

An Overview of 5G Technology

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Abstract:

5G (5th generation mobile networks) stand for the next major phase of mobile telecommunications standards beyond the current 4G/IMT advanced standards which describes the compatibility of 5G technology. 5G has speeds further what the present 4G can provide. From generation 1G to 2.5G and from 3G to 5G this world of telecommunication has seen a number of advancement along with improved performance with every passing day. This fast change in mobile computing gives us change our day to day life that is way we work, interact, learn etc. This paper also highlight on all preceding generations of mobile communication along with fifth generation technology. 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, 4G/IMT advanced, WWW, DAWN, Flat IP, real wireless world.

1. Introduction

The new mobile generation came approximately every 10 years since the first 1G system was launched, Telephone, was introduced in 1982. In 1992 the first 2G system came 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.

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 the 3G 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.

The 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 coined for this. For 5G technology to be able to achieve this, new mechanism and 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.

II. 5G Mobile Network Architecture

The below figure shows the 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. Architecture of 5G mobile

III. 5G waveform background

Orthogonal frequency division multiplexing has been an excellent waveform choice for 4G. It provides superior spectrum efficiency, it can be controlled and processed with the levels of processing achievable in current mobile handsets, and it operates better with high data rate stream covering wide bandwidths. It performs well in any situations where there is selective fading.

The advance results of achieving better technology of 5G will come 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.

A) 5G waveform requirements

The potential applications for 5G containing high speed video downloads, car-to-car, gaming, car-to infrastructure communications, general cellular communications, IoT / M2M communications, 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.

IV. Other 5G concepts

There are some new concepts that are being examined for Developing 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, The 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 adhoc networking:** With the variety of different approaches schemes it will be possible to link with 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.

V. 5G technology requirements

In the current years there have been several aspects about the ultimate form that 5G wireless technology should take place. There are two aspect of what 5G wireless technology should be involved and they describes what actual view contents of 5G technology:

- **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 which serves higher coverage and availability, along with the more dense networks which gives more specification and better result. Apart from that 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 which serves most of the valuable gadgets to run fastly. 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 with good compatibility.
- **Next generation radio-access technology:** This aspect of the 5G requirements takes the more technology driven view and sets specifications for the data rates, latency and other key specification for 5G technology.. 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 for user specification, it is necessary to accommodate all requirements within the definition process, ensuring that the final definition meets the majority of users who wants without becoming so demanding that any system cannot succeed for their compatibility.

A) 5G requirements summary

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

- 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 more different interested parties involved in it, each wants their own requirements to be met by the new 5G wireless system. They are waiting to get the profit of 5G connectivity which led down 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 according to need of the client side. As very high data download from the server 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. This really increases the speed of the internet connection.

B) WHY NEED OF 5G?

- It provides a very high speed, high capacity, and low cost per bit.
- It supports interactive multimedia, voice, video, Internet and other broadband services, greater effective and more attractive, and has Bi-directional, accurate traffic statistics.
- It is supporting large broadcasting capacity up to Gigabit which supporting almost 65,000 connections at a time.
- 5G technology offers remote management that user can get better and fast solution.
- 5G technology offers Global accessing and service portability.
- It provides the high quality services due to high error tolerance requirements.
- 5G technologies provide high resolution for crazy cell phone user and bi-directional large bandwidth shaping.
- The uploading and downloading speed of 5G technology is very high.
- 5G technologies provide transporter class gateway with unparalleled consistency.

V. Advantages of 5G over 4G

- Peak Data Rate of 5G is 10Gbps where as 4G has 1Gbps.
- TTI(Transmission Time Interval) of 5G varies from 100microsec(min) to 4ms(max) but in 4G it is 1ms(milli sec).
- Latency of 5G is <1ms(radio) but in 4G it is 10ms(radio)
- Mobility of 5G is 500kmph where as 4G has 350kmph.
- Frequency Bandwidth of 5G is 3 to 300GHz where as in 4G is 2 to 8GHz.
- 5G provides services as (Dynamic information access, wearable devices, HD streaming, any demand of users) and 4G provides services as(Dynamic information access, wearable devices, HD streaming, global roaming).
- The core network used by 5G is (Flatter IP network, 5G networks interfacing (5G-IN)) and by 4G is (All IP Network).

VI. Future Scope:-

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 which is suggested for 5G wireless performance.

Typical parameters for a 5G standard may include:

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.

VII. Conclusion:

5G will give the foundational infrastructure for building smart cities, which will push mobile network performance and capability requirements to their extremes. 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.

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