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5G Wireless Technologies- Future Generation Communication Technologies

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Abstract: This paper focuses on the characterization of future wireless smartphone communication networks. This paper is focused on the evolution of the 5th generation smartphone network. 5th generation wireless networks was designed to be a perfect network on nationwide without any obstacles or limitations on accessing handling data than earlier generations. With 5G networks, users will surely notice a big change when accessing their phones experiencing a new edge of call volume. Many services in various fields will be offered to the users through 5G technologies such as Documentation, supporting electronic transactions (e-Payments, e-transactions). This paper reviews an introduction to 5G along with a brief description of the evolution of 5G wireless network. It highlights all earlier generations of smartphone communication comparing them with fifth generation technology. It focuses on network architecture of 5th wireless technology as well. The paper also illustrates why there is a need for 5G along with some applications of 5G wireless communication. 5G wireless network technologies will add a new dimension to the users who accessing their Mobile Radio Communication (MRC), which provides them an advantage over preceded smartphone networks.

Keywords: 5G Architecture, Why 5G, All IP Network, Cloud Computing.

1. INTRODUCTION

Wireless manufacturing has witnessed a massive evolvement for the last few years. Improving wireless networks technology are upon in order to implement their 5th generation. The first generation was focusing on the simple mobile voice, whereas the 2nd generation focuses on both bandwidth and coverage. 3rd generation concerns about higher data level, multimedia backing, and spread spectrum. 4th generation offers access to multiple zones of communication facilities including developed smartphone services, and mobility application. Fifth-generation technology has many features such as data capabilities, unlimited call volumes, unrestricted data broadcast, live camera, MP3 recording, video chat, huge phone memory, and many others which consumer can never imagine. 5G wireless mobile networks are completely wireless telecommunication without obstacles, making it a real wireless– World Wide Wireless Web (WWWW).

5G wireless smartphone networks are backed by, OFDM(Orthogonal frequency-division multiplexing), UWB(Ultra-wideband), LASCDMA(Large Area Synchronized Code-Division Multiple Access), MCCDMA(Multi-Carrier Code Division Multiple Access), Network-LMDS(Local Multipoint Distribution Service), and IPv6. Fifth generation will certainly add more services to the users of 4G technology due to its capabilities to interconnect the whole world with no limits or delay resulting in a world with remarkable facilities like a continuous access to data, entertainment and telecommunication shall open new epoch to our society.

2. DEVELOPMENT OF WIRELESS TECHNOLOGY

This part illustrates briefly the development of wireless technology.

A. 1G network

First generation pioneered in the 1980s. It consists of Analog System and introduces mobile technologies such as Improved Mobile Telephone Service (IMTS), Mobile Telephone System (MTS), Push to Talk (PTT), and Advanced Mobile Telephone System (AMTS). Frequency-Division Multiple Access (FDMA) was being used for voice call modulation along with analog radio signal which has a frequency of 150 MHz. 1G

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disadvantage were limited capacity, poor voice links, and limited security.

B. 2G network

Second generation deployed in late 1980s. Digit signals were used for voice transmission with speed of 64 kbps. Featuring the SMS service (Short Message Service) with 30 to 200 KHz bandwidth. 2G system uses packet switched and circuit switched domain and provide data rate up to 144 kbps. e.g. GPRS, CDMA, and EDGE [1].

C. 3G network

Wide Brand Wireless Network was first used in third generation wireless communication. The data are transmitting through Packet Switching technology. Whereas Circuit Switching interpreted Voice calls. 3G provides many services including data services, access to television/video, and Global Roaming. It runs under 2100MHz of frequency and 15-20MHz of bandwidth which has been used for High-speed internet service, and video chatting [1].

D. 4G network

4G added additional features along with the 3G such as Multi-Media papers, watching television with more vivid view and sending signals much quicker than earlier networks [1]. 4G provides a high downloading speed of 100Mbps. 4G has been developed to be suitable for the QoS and level demands approved by forthcoming applications such as wireless broadband access, Multimedia Messaging Service (MMS), video chat, mobile TV, HDTV content, Digital Video Broadcasting (DVB), lesser facilities such as voice and information[2].

TABLE 1. COMPARISON OF ALL GENERATIONS OF WIRELESS NETWORKS

Technology Services	**1st**	**2nd**	**3rd**	**4th**	**5th**
Begun/ Deployment	1970 – 1980	1990 - 2004	2004-2010	Present	2020
Data Rate	2kbps	64kbps	2Mbps	1 Gbps	more than 1Gbps
Technology	Analog Cellular Technology	Digital Cellular Technology	CDMA 2000 (1xRTT, EVDO) UMTS, EDGE	WiMax LTE Wi-Fi	WWWW
Features	Mobile Telephony (Voice)	Digital voice, SMS, Higher capacity packetized data	Integrated high quality audio, video and 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 N/W	Internet	Internet

3. CHALLENGES IN THE DEVELOPMENT OF 5G NETWORKS

The idea of 5G systems is not trivial to accomplish. There are quite a few confronts (some of the following challenges are shown in Fig. 1

1- Data rate and network capacity expansion

The distribution of additional BSs in a terrestrial area, the greater usage of frequency bands, and link development may sustenance the system capacity expansion, lots of UEs, high information level, large amount of information, and proficient information transferal towards network hub. On the other hand, the employment of these resolutions is a bulky task regarding the financial system and power consumption. Therefore, network capacity is entailed to be considerably improved, maintaining the power intake and charge beneath strict management.

2- Scalability and flexibility

These are the main important characteristics for potential cellular transmission. The potential mobile substructures and approaches should be planned to operate in Het Nets. Furthermore, many possible clients may call for a group of amenities instantaneously. Hence, 5G grids should be effective to advocate ascendable client request around the coverage area.

3- Single outlet for both UL and DL

Full duplex wireless radio [3] utilities a separate outlet for transferring and dispatching signs at equal time and frequency. Accordingly, such scheme attains a duplicate functioning like holding unique UL and DL outlets, therefore, enlarges linkage capability, protects the spectrum, and charge. Nevertheless, the employment of full duplex schemes is not negligible, since today a radio needs to employ complex procedures for the substantial

and information linkage layers[4], and structures to eliminate the consequences of interfering [5].

4- Managing meddling

Managing meddling between linking devices is a familiar dispute in wireless transmission. Because of the increasing amount in UEs, knowledge, and devotions, the meddling shall enlarge in 5G systems as well. Thus, it is essential to obtain an effective and consistent meddling controlling procedure for outlet sharing, energy regulating, unit connection, and overload estimation.

5- Environmentally friendly

The present radio access network (RAN) utilizes 75% from overall energy [6]. The wireless equipment exhausts stacks of power which cause vast CO2 release and increase the charge. Therefore, it is essential to advance power - proficient transmission schemes, hardware, and knowledge, thus the proportion among the grid throughout put and power expenditure is reasonable.

6- Low potential and high consistency

Low potential and high consistency are significant in some real-time usages, such as message conduction by androids observing patients, living security procedures, cloud-centered gaming, nuclear reactors, sensors, buzzes, and linked transference techniques. Though, it is actually difficult to have particularly low potential and consistent distribution for the information on a huge scale system with no growing in system substructure fee, while it entails the enlargement of procedures affording express connections, rapid deliveries, and excessive information transmission speed.

7- System implementation optimization

The implementation factors, e.g., ultimate information frequency, physical region reportage, spectral proficiency, affluence of conductivity, power-proficiency, potential, consistency, equality of consumers, and employment intricacy, are critical for mobile system [7]. Consequently, a typical structure for 5G systems must considerably enhance these factors.

8- Economic collisions

Innovative revolution in upcoming cellular transmission methods will have radical economic collisions regarding the employment and inspiration for consumer contribution. It is important to offer a completely novel substructure causing an economical collision. For that reason, the fee of employment, continuation, administration, and process of a substructure should be reasonably priced from the evaluation of administrations, controlling consultants, and system operatives.

9- High flexibility and handoff

The 5G wireless is intended for holding a dynamic overhaul association whilst regularly changing from one cell to another. The flexibility variation for the wireless facilities must not stop still at an extremely great rate like user sitting in a moving automobile. Furthermore, throughout specific intermission, several users travel from position to another.

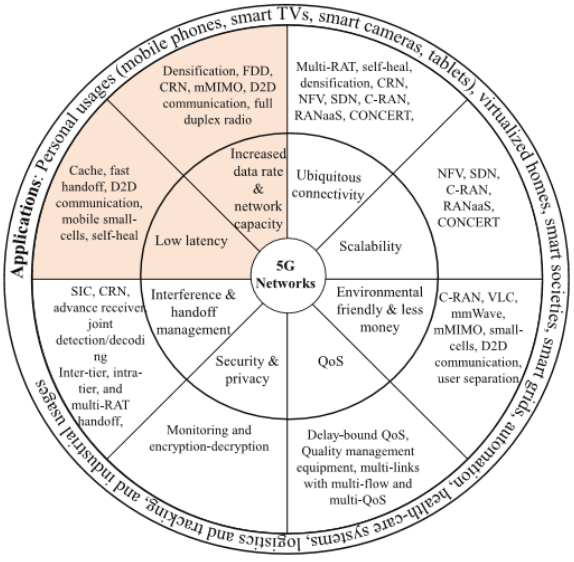

FIGURE 1. CHALLENGES IN THE DEVELOPMENT OF 5 G.

4. BASIC ARCHITECTURE OF 5G TECHNOLOGY

Figure 1 below illustrates the network architecture which presumes a design of 5th generation smartphone network, which is all-IP based model. The network composite from subscriber terminal (which has a critical part in the new architecture), autonomous radio access technologies, and a Number of independents. The IP link for each terminal is represented as radio access technologies in the 5G network systems.

On the other hand, on each cellphone terminal side, there must be different radio interface for every Radio Access Technology (RAT) [8]. In the 5G network, every smartphone shall have constant "Home" IP address and "care of address" that stands for its current location. As

soon as the user computer attempts to contact with user smartphone, first a packet of data will be sent to the user house address stimulating the server on that address to send back a packet to the same location via the same terminal.

At the same time, another packet from the server will also be sent to the computer in order to confirm the correct address. For such technology, a Cloud computing would be the best choice for the 5 G. A content provider will represent the central remote server in our 5G network. Customers and vendors will not need to install and access to their personal files anymore due to Cloud computing technology which permits the use of applications without the need to log into any private documents via any computer with internet access. The evolution of cloud computing technology equips vendors with great advantages. Development in billing interfaces of 5th network makes it more engaging and effective due to their future perspectives [9]. 5th generation network certainly will uncover a new eon in smartphone telecommunication technology. A high resolution is offered as well for crazy smartphone users.

Users will have the ability to monitor any location from anywhere on their smartphones such as observing space and watching TV channels at HD clarity with no obstruction. The 5G mobile phones will evolve many mobile embedded technologies [10].

5. WHY IS THERE A NEED FOR 5G

5th generation networks have put a new definition to the use of smartphones with a very high bandwidth. Such a high-rank technology has never been experienced before from users. For the time being, mobile subscribers have much sensibility of the smartphone technology.

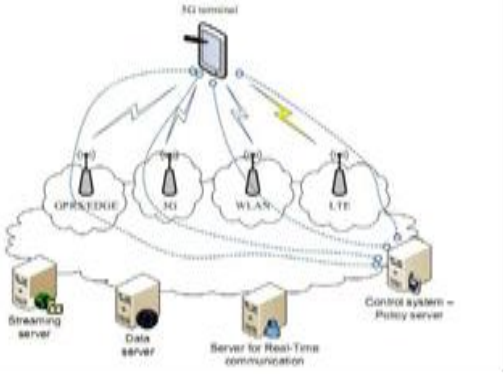

Figure 2. Basic Architecture of 5G Wireless Technology.

5G aims to provide plenty of services to the subscriber at low cost and high speed. In near future, 5G technologies will be the most powerful technology and in big demand around the world due to its advanced features [11].

Some of these features are listed below:

1) Upgraded and innovative data coding and modulation techniques.
2) Less battery consumption.
3) Less outage probability and higher efficiency.
4) Better coverage and very high speed.
5) Multiple synchronous data transfer paths.
6) More secure; better cognitive radio/SDR Security.
7) Supporting interacting features, voice, video, Internet, and other broadband services, more effective and more attractive.
8) It includes World Wide Wireless Web (WWWW) features which cover multimedia requirements over 4th generation speed rate.
9) Ability to be deployed along with Artificial Intelligent (AI).
10) 5G technology proposes Global access and service portability.
11) Does not harm or affect human health.
12) Lower traffic charges because of minimum infrastructure deployment charges.
13) Intelligent beam wireless circuits.

6. APPLICATIONS OF 5TH MOBILE SYSTEM

Some deployment of 5G network is designed to include all multiplatform environments. 5G deployments shall be around for different wireless technologies such as LTE, Wi-Fi, smartphones, computers, e-readers, digital cameras, and printers.

1) Virtual Presence
Meaning that 4th generation and 5th generation systems supply subscriber with facilities all time long, even when the subscriber is off-line.

2) Tele-Medicine
4th and 5th generation are supporting health monitoring of patients remotely. Meaning that a subscriber can communicate with his doctor from anywhere at any time.

3) Tele-geoprocessing
This application is a set of GIS (Geographical Information System) and GPS (Global Positioning System) where a subscriber can get the desired location via querying.

4) Crisis management
Shutdown resulting from Natural disasters could accrue on any telecommunication networks. Nowadays for such problem, it would stop for months in order to run the network again. However, via 5G a few hours will fix such problem.

5) Education

5G delivers a perfect chance for users around the world to do their education online with fewer charges.

6) Artificial Intelligence

Smartphones will interact directly with artificial intelligent (AI) through applications consist of artificial sensors which could affect human's life.

7) Traveling

With the new smartphone apps and the use of Bluetooth & NFC technology, traveling is easier and more exciting. Such technology is probably will take a part in re-ordering those phases for the upcoming years, permitting, similarly, when users want to get familiar with a location before or to share information live.

8) Security

In 5G network infrastructure, security includes many branches across the layers of the 5G network such as authentication, legation, data encryption, association and deployment of service policy convention among many different operators.

9) Economic growth

Changes in this technology benefit both subscribers and venders resulting an increase in the economic. That connection has not been explicitly quantified lately [12].

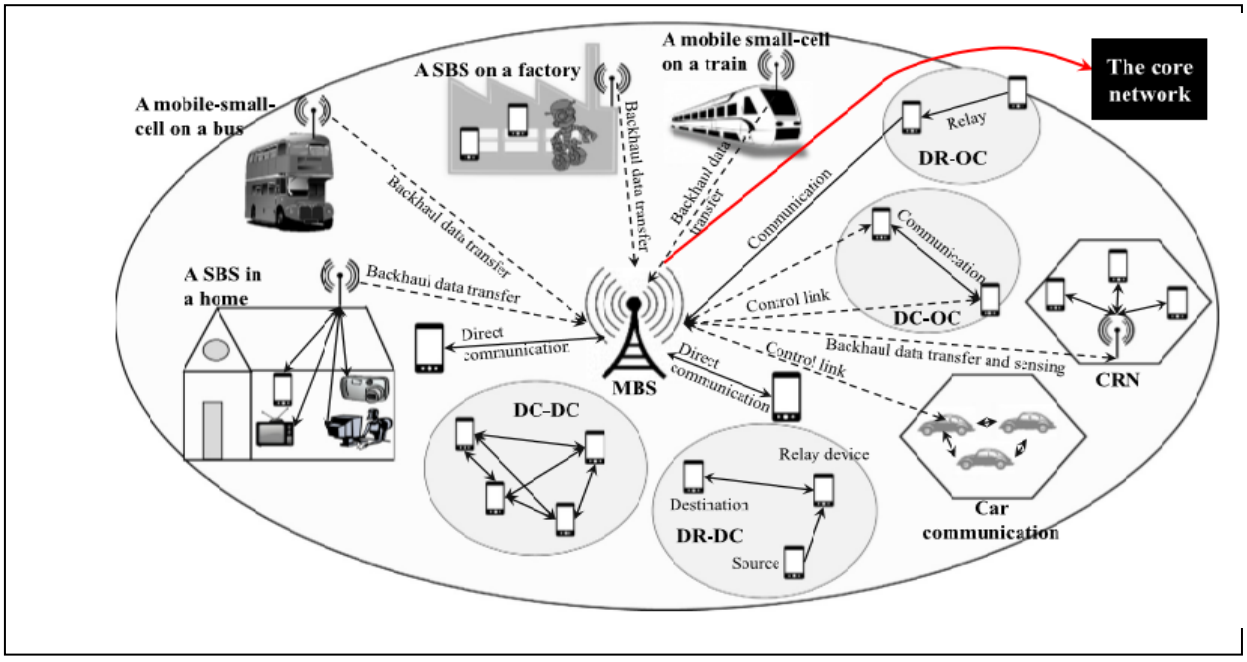

Figure 3. Main Technologies for 5 G

7. PROCEDURES AND TECHNOLOGIES FOR 5G SYSTEMS

The improvement for 5G systems needs both strategy and employment of novel approaches, procedures, and structural design. In this section, a brief description of several procedures will be illustrated.

1) Self-Interference Cancellation (SIC)

Once a full duplex radio collects signals from alternative radio, it similarly collects intrusion signals thru its private conduction, causing in self-interference. Therefore, a full duplex radio had to employ procedures to terminate self-interference [14, 15, 16]. By means of benefit, the employment of SIC permits unified universal drifting, great amount of amenities, and low potential functions.

2) Downlink and Uplink Decoupling (DUD)

On the existing mobile systems, a UE is linked with a BS founded on the arriving signal power in its DL outlet, at that time, utilities the similar BS for UL outlet communication [20]. DUD permits a UE to choose a DL outlet and a UL canal outlet from two unalike BSs, centered on the link excellence, the cell capacity backhaul load [20]. Consequently, a UE might have the DL outlet linked across BS and the UL outlet linked across unlike BS, causing in a client -centric 5G construction and adjusting the capability of UL outlets.

3) Network Function Virtualization (NFV)

NFV [17] employs network functions like link address rendition, firewalls, invasion recognition, dominion title facility, the circulation load managing, and storing over software operating on product servers. Nevertheless, the conservative grids employ those serves on devoted and function particular servers. For this reason, NFV declines the load on grid operatives via not informing devoted servers/ hardware, saving money.

4) Software-Defined Networking (SDN)

SDN [18,19] constructions compartment system manages utilities and information dispatching functions, in that way the net manage utilities a reprogrammable, and the net substructure controls functions and net amenities.

5) Millimeter Waves (mmWave)

The present wireless bandwidths are not capable of maintaining a vast amount of users in 5G systems. Therefore, academics are looking for 30–300 GHz frequency bands, where mmWave transmission is planned for attaining high-speed information transmit. On the other hand, mmWave have quite a few challenges at the physical, MAC, and grid layers.

6) Machine-to-Machine (M2M) transmission

M2M transmission indicates into transmission among machines with no individual interference. Several models of M2M transmission are intellectual transfer schemes, physical condition measurement, observing of structures, gas and oil pipes, intellectual trade schemes, and safety and protection schemes. On the other hand, the improvement of M2M transmission includes many obstacles to be managed in the upcoming days, such as a connection between huge appliances erupted in information, short potential, scalability in terms of sustaining machines, knowledge and varied functions, rapid and consistent transfer of messages, and rate of schemes.

7) Massive MIMO (mMIMO)

mMIMO schemes are identified as large-scale transmitter schemes, extremely big MIMO, hyper-MIMO, and full-dimension MIMO [21,22]. mMIMO schemes use transmitter ranges with lots of transmitters at MBS for instantaneously obliging several users with a single transmitter in duplicate period and rate. An mMIMO scheme has confidence in latitudinal multiplexing, where it count on the outlet information at MBS, on both UL and DL outlets. An mMIMO scheme decreases potential and power, shortens the MAC layer, displays sturdiness anti deliberate congestion, and enlarges the capability owing to latitudinal multiplexing.

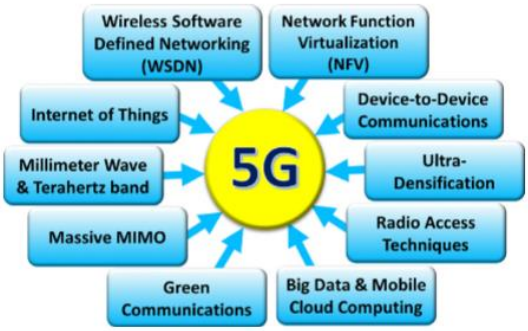

Figure 3. Technology of 5 G.

8) Visual Light Communication (VLC)

VLC is an excessive rate information transmission standard for small-scale LOS optical links in the upcoming mobile systems [23]. The light-emitting diodes (LEDs) offer VLC via amplitude adjustment at greater rates and attain better information frequencies whilst saving the LED's main enlightenment perform untouched. VLC could be depleted for outside purposes, where great energy laser-based tools offer conduction links, and for internal purpose, where LEDs offer small distance conduction links. VLC is power- proficient equipment, operates on a larger scale of tolerant rate groups, indications great latitudinal reprocess, and receives safety owing to LOS.

8. FUTURISTIC STATES AND 5G FULFILLMENT

The IoT with intellectual and cohesive sensor schemes and in home-based sensor grids will alter the style public direct their lives. "Smart living" public will oblige continuous and global cellular connectivity to the grid to upload their commotion information and IoT operates orders, therefore creating a "massive reporting" uplink information flow [24]. Massive machine to machine transmission and critical machine to machine transmission will perform essential parts in facility distribution and production procedures. Vehicular ad-hoc networks (VANETs) are continually progressing. Near 2020, VANETs cohesive with mobile grids will be in process as VANET cloud, escorting to a quicker and securer transportation scheme [25]. When few machines are linked to the Internet passages hundreds in the

upcoming years, the discharging of interacted information on unrestricted ranges will perform a crucial part in grid load equalizing, offering promised bit frequency amenities and a decrease in regulating signaling. Consequently, it is essential that 5G will offer unified compatibility with opaque various grids to fulfill the great need of real-time load, thus that ending consumers shall live through efficient connectivity to the grid [26].

9. RESEARCH GROUPS AND THEIR WORK

Several research groups are performing on 5G requirements. Some models are Mobile and Wireless Communications Enablers for the Twenty–twenty Information Society (METIS), 5th Generation Non-Orthogonal Waveforms for Asynchronous Signaling (5GNOW), Enhanced Multicarrier Technology for Professional Ad-Hoc and Cell-Based Communications (EMPhAtiC), 5G Infrastructure Public Private Partnership (5GPPP), Network of Excellence in Wireless Communications (NEWCOM#), 5G Innovation Center at the University of Surrey, NYU WIRELESS, and the Electronics and Telecommunications Research Institute (ETRI), Korea. These groups are investigating various practical and possible calibration features of 5G. Amongst these, METIS is the biggest framework program 7 (FP7) 5G scheme. FP7 is the European Union's study and revolution platform [27]. METIS recruited best cable corporations, for example, NSN, Ericsson, T-Mobile, DoCoMo, and Orange.

METIS lately announced their conclusive scheme report (Deliverable 8.4 on April 30, 2015) covering the key results of their scheme: structural design, architectural demonstrations, a network standard, and more than 140 technology modules along with their estimations [28]. They presented the filter bank multi-carrier (FBMC) as an effective enabler for inventing adaptable space boundaries. Their imitation report displays estimations of 5G key performance indicators (KPIs), like load rate per user, load rate per region, typical consumer information amount throughout demanding times, and definite consumer information amounts. Stimulatingly, their imitation outcomes displayed a radio access network (RAN) latency below 1 ms. Similarly, they performed various RAN constructions and load stream in unalike situations, like interior workplaces, shopping malls, stadiums, and open-air crowded rural areas. Nowadays they are redeploying the METIS-II project visualizing an inclusive 5G RAN project, cooperative estimation of 5G RAN, and worldwide consent structure amongst all calibration groups.

5G-PPP, a different research group, was introduced via the European Commission, industrialists, cable operatives, and academics. The 5G concept is closely described as: "...that in ten years from now, telecom and IT will be integrated towards a common very high capacity ubiquitous infrastructure, with converging capabilities for both fixed and mobile accesses..." [29].

5GNOW studied united framework buildings, extreme-low potential, extreme-high consistency, and feasible waveforms for 5G. Their mainly current deliverable explains Gabor signaling, where the developed signal is the summation of the mounted time–frequency periods of a model frame. The mounting aspects are given by the Gabor expansion coefficients. Furthermore, it argues obtaining both time and rate level data of a signal by means of the short-term Fourier transforms (STFT) [30].

EMPhAtiC is surveying multiple-input multiple-output (MIMO) communication, equalization, improvement of extremely adaptable filter-bank, and multi-hop- or relay-based transmission systems with a synchronicity.

NEWCOM# is functioning on great edge potentials, such as discovering the firmest greater limits of wireless grids, unscrupulous multi-hop telecommunications, and power and outlet proficiency in wireless telecommunications and networking. Some of the project's newest deliverables cover complete study on Cloud-RAN, cellular distribution, 4G/5G existence employing scale overlap, multi-hop coding, and localization with scattered transmitters. The project's associates have contacted that base band handling largely counted on the scheme bandwidth, the command of the modulation coding scheme (QAM), and the resource block used [31].

At NYU WIRELESS, Rappaport et al. are inventive millimeter wave (mm-wave) trials for 5G and have tested with mm-wave propagation standard and track failures in two areas, New York and Austin [32].

5GIC, UK's simply examining body devoted to 5G study, lately accomplished an outstanding innovation in wireless velocity grow: a speed of 1 Tbps speed in a wireless point-to-point (P2P) transmission. Its affiliates are deliberating ultralow potential -sensitive function facilities for futuristic objective [33]. The Electronics and Telecommunications Research Institute (ETRI), Korea, in its GIGA 5G scheme, is concentrating mostly on adjusting consistency, device-to-device (D2D) transmission knowledge, and the mobile hotspot network (MHN) procedure pack [33,34].

5Gforum, the Republic of Korea, is striving for novelties and marketplace exploration for the forthcoming model as well. 4G-Americas is the "voice of

5G" for the Americas. In recent times it has issued (October 2015) its white papers on 5G evolution and recommendations, where information centric networking (ICN) is highlighted.

10. CONCLUSION

Smartphones and wireless networks play a major role in everyone's life. Each and every year, Mobile network systems are consuming more processing power, costing more money, and draining more battery life for the same applications. This paper includes an introduction to 5th generation networks, an evolution of 5th generation, a wireless network architecture for 5G wireless technologies advantage of 5G technology, and applications of 5G.

Fifth generations technologies propose massive data capabilities, boundless of call volumes, and unlimited data broadcast. Fifth generation will certainly make a remarkable difference and capitalize to the world over 4G. 5G offers latest features like cloud computing, nanotechnology, SDR, and cognitive radio based on All IP Platform. This generation is predictable to be released around 2020. A whole new dimension will be wide open to the world and to our lifestyle by having such amazing features such as unlimited access to the internet, entertainment, and communication.

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