

An Overview of 5G Technology

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Abstract: 5G—“connect anytime, anywhere, anyhow” promising everywhere network access at high speed to the end users, has been a topic of great interest mainly for the wireless telecom industry. 5G seems to be the solution for the growing user necessities of wireless broadband access and the boundaries of the existing wireless communication system. The wireless industry is busy with the standardization of the 4th generation (4G) cellular networks. The 4G standards are expected to be concluded in the next year or two. 4G wireless system cannot exist in today’s market without standardization. The 4G concept have already moved to the standardization phase, we must begin to work on the structure blocks of the 5G wireless networks. The major difference, from a user point of view, between current generations and expected 5G techniques must be increasing data speed, low battery consumption, more secure. The development of 5 G technologies is a cornerstone for realizing breakthroughs in the transformation of ICT network infrastructure. Ultra- broadband and intelligent-pipe network features that achieve near- instantaneous, “zero distance” connectivity between people and connected machines – no matter where they are – are just the first step. In this paper also we discuss architecture, waveform concept, requirements etc.

Keywords- 5G, zero distance, speed, performance Use this style for subheadings

1. INTRODUCTION

A new mobile generation has come approximately every 10 years since the first 1G system, Telephone, was introduced in 1982. The first 2G system was commercially came in 1992, and the first 3G system came in 2001. 4G systems fully compliant with IMT Advanced were first standardized in 2012. The development of the 2G (GSM) and 3G (IMT- 2000 and UMTS) standards took about 10 years from the official start of the R&D projects, and development of 4G systems began in 2001 or 2002. In April 2008, NASA assists with Machine-to-Machine Intelligence (M2Mi) Corp to develop 5G communication technology.

As the different generations of cellular telecommunications have evolved, each one has brought its own improvement. The same will be true of 5G technology.

- First generation, 1G: These phones were analogue and were the first mobile or cellular phones to be used. Although revolutionary in their time they provide very low levels of spectrum efficiency and security.
- Second generation, 2G: These were based around digital technology and provide much better spectrum efficiency, security and new features such as text messages and low data rate communications.
- Third generation, 3G: The main goal of this technology was to provide high speed data. The original technology was enhanced to allow data up to 14Mbps and more.
- Fourth generation, 4G: This was an all-IP based technology capable of providing data rates up to 1Gbps.

Any new 5th generation, 5G cellular technology needs to provide significant benefits over previous systems to give an enough business case for mobile operators to invest in any new system. Facilities that might be seen with 5G technology include far better levels of connectivity and coverage. The term World Wide Wireless Web or WWW is being coined for this. For 5G technology to be able to achieve this, new methods of connecting will be required as one of the main drawbacks with previous generations is lack of coverage, dropped calls and low performance at cell edges. 5G technology will need to address this.

A) 5G specifications

Although the standards bodies have not yet defined the parameters needed to meet a 5G performance level yet, other organizations have set their own aims that may eventually influence the final specifications.

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SUGGESTED 5G WIRELESS PERFORMANCE	
PARAMETER	SUGGESTED PERFORMANCE
Network capacity	10 000 times capacity of current network
Peak data rate	10 Gbps
Cell edge data rate	100 Mbps
Latency	< 1 ms

These are some of the ideas being put forwards for a 5G standard, but they are not accepted by any official bodies yet.

2. 5G MOBILE NETWORK ARCHITECTURE

Figure 1 shows network architecture for 5G mobile systems. Architecture of 5G is highly advanced; its network elements and various terminals are characteristically improved to allow a new situation. Likewise, service providers can implement the advance technology to accept the value-added services easily. It is all-IP based model for wireless and mobile networks interoperability. The IP technology is designed exclusively to ensure sufficient control data for appropriate routing of IP packets associated to a certain application connections i.e. sessions between client applications and servers somewhere on the Internet. The system resides of a user terminal (which has a crucial role in the new architecture) and a number of free, autonomous radio access technologies. Within each of the terminals, each of the radio access technologies is examine as the IP link to the outside Internet world. However, there should be different radio interface for each Radio Access Technology (RAT) in the mobile terminal. For an example, if we want to have access to four different RATs, we require to have four different accesses - specific interfaces in the mobile terminal, and to have all of them effective at the same time, with aim to have this architecture to be functional.

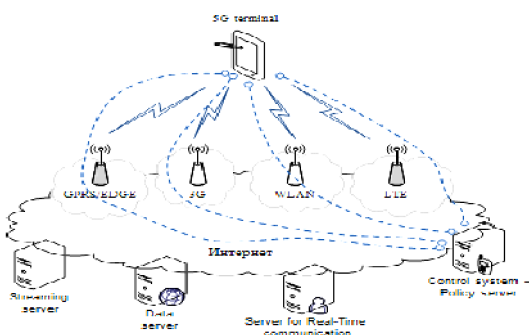


Fig.1. Functional Architecture for 5G Mobile Networks

3. 5G WAVEFORM BACKGROUND

Orthogonal frequency division multiplexing has been an excellent waveform choice for 4G. It provides superior spectrum efficiency, it can be processed and controlled with the processing levels achievable in current mobile handsets, and it operates better with high data rate stream covering wide bandwidths. It performs well in situations where there is selective fading. However with the advances in to achieve a result of capabilities that will be available by 2020 when 5G is wanted to have its first cast means that other waveforms can be considered. There are several advantages to the use of new waveforms for 5G. OFDM wants the use of a cyclic prefix and this occupies space within the data streams.

There are also other benefits that can be introduced by using one of a variety of new waveforms for 5G. One of the key requirements is the opportunity of processing power. Although Moore's Law in its basic form is running to the limits of device feature sizes and further advances in miniaturization are unlikely for a while, other techniques are being developed that mean the energy of Moore's Law is able to continue and processing capability will increase. As such new 5G waveforms that need additional processing power, but are able to provide additional advantages are still viable.

A) 5G waveform requirements

The potential applications for 5G containing high speed video downloads, gaming, car-to-car / car-to-infrastructure communications, general cellular communications, IoT / M2M communications and the like, all place requirements on the form of 5G waveform scheme that can support the required performance. Some of the key requirements that need to be provided by the modulation scheme and overall waveform include:

- Capable of handling high data rate wide bandwidth signals
- Capable to provide low latency transmissions for long and short data bursts, i.e. very short Transmission Time Intervals, TTIs, are required.
- It give fast switching between uplink and downlink for TDD systems that are likely to be used.
- Allow the possibility of energy efficient communications by minimizing the on-times for low data rate devices. These are a few of the necessity that are needed for 5G waveforms to support the facilities that are needed.

4. FEATURES OF 5G

To enhance such a wide range of technologies, 5G obviously have to concentrate on some parameters which lead to the requirements and capabilities for the network to differ from other generations. Some of them are listed below Energy consumption and low cost: It has been always the great

challenge for mobile communication to provide the services and features for low energy and low cost. However, to avail all the services for wireless sensor network wherein we have millions of sensors, subsystems and actuators connected, work has been done in many energy efficient protocols and algorithms and thus in 5G they are yet to be implemented.

Performance of Network:

As the device energy consumption was up to manageable with high energy efficient algorithms there exists a problem of 'High Network Energy Performance' which is again a major emerging task for operator. Recent technologies are relying on large solar panels for power supply, thus the energy problems in remote areas are widely handled by these solar panels. so energy efficient of large network is always a challenge for an operator to fulfill all its services.

Lower Latency:

Latency is mainly defined as the delay response of the device. as the name suggest, it is the important parameter to achieve the promising services as higher data rates and high response time. However, to achieve the low latency it's always been a challenge for developers. As the 5G deals with higher data rates there exists a main issue of how to lower the latency. To support such lower latency applications should be given end-end latency of less than 1ms. It is somehow achieved for fast growing applications as

- Traffic safety
- Control of infrastructure
- Industrial processes

High availability & Reliability:

Another important aspect after lower latency is high availability and high reliability. High reliability includes the system services as well as hardware architecture where in high availability includes the channel bandwidth, providing a higher bandwidth is again a difficult task. Connectivity with the required characteristics is essentially available with less deviation. Very large System Capacity: Traffic services for cellular communication systems are dramatically increasing. To enhance with such traffic in simple way, 5th Generation networks must be capable of transferring data at much lower cost on bit rate compared to present networking system. However, in order to operate with the same or even lower the energy consumption, 5G has to work on lower energy consumption per bit delivered.

As compared with present scenario 5G system must be capable of supporting huge number of devices. Thus it's again a challenge for 5G operation in millions of wireless sensor networks which include sensors, actuators, sink, and sources etc. This challenge is mainly in terms of efficient use of protocols.

5. OTHER 5G CONCEPTS

There are many new concepts that are being examined and developed for the new 5th generation mobile system. Some of these involve:

- Pervasive networks:** This technique being considered for 5G cellular systems is where a user can together be connected to several wireless access technologies and seamlessly moves between them.
- Group co-operative relay:** This is a technology that is being considered to make the high data rates available over a wider area of the cell. Currently data rates decreasing towards the cell edge where interference levels are higher and signal levels lower.
- Cognitive radio technology:** In case cognitive radio technology was used for 5th generation, 5G cellular systems, then it would allow the user equipment / handset to see at the radio landscape in which it is located and choose the best radio access network, modulation scheme and other specification to configure itself to gain the best connection best performance.
- Wireless mesh networking and dynamic ad-hoc networking:** With the variety of different approach schemes it will be possible to link to others adjoining to provide ad-hoc wireless networks for much speedier data flows.
- Smart antennas:** Next major element of any 5G cellular system will be that of smart antennas. Using these it will be available to alter the beam direction to allow more direct communications and limit interference and increase overall cell capacity.

6. 5G TECHNOLOGY REQUIREMENTS

In current years there have been several aspects about the ultimate form that 5G wireless technology should take. There have been two aspect of what 5G wireless technology should be:

- Hyper connected view:** This view of the requirements for 5G wireless systems goals to take the existing technologies including 2G, 3G, 4G, Wi-Fi and other relevant wireless systems to serve higher coverage and availability, along with more dense networks. Apart from having requirements to give traditional services, a key differentiator would be to enable new services like Machine to Machine, M2M applications along with added Internet of Things, IoT applications. This set of 5G requirements could require a new radio technology to allow low power, low throughput field devices with long battery lifetimes of ten years or more.
- Next generation radio-access technology:** This aspect of the 5G requirements takes the more technology driven view and sets specifications for data rates, latency and other key specification. These requirements for 5G would enable a clear demarcation to be made between 4G or other services and the new 5G wireless system.

In order to meet the industry and user wants, it is necessary to accommodate all requirements within the definition process, ensuring that the final definition meets the majority of users wants without becoming so demanding that any system cannot succeed.

A) 5G requirements summary

By accounting for the majority of wants, the following set of 5G requirements is gaining industry acceptance.

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

One of the key concerns with the 5G requirements is that there are many different interested parties involved, each wanting their own requirements to be met by the new 5G wireless system. This leads to the fact that not all the requirements form a consistent list. None of the technology is going to be able to meet all the needs together.

As a result of these widely varying necessities for 5G, many anticipate that the new wireless system will be an umbrella that authorize a number of different radio access networks to work together, each meeting a set of needs. As very high data download and ultra low latency concerns do not easily sit with low data rate and long battery life times, it is likely that different radio access networks will be want for each of these requirements. Accordingly it is likely that various mixtures of a subset of the overall list of requirements will be supported when and where it matters for the 5G wireless system.

7. CONCLUSION

5G will give the foundational infrastructure for building smart cities, which will push mobile network performance and capability requirements to their extremes. 5G will provide great speed and enough capacity; it's like wherever the mobile station moves there will be no drop in speed even though any numbers of mobile users are connected to the network at the same time. It supports interactive multimedia, voice, video Internet and other broadband services, greater effective and more attractive, and has Bi- directional, accurate traffic statistics. It will give unbelievably fast broadband speeds, but more importantly it will have enough capacity wherever you go to achieve each function you want it to without a decrease in speed or connection, no matter how many people are connected at the same time.