible speed and higher throughput than the bit rates offered by existing technologies. Some may wonder why such high capabilities. Indeed, this new standard will be the first to be designed to host a fully connected world. It should connect not only our smartphones, tablets, computers but also connected objects as diverse as our clothes, household appliances, cars, streets, ... etc. Gartner estimates that our planet will have more than 20 billion of these intelligent objects by 2020, and we will witness a tremendous growth in the amount of data to be processed, which can be, by the way, very useful for decision-making in several sectors: economical, political, demography, GIS, environmental and social.

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

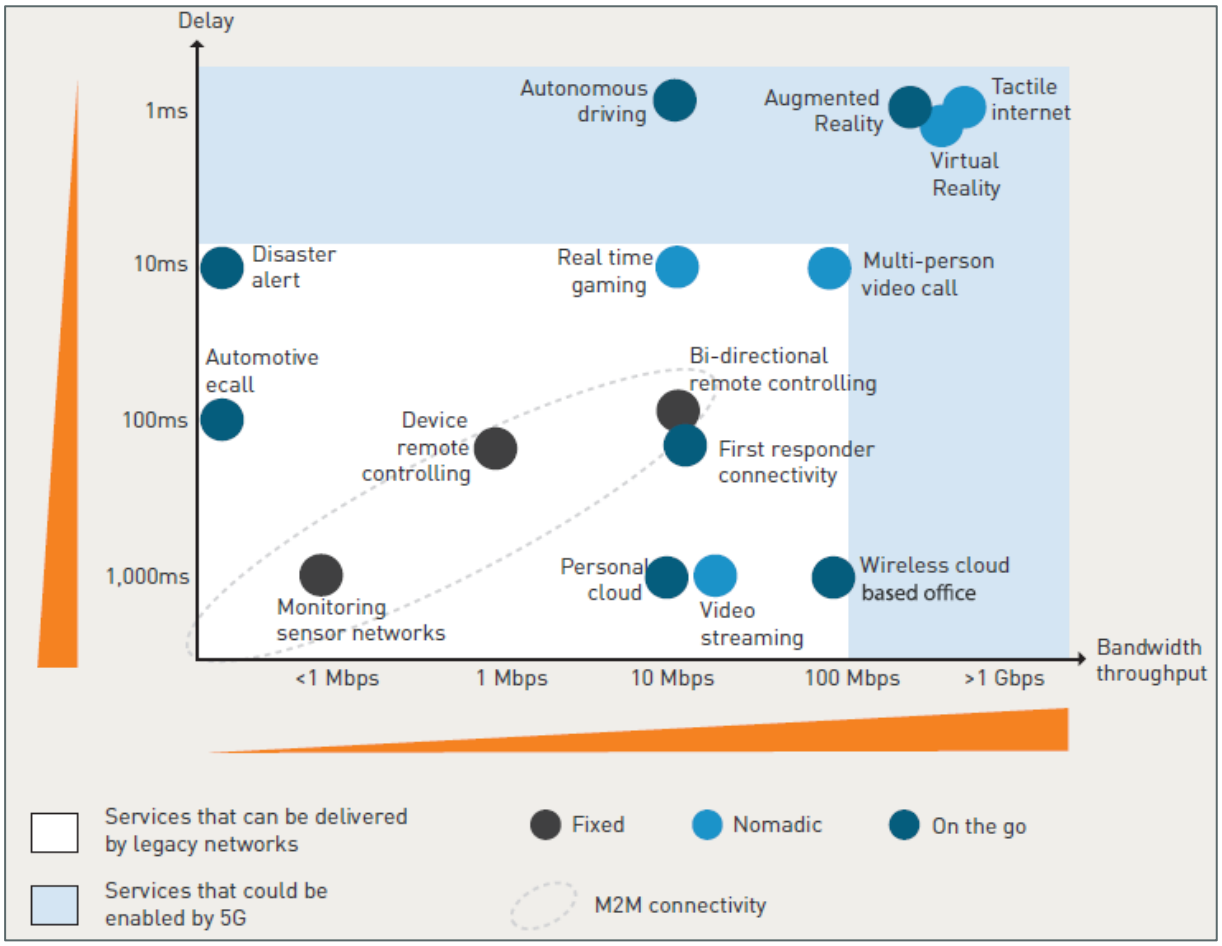

Figure 3: Bandwidth and latency requirements of potential 5G use cases

Source: GSMA Intelligence

5G technology has enormous potential in several industries and will contribute to the creation of new market opportunities in many sectors. The many applications resulting from this future network will also allow the creation of new jobs. 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, the speed of the 5G and its latency, to reduce some human errors on our roads.

- **Healthcare systems:** With the breakthroughs in medicine and new technologies in sensors, IoT and mobile networks main expectation from 5G will be to be able to witness operations through 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 capabilities (taps, red lights, bus shelters, garbage bins ...) will allow the collection of valuable data for cities to monitor their operations and to 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 which will reduce cost 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 lab activities 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. It is however clear that in several countries in the continent, access to mobile data services is still a major brake to the adoption and growth of these technologies. Along with the service pricing by operators, the devices price has been an important issue for long also.

The invasion though of the mobile terminals market in Africa by Asian brands is reducing the cost of purchasing smartphones and is making access to mobile data services more and more accessible to a large proportion of the population. The Asian suppliers will be the solution again for 5G terminals and the connected objects.

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 will reach around 83% of subscriptions. These statistics show the important potential of mobile data in Africa and the players in the telecommunications sector need to be ready to address these challenges.

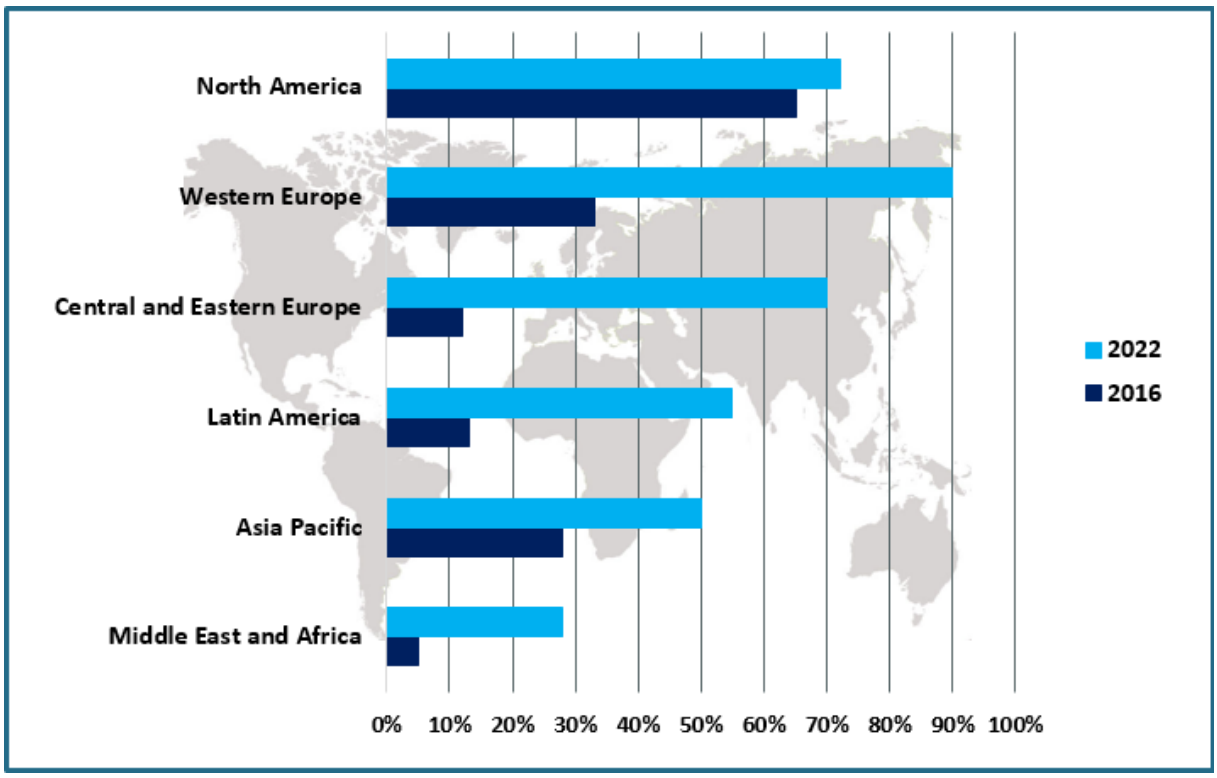

Fig 4: LTE network mobile subscriptions by region

Source: Ericsson mobility report

Several operators have already announced their interests and are already preparing for the modernization of their networks of the future. Among them Tunisia Telecom which through its CEO announced the modernization of transmission capacities in anticipation of its future 5G network. 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. WBS has declared its intention to switch to 5G in 2020 to ensure 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 trend which would offer for sure many opportunities and create a new way of doing business.

6. About MNS

MNS Consulting is an international management and engineering consulting firm specialized in the telecommunications and digital industry. We distinguish ourselves with a strong combination of deep technological expertise and strategic vision that allows us to address the challenges of our clients. We are committed to delivering outstanding consulting services and highest value to our clients by helping them to drive growth, manage complexity, and improve operations and performance in a complex and fast changing market. Our engineering consulting capabilities and expertise are structured around the 6 fields of activities below.

MNS is headquartered in Paris and has also operations in Africa and the Middle East.

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