Review Article

Analysis of 5th Generation Mobile Networks Architecture with Essential Wireless Access Technologies

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Abstract: Mobile networks consists of mobile nodes connected with high speed access technologies to provide triple play services to users at mobility with passage of time mobile networks have evolution from its 1st generation to 4th generation. Now on word world is looking for 5th generation mobile network. A new mobile network generation depends upon completely new architecture which can co-operate with older mobile network generations and existing Internet technologies. The 5th generation of mobile network is known as 5G and also called World Wide Wireless Web (WWWW). Existing technologies have limitation in data rates and over mobility and environmental changes can decrease efficiency. This Paper focus on the basic architecture of 5G technology which depends upon new access technology new radio (NR) which is key component of 5G and enables higher data rates to compete older technologies for   mobile communication co-existing with LTE (long term evolution) architecture.

Keywords: Code Division Multiple Access; Base Transceiver Station; Long Term Evolution; Evolved Packet Core; and User Plane Function.

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1. Introduction

As we know that the importance of advance mobile networks reflected in higher data rates as technology innovations happened. The coming 5th generation of mobile networks technology upgraded by 5G-NR which is new radio developed by 3GPP which is main focused point to get required advance technology. The research on new radio access technologies started in 2015 to unlocking the higher data rates for advance mobile networks and also to compare with existing access technologies advantages and disadvantages. The frequency bands there as NR are divided into two individual frequency ranges called frequency range-1 which includes 6GHz frequency bands and another frequency range-2 which includes 24.25 GHz to 52.6 GHz frequency bands. [1]

The 5G technology promises to provide economical higher data rates. Global System Mobile Association (GSMA) planning to lunch 5G as an initial launch strategy in 2019. The 5th generation commercial services expected to ten's times faster than 4G-LTE while providing minimum 1Gbps for downlink and potentially exceeding to 10Gbps which enables users to get HD services over wireless mobile network [2]. 5G includes technically roaming, interconnection, spectrum bands, new access technology NR, as to define advance highly efficient technology it can easily broadcast over 60,000 channels with bi-directional features [2].

The evolution from second generation to 5th generation of mobile networks in term of years and data rates describe by figure 1 below mentioned. The 5G also refers as the future of telecommunication which is the world's largest growing industry. The 5G network can be evolutionary change in the telecom

industry with higher business aspects as to connect the world as 1000 times faster than existing technologies. Which might be provides evolution in health, transport, defense, entertainment areas [3.]

Figure 1. Representing technological evolution of mobile networks

2. Generation of Mobile Networks

2.1 First Generation

First Generation First generation mobile networks were based on analog communication called 1G in 1980 first time launched in Japan. Motorola Mobile Phone Company launched First generation mobile network in USA. 1G was using frequency division multiple access technology for communication. 1G was providing 2kbs over wireless communication for short distance [4].

2.2 Second Generation

Second generation was based on digital communication by using Time Division Multiplexing (TDM) Called 2G cellular communication was providing 64kbps with better voice quality. 2G was also offering text messaging services that was introduces in late 1980. Second Generation mobile system was called GSM (global system for mobile) started in 1991 in Finland. After 2G up gradation 2.5 was introduced and that was based on packet switching GPRS (General Packet Radio System) technology. After 2.5G more up gradation in technology and we get 2.7G which was also called EDGE [5].

2.3 Third Generation

Third generation mobile network also called UMTS European standard based on (WCDMA) wide band code divisionmultiple access which is providing triple play services over mobile communication. 3G connects high speed mobile communication with internet protocol (IP) network. CDMA 2000 code division multiple access technology used by 3G introduced in 1999 the international telecommunication union select CDMA as 3G wireless system [6].

2.4 Forth Generation

Forth Generation 4G Mobile communication also called long term evolution (LTE) and Advance-IMT200. 4G provides high speed internet access with 100Mbs at mobility with audio, video, data services. LTE architecture called system architecture evolution (SAE) with evolved packet core (EPC) SAE uses eNodeB as BTS and access gateway (AGW) and LTE removes radio network controller (RNC) that was used in third generation network. SAE also included entities to facilitate other networks like (WCDMA, WiMAX, and WLAN). The 4G main objective is to provide higher network capacity with higher quality of service. The 4th generation of mobile networks uses (OFDMA) orthogonal frequency division multiple access technology as backbone [7].

2.5 Fifth Generation (5G) of Mobile

5G technology promises to provide evolutionary change in the life style of users which can b supportive in the areas of health, research, astrology, and also provide connectivity for artificial intelligent networked devices, robots, defense systems to keep vigilant. 5G supports very high bandwidth and higher network capacity with new access technology called new radio (5G-NR). The 5G mobile networks include

advanced features which enables 5G mobile technology as most advance technology with huge demanding future for all over world [8].

5G mobile network technology proves itself as fast and reliable with higher bandwidth providing technology which can create revolutionary change for wirelessly connected devices in hospitals, metro stations for transport, military bases connected with defense weapons all are go on IP based network with hirer reliability to keep alive countries and citizens of world. Telecommunication industry now becomes more powerful to play its role for prosperity of the world with fifth generation networks [9].

Multi input multi output (MIMO) is a pre-5G technology that pay a supportive and important role to get 5th generation goal achievements of higher data rate at faster speed. MIMO increases efficiency of access by decreasing signal to noise ratio (SNR) with creating 3D beams towards users with directional diversity [10].

The 4G provides approximately 20 mbps for downlink with using frequencies of 2-8 GHz and access technology of OFDM. Now onward recently launched advance wireless mobile networks technologies like (HSPA) and (LTE) long-term evolution are launched with series of evolution in technologies towards 5th generation networks. The 5G technology has main target to reduce approximately 91% of the power in wirelessly connected nodes and network center devices and dominantly (5G) as advance green technology[11].
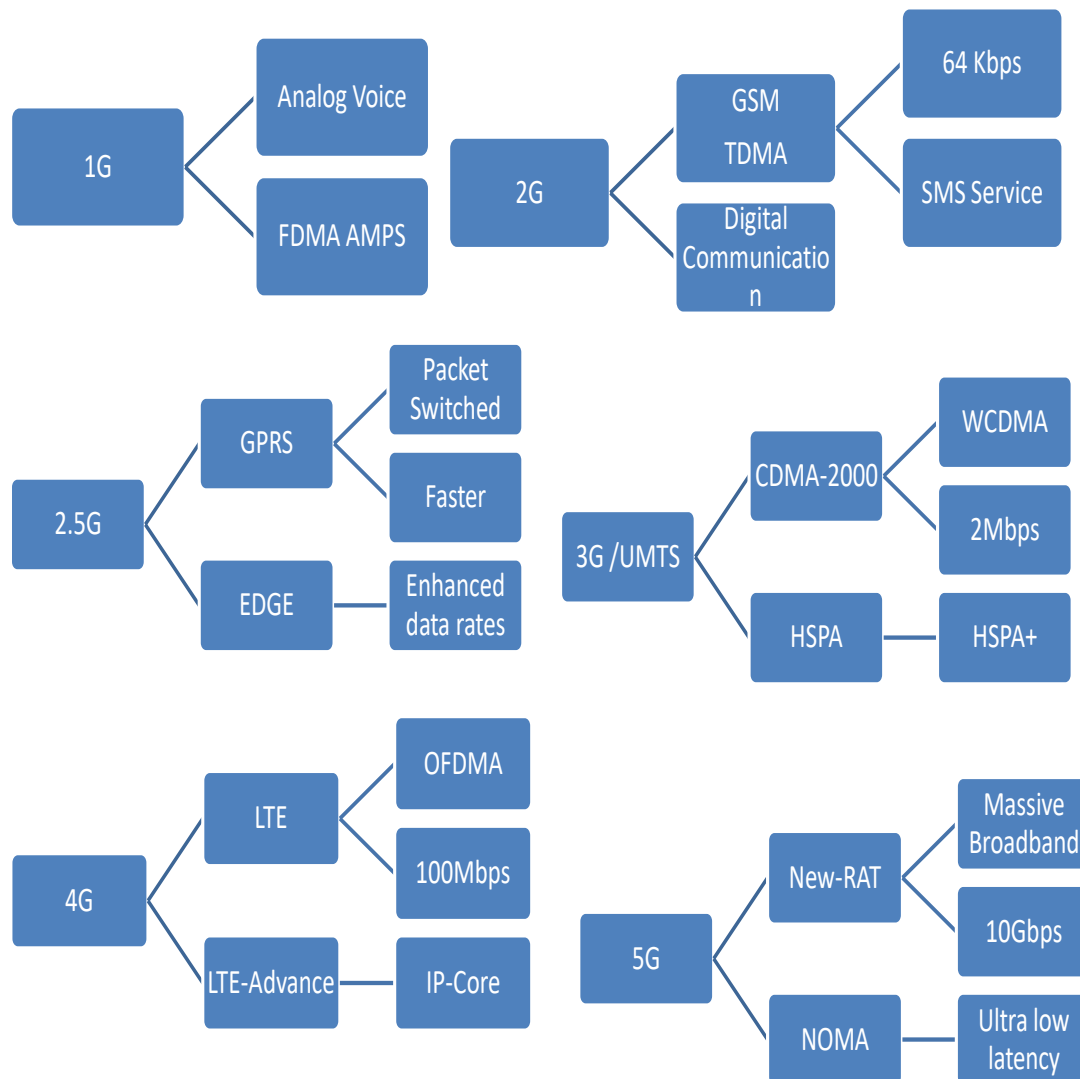
Figure 2. Mobile network evolution with access technologies.

3. Features of 5G Networks

The main purpose of 5G Network is to get higher data rate transmission from 20 to 30Gbps which can be 50 times faster than traditional 4G networks. The 5G technology provides low ultra latency feature with range between 1-ms to 10-ms the 5G network also facilitating the user capacity with demand of unlimited data transfer. The use of 5G technology enables the high HD resolution and fast speed Internet access for end users. The 5G mobile networks also enable more accurate and highly reliable results for wireless communication [12].

It also enables supports for virtual private networks which are used for industrial data communication. The 5G technology has high peak bit rate to enable reliable connectivity and communication to cover extra geo graphic region which provides connectivity to large number of users and devices to stay connected. [13] 5th generation is a more intelligent unbeatable and higher data rate providing latest technology. 5G technologies are new era in wireless mobile communication likely to appear in market by 2020 with higher quality of service. 5G future enhancement will be incredible with combination of artificial intelligence. The 5G artificial intelligent network will provide facilities to users with higher efficient solutions [14].

Artificial agents can be controlled automatically with mobile devices with this feature technology with 5G technology user can b able to connect with multiple wireless access technologies and multiple data transfer paths by using MIMO with higher resolution and QOS. End users can connected and stay with single core with single platform infrastructure that shall be called super-core. In the feature 5G mobile network will be replaced with 6th generation mobile networks which have not been fully appeared yet. As demanding trend of higher data rates for mobile networks, the 5G main aim is to enable and create multi-bandwidth path channel with integration of current and future mobile networks [15].

There should be edge data rate 100 Mbps bandwidth, moreover one million devices per square km should be there with 5G mobility and 500km/h speed. Spectral efficiency of 30bits/Hz for downlink and 15 bits/Hz for uplink data rates used for 5G. There should be network capacity must 10000 times greater as compare with the capacity of the current 6G mobile network peak data rate 20-Gbps as downlink and 10-Gbps as uplink [16].
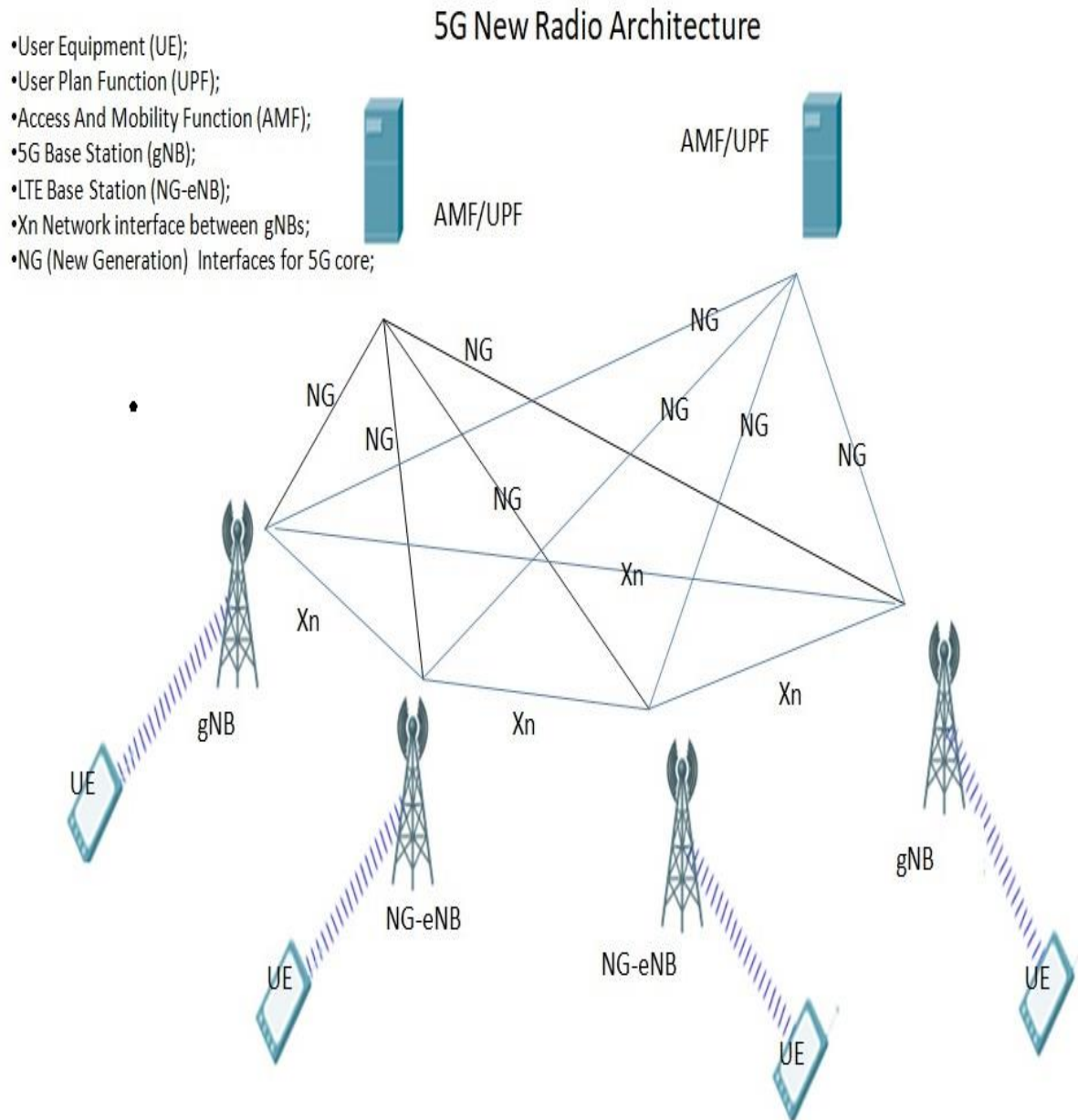
4. Methodology

The 5G technology architecture main components includes user terminal which has an innovative role in the new architecture and multiple other independent and autonomous radio access technologies. The radio access technologies works as separated paths using as IP link to the Internet. The major role of IP is to ensure enough control of data and management traffic for routing of IP packets related to specific application generated connections [17].

There should be different radio interfaces for each radio access technology (RAT) in the end user terminal. The 5G networks required different (RATs) with different access interfaces in the connected mobile terminal to get services and should be active simultaneously. The data packets are routed through tunnels using (RATs) which are functioned by policies and protocols. There will be the rules exchanged for virtual network layer protocol. Using this methodology we can get required abstraction of the network for the client applications running at end mobile terminal. Tunneling connections in the 5G are maintaining and handling basic functionality of the virtual network [18].

The 5G mobile networks consist of flat IP architecture concept which has different RANs radio access networks used as the single core network. The 5G mobile network aggregator located at RNC which can be used to aggregate all of the RAN traffic and routes towards gateway. Flat IP architecture provides innovative services for the 5G networks to be exist as fast and latest technology for mobile networks. The All-IP Network (AIPN) is evolution for triple play services and for third generation partnership project (3GPP) to fulfill the increasing demand of user for advance mobile networks. AIPN delivers a highly competitive advantage as for performance regarding and cost regarding [14]. The end user latency and throughput must be low to provide and encourage high throughput, dense network deployment for user terminals requirement [19].

The advanced 5G networks includes enhanced Signaling that improved efficiency, and Innovative Data coding techniques to get higher data rate, smaller waves frequencies for wireless access, and use of smart beam antennas. 5G uses for artificial Intelligent create a tremendous change in human Life [20].

5G New Radio Architecture

•User Equipment (UE);
•User Plan Function (UPF);
•Access And Mobility Function (AMF);
•5G Base Station (gNB);
•LTE Base Station (NG-eNB);
•Xn Network interface between gNBs;
•NG (New Generation) Interfaces for 5G core;

AMF/UPF

AMF/UPF

NG   NG   NG   NG   NG   NG   NG   NG

Xn   Xn   Xn   Xn

gNB   UE   NG-eNB   UE   NG-eNB   UE   gNB   UE

Figure 3. Representing 5th Generation New Radio Architecture [8]

The 5G-NR network interfaces includes Xn interface which connect g-NB to g-NB nodes, NG interface these covers functions and locations between 5G RAN (Radio Access Network) and 5GC (5G Core). The 5G-NR architecture is briefed in (Figure 3) which represents it's various connections and components 5G-NR architecture defined in 3GPP TS 38.300 specifications. The 5th Generation new radio access technology consist of NG-RAN and 5GC and gNB nodes to facilitate UE (User Equipment) with NR (New Radio) access technology with control plane protocol terminations. The 5G Network NR base station and gNB nodes are directly connected to AMF (Access and Mobility Management Function) and UPF (User Plane Function) in 5GC.

5. Findings and Conclusions

The 5G mobile networks evolution appears just like beginning o in wireless communication to connect world.   At world level private sectors are striving and investing to be first to market with 5G technologies and services to capture the economic benefits from this new upcoming technology. Development and deployment of 5G technology is expected to extend through 2035. [6]

According to this research analysis the 5G networks are very fast and reliable to provide triple play services to end user. The 5G technologies consists of Large Area Synchronized Code Division Multiple Access as access technology and Orthogonal frequency division multiplexing which is also used for LTE, The 5G also includes Multi Carrier Code Division Multiple Access with ultra wideband and network local multipoint distribution Service with alternative of IPV4 with IPv6. [9]

The 5th Generation mobile internet is real high speed wireless network foe whole world as innovation. The 5G main terminology is based on mobile networks encourages with performance, efficiency and capability to provide triple play services. The 5G technology will be capable to deliver tremendous data transfer rates with unrestricted call volumes over internet and infinite data broadcast which would be compatible with latest operating systems used by latest devices. [3]

Latency as over all delay reduced with thousands times as compared with 4G to enhance response time to overcome the delay for data travels across a network. Real time applications required lower latencies to get required goals for 5G services. [7]

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