5G MOBILE COMMUNICATION TECHNOLOGY: AN OVERVIEW

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Abstract - *With the advancement of technology, the services that can be obtained using the telecom networks have widened, as the expectations of the public. With applications like High-speed internet, Internet of Things, critical communications etc. the telecom network needs to support high data rate, low latency, reliability etc. All these varied requirements can only be supported through significant changes in the existing network. From the use cases for IMT 2020, there are several requirements from the user/device side and several requirements from the network side, which have to be supported in 5G to support the use cases. To satisfy the requirements, several technologies are being considered in 5G.*

The demand for mobile broadband will continue to increase in the next years, largely driven by the need to deliver ultra-high definition video. However, 5G networks will also be the platform enabling growth in many industries, ranging from the IT industry to the automotive, manufacturing industries entertainment, etc. 5G will enable new applications like for example autonomous driving, remote control of robots and tactile applications, but these also bring a lot of challenges to the network. Some of these are related to provide low latency in the order of few milliseconds and high reliability compared to fixed lines.

5G networks represent a shift in networking paradigms: a transition from today's "network of entities" to a "network of (virtual) functions". Indeed, this "network of (virtual) functions", resulting, in some cases, in the decomposition of current monolithic network entities will constitute the unit of networking for next-generation systems.This paper deals with an overview of 5G Technology.

***Key Words*: 5G, Evolution, Architecture, Applications, Challenges**

1. INTRODUCTION

In 1897 Guglielmo Marconi was the first to demonstrate that it was possible to establish a continuous communication stream with the ships that were sailing in the English Channel, by means of radio waves. Since then, the wireless technologies that make "on-the-move" communication possible for us have evolved remarkably.

Cellular Mobile Communication systems are wireless systems that divide a given geographical area into cells and use a large number of transmitters to communicate wirelessly within those cells. They provide mobility to the user within the cell, and when he/she moves from one cell to another, a 'hand-off' mechanism takes care of continuous connectivity. Therefore cellular communication ensures connectivity with a single network over a large geographical area.

Over the years, we have seen remarkable growth of cellular communication over the radio. With ever- increasing subscriber base and limited radio resource, providing quality telecom services became difficult. These issues led mobile service providers to research into technologies and improve the quality of service and be able to support more users in their systems. Wireless communication networks have become much more pervasive than anyone could have imagined when the cellular concept was first deployed in 1960's and 1970's. Mobile cellular subscribers are increasing by more than 40% per year. Therefore Cellular communication has been continuously evolving into newer forms.

Fifth generation technology offers very high bandwidth that user never experienced before. The Fifth generation technologies offer various new advanced features which makes it most powerful and in huge demand in the future.

The fifth generation wireless mobile multimedia internet networks can be completely wireless communication without limitation, which makes the perfect wireless real world – World Wide Wireless Web (WWWW).

The 5th wireless mobile internet networks are real wireless world which shall be supported by LAS-CDMA (Large Area Synchronized-Code Division Multiple Access), OFDM (Orthogonal Frequency - Division Multiplexing), MC-CDMA (Multi-Carrier Code Division Multiple Access), UWB (Ultra-Wideband), Network-LMDS (Local Multipoint Distribution Service), and IPv6. Fifth generation technologies offer tremendous data capabilities and unrestricted call volumes and infinite data broadcast together within the latest mobile operating system. Fifth generation should make an important difference and add more services and benefits to the world over 4G. Fifth generation should be more intelligent technology that interconnects the entire world without limits. This generation is expected to be released around 2020.

EVOLUTION

0G

At the end of the 1940's, the first Radiotelephone service was introduced, and was designed for users in cars to the public land-line based telephone network.

1G

1G referred to as **FIRST GENERATION MOBILE TECHNOLOGY,** was emerged in 1980's. It replaced 0G technology and introduced mobile technologies such as Mobile Telephone System (MTS), Advanced Mobile Telephone System (AMTS), Improved Mobile Telephone Service (IMTS), and Push to Talk (PTT). It uses analog radio signal which has frequency 150 MHz, voice call modulation is done using a technique called Frequency-Division Multiple Access (FDMA). It has low capacity, unreliable handoff, poor voice links, and no security at all since voice calls were played back in radio towers, making these calls susceptible to unwanted eavesdropping by third parties.

2G

2G is the **SECOND GENERATION MOBILE TECHNOLOGY**, based on digital technologies and in early 1990's. 2G provided services such as text message, picture messages, and the MMS. 2G system uses digital mobile access technology such as TDMA (Time Division Multiple Access) and CDMA (Code Division Multiple Access).

2.5G

2.5G is an extension of existing 2G network to have the capacity of launching packet-based services while enhancing the data rates supported by these networks. The term "Second and a half generation" is used to describe 2G-Systems that have implemented a packet switched domain in addition to circuit switched domain. GPRS, EDGE and CDMA 2000 were 2.5G technologies.

3G

3G THIRD GENERATION MOBILE TECHNOLOGY was invented in the year 2000. Comparing 1G & 2G technology to 3G, in 3G Data transmission speed increased to about 2Mbps. 3G technology is for the multimedia cell phone, typically it is called smartphone. It uses Wide Band Wireless Network with which clarity is increased. The data are sent through the technology called Packet Switching. Voice calls are interpreted through Circuit Switching. Along with verbal communication it includes data services, access to television/video, new services like Global Roaming. It operates at a range of 2100MHz and has a bandwidth of 15-20 MHz used for High-speed internet service, video chatting. 3G uses Wide Band Voice Channel that is by this the world has been contracted to a little village because a person can contact with other person located in any part of the world and can even send messages too.

4G

4G, **FOURTH GENERATION MOBILE TECHNOLOGY,** offers a downloading speed of 100Mbps. 4G provides the same feature as 3G and additional services like Multi-Media Newspapers, to watch TV programs with more clarity and send Data much faster than previous generations. LTE (Long Term Evolution) is considered as 4G technology. 4G is being developed to accommodate the QoS and rate requirements set by forthcoming applications like wireless broadband access, Multimedia Messaging Service (MMS), video chat, mobile TV, HDTV content, Digital Video Broadcasting (DVB), minimal services like voice and data, and other services that utilize bandwidth.

5G

5G **FIFTH GENERATION MOBILE TECHNOLOGY ,** wants to be the disruptive generation, the generation that no longer only caters to the needs of mobile operators and consumer communications, but which opens up new prospects and enables an extremely wide diversity of applications and use, unified within a single technology. 5G is setting itself up as an enabler of the digitization of society and the economy. 5G is targeting a wide variety of sectors, which will not necessarily have anything other than this technology in common, but which are central pillars in a society: energy, healthcare, media, industry, and transportation.

TABLE 1 : COMPARISON OF ALL GENERATIONS OF MOBILE TECHNOLOGIES

Technology Features	1G	2G	3G	4G	5G
START	1980s	1990s	2000	2010	2020 (Expected)
DATA BANDWIDTH	2 kbps	64 kbps	2 Mbps	200 Mbps	1 Gbps
TECHNOLOGY	Analog Cellular	Digital Cellular	Broadband with CDMA, IP technology	Unified IP & seamless combination of broadband, LAN, WAN & WLAN	Unified IP & seamless combination of broadband, LAN, WAN, WLAN & WWWW
SERVICES	Mobile Technology (Voice)	Digital Voice, SMS, Higher Capacity Packetized	Integrated High Quality Audio, Video & Data	Dynamic Information Access, Wearable Devices	Dynamic Information Access, Wearable Devices with AI Capabilities
MULTIPLEXING	FDMA	TDMA, CDMA	CDMA	CDMA	CDMA
SWITCHING	Circuit	Circuit & Packet	Packet	All Packet	All Packet
CORE NETWORK	PSTN	PSTN	Packet Network	Internet	Internet

CONCEPT OF 5G ARCHITECTURE

To meet the needs of new services, with diverse and demanding performance requirements, across a wide variety of industries, the 3GPP standards development organization is developing a new 5G system architecture (5GS), including 5G New Radio (NR) access and a new 5G Core Network (5GC). This new core is fundamental to the commercial success of 5G because it will enable new service types and benefits from cloud economics.

The 5G Core Network is responsible for functions such as session management, authentication, mobility and security. These are critical to delivering a service. The 5G system architecture under development in the 3GPP's Technical Specification (TS) 23.501 working group- entitled System Architecture for the 5G System- identifies two representations of the 5GC architecture: one services-based, and one point-to-point based. In the first instance (Release 15), service- based interfaces apply to control- plane functions, while user-plane functions connect over point-to-point links.

The 5G core is now under development across the industry. 3GPP standards work is currently ongoing as part of Release 15, scheduled to freeze by mid-2018. At the same time, operators and vendors are co-developing systems and using live trials to feed back into the standards process. This iterative development process is a notable difference between 5G and previous generations of mobile technology. China Mobile, for example, has already tested SBA for 5G core and will move on to multi-vendor testing in 2018.

The objective is for operators to be able to deploy 5G in "standalone" mode, using a 5G Core and without dependencies of the LTE network, by 2020.

5G CORE DESIGN PRINCIPLES

The 5G core architecture is designed to be " cloud-native", in the sense that it should make use of Network Function Virtualization (NFV) and Software- Defined Networking (SDN) techniques, and use service-based interactions between control-plane functions. As discussed below, Service Based Architecture (SBA) aligns well with the micro services view of network function composition.

The expectation, in other words, is that 5GC will be deployed on a shared, orchestrated cloud infrastructure and should be designed accordingly. Some of the key 5GC design principles are :

- Control- and User-Plane Separation (CUPS) to enable independent scalability and decoupled technical evolution. This will also support flexible deployments, such as at centralized and edge locations. CUPS can also be applied to the EPC in 4G.

- Modular function design - This is a form of functional disaggregation such that a function composed of multiple modules can be created according to the use case's requirements- for example, network slices A and B may have different requirements.

- Minimise dependencies between the Access Network (AN) and the Core Networks (CN)-This will enable operators to build a multi-access, converged core network, with common AN-CN interfaces, which integrate different 3GPP and non-3GPP access types.

- A unified authentication framework - This is useful in the multi-access core, for efficiency and to enable operators to offer " follow- the-user" services, independently of access method.

- Support "stateless" network functions, where the " compute" resource is decoupled from the " storage" resource. This concept is derived from cloud applications. It enables the much more efficient creation and consumption of network processing paths.

- Network capability exposure - Exposing information about the network's capabilities to internal and external applications is expected to be more important in 5G. This is especially the case where operators want to integrate 5G with vertical industry process. Standardizing this makes life simpler for vertical customers, especially those with international operations and multi-operator relationships.

- Concurrent access to local and centralized services - This is to support access to low-latency services hosted in local data centers. Typically, user-plane functions might be deployed remotely, while the control plane is centralized. In very low-latency, mission-critical applications, the control plane may also be distributed. The actual deployment and operation of the 5GC is independent of specification development and is not prescribed by the 3GPP. Operators and vendors have considerable freedom to implement the architecture in ways that are suited to the use cases or customer.

WHY THERE IS A NEED OF 5G?

The major difference, from a user point of view, between current generations and expected 5G techniques must be something else than increased maximum throughput; which are listed as follows -

- **Data Bandwidth-** 5G provides data bandwidth of 1Gbps or higher. It is a great service for wireless communication.

- Lower battery consumption.

- World Wide Wireless Web (WWWW)-Wireless-based web applications that include full multimedia capability beyond 4G speeds.

- Lower outage probability- Better coverage and high data rates available at the cell edge.

- Multiple concurrent data transfer paths.

- Not harmful to human health.
- More secure; better cognitive radio/SDR Security.
- Higher system level spectral efficiency.
- More applications combined with Artificial Intelligence (AI) as human life will be surrounded by artificial sensors which could be communicating with mobile phones.
- Cheaper traffic fees due to low infrastructure deployment costs.
- 5G technology offers transporter class gateway with unparalleled consistency.
- More applications combined with Artificial Intelligence (AI) as human life will be surrounded by artificial sensors which could be communicating with mobile phones.

Smart Networking: 4G is based primarily on cell or base station WAN design. 5G aims at building hybrid networks utilizing both the Wireless LAN concept and WAN design. Thus, the world would have base stations everywhere providing ubiquitous network coverage to users at high speed. For example, A user walking on the road is browsing the internet using GPRS (General Packet Radio Service-WAN design). The moment he enters a mall with Wi-Fi (LAN design), seamless handover from GPRS to Wi-Fi would take place without the user's knowledge.

APPLICATIONS OF 5G

- Connected Vehicles- Such vehicles not only will deliver entertainment and information to passengers but also to guarantee safety via communications both between vehicles and between vehicles and infrastructure.
- Smart cities with requirements in the areas of public transportation (similar to the needs of connected vehicles), the environment, managing buildings, and energy consumption.
- Smart Grid Flow monitoring and management (electricity, gas, water, etc.).
- Tele-Medicine: 5G will support remote health monitoring of patients. A user need not go to the hospital, instead a user can get video conference assistance for a doctor at anytime and anywhere.
- Tele-geo processing applications: This is a combination of GIS (Geographical Information System) and GPS (Global Positioning System) in which a user can get the location by querying.
- Artificial Intelligence (AI): More applications combined with Artificial Intelligence (AI) as human life will be surrounded by artificial sensors which could be communicating with mobile phones.

CHALLENGES TO 5G

A successful transition to 5G will require overcoming several challenges and establishing a policy environment that enables robust research and development. Among the key challenges that 5G will be facing are:

- **Integration of various standards:** Each engineering practice has their own standard (eg 3GPP, 3GPP2, ITU, IETF, etc). To integrate these various standards requires systematic and time-consuming approach.
- **High redundancy requirement:** Under Super core concept, all network operators will be moving to single core infrastructure, high redundancy and security among core network entities are required. A failure of the single node will impact the huge number of subscribers across various network operators.
- **Transparency:** Transparency among network operators, regarding Subscriber Data, churn management, etc.
- **Density:** 5G networks will need to have considerably more base stations to meet the performance needs of future applications. These dense networks will be deployed as heterogeneous networks, combining macro sites with smaller base stations and using a range of radio access technologies including LTE-A, Wi-Fi and any future 5G technologies. These technologies will be used in macro, small and super small cells and will integrate various radio technologies flexibly and in various combinations.
- **Performance:** In 5G, the best possible network performance will not be just about peak speed. There will be a wide range of performance measures to meet individual requirements imposed by each use case. Some real-time applications, such as driverless cars, will require virtually zero latency, while others, such as 3D video capture, will be more tolerant to latency but will require high capacity upload instead.

ISSUES NEED TO BE ADDRESSED BEFORE 5G IMPLEMENTATION

The following issues need to be addressed before the implementation of 5G network as a future system :

- Since all the network operators and service providers would share a common core network infrastructure, compromise of a single operator will lead to the collapse of the entire network infrastructure, if not carefully guide against.

- **Spoofing and Jamming Spoofing:** Spoofing and Jamming Spoofing is a fake GPS signal being sent out, in which the GPS receiver considers that the signals arrive from the satellites and computes the wrong coordinates. Such wrong computation can lead to more criminal activities and increase the crime rate. Jamming occurs when a transmitter sending out signals at the same frequency shifts a GPS signal.

- **Data Encryption:** If a GPS receiver will communicate with the main transmitter then the communication link between these two is easy to break and the consumer must use the encrypted data.

- On the lines of email-spam, the Spam over Internet telephony (SPIT), the new spam over VoIP may become serious and become serious threats.

- Spooling attacks can lead to misdirected communication and internet banking related frauds.

- Eavesdropping and interception of private communications.

- Phishing attacks, stealing bank account details and other secured information, are more likely.

CONCLUSION

Today, mobiles have become a very essential part of our everyday life. A new revolution of 5G technology is about to begin whose development is the outcome of various generations. 5G technology is going to give tough competition to normal computer and laptops whose marketplace value will be affected. There are lots of improvements from 1G, 2G, 3G, and 4G to 5G in the world of mobile communication. 5G technology offers high resolution for passionate mobile phone consumer. This generation is expected to be released around 2020. The world of universal, uninterrupted access to information, entertainment and communication will open a new dimension to our lives and change our lifestyle significantly.

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