

A comparative study on Utilization and Benefits of Wireless Mobile Networks

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Abstract: The next generation of mobile communication networks are based on the multi-technology concept. Software plays an important role in the network management task. To solve the critical problems of the upcoming generation of mobile communication networks, a problem solver should have a better understanding of previous mobile networks. This comparative study is based on multiple communication parameter of different generation networks will support the researchers to compare the different generation of mobile communication network and solve the critical problems of future mobile networks during COVID-19 pandemic.

Keywords: 4G; 5G; Mobile Networks; Cognitive Radio Software Defined Radio; molecular nanotechnology;

I. INTRODUCTION

In the early days of telecommunication technology, mobile communication is not popular because of its limitations. Noise, compatibility, connectivity reliability are the main issues. This has to be improved up to the customer satisfaction level and fulfils the requirements of the subscriber. In 1970 [1] the invention and innovative research work open the new windows for mobile communication. Efficient algorithm different call admission method and multiprocessing hardware devices bring the mobile network in the public domain. After 1990 customer started to use the mobile network in the commercial domain with the help of different frequency spectrum [2]. Government of different nations came together and set the global standard for mobile communication which improves the growth of the cellular network. [3]

- First Generation Network
- Second Generation Network
- Third Generation Network
- Fourth Generation Network.
- Fifth Generation Network

II. ANALYSIS OF MOBILE NETWORK

A. First Generation (1G) Networks

Advance Mobile Phone Service launched the first mobile system in the market. In 1983 the United State implements the telephones. The first generation system was worked on FDMA technique with frequency modulation. Norway implemented the first cellular system in 1981 which was working on 900MHz frequency.[4]



Figure 1: First-generation Network

B. Second Generation (2G) Networks

Second generation networks were working on TDMA or CDMA technique having the following principles Standards [5]

GSM: Global System for Mobile

Country: Europe

900MHz Frequency band

Eight full rate Radio channels [200KHZ]

Sixteen half-rate Radio channels [200KHZ]

IS-136: Interim Standard

Country: American

Three full rate time division multiple access channels

PDC: Pacific Digital Cellular

Country: Japan

Use a maximum range of frequency spectrum

Second-generation mobile systems were based on digital technology[6].The second-generation system was using 25MHz frequency. These networks are called as GSM.This carrier frequency is further divided into eight slots by using Time Division Multiple Access techniques.

A single carrier is divided into eight channels by using TDMA so that eight different users can communicate with each other. Channels were able to send voice or text data at a time without any interference.Europe introduced this GSM technology working on frequency band 900MHz to 1.8GHz only US systems are using 1.9 GHz band.American launched CDMA technology. Code division multiple access utilized digital segments for data communication. voice data from different users is divided into small segments. A code is assigned to each segment to identify each call.[7]

C. 2.5G: Mobile Networks

2.5G technology has solved the problem of 2G technology by introducing the new concept of

- GPRS
- WAP

GPRS work on the concept of IP assignment to existing GSM systems which help to manage the traffic. By using WAP Protocol the Webpages can be sent on the mobile telephone on the wireless network with limited bandwidth. 2.5G is the improved version of 2G system in which the channel capacity increases and due to an increase in channel capacity user can access various services like internet multimedia with the help of various devices.It also has low noise more reliable and high performance.[8]

D. Third Generation (3G) Networks

Third-generation mobile systems provide multiple services

- Voice transmission
- Data transmission

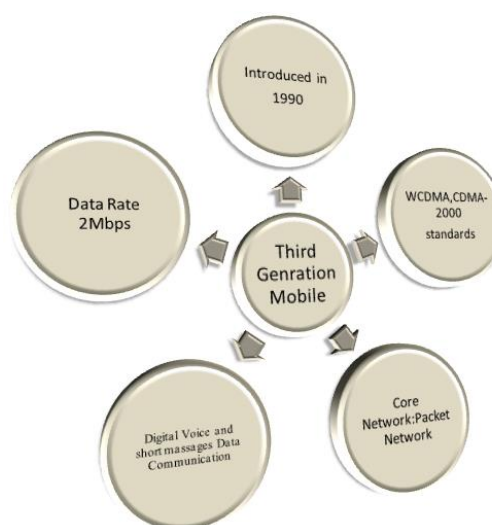


Figure2: Third Generation Network

In the third-generation mobile system [9]the audio quality of the signal is better than the second generation mobile system. It transmits the data with a speed of 2Mbps.

The growing market of communication industry having new challenges of maintaining the relationship between advance research work and customer demands. The subscriber wants various services like voice communication, data communication and multimedia communication on a single communication network. To fulfil such requirement network needs highly compatible devices with multitasking facility. The electronic devices are working on digital data with multiple data transmission speed. Day by day user is expecting higher speed microtechnology and Nanotechnology are providing better speed and high-reliability factor[10]. Global system for mobile communication provides voice and data service simultaneously. A user can send 160 alphanumeric characters to the destination party. The data transmission speed of second-generation mobile system is in between 9.5 kb/sec and 14.5 kb/sec. In 1981 third-generation mobile systems were the initial phase of its designing transmitter transmits the voice signal receiver receives the transmitted signal. The transmitter and receivers are stationary in position and geographical locations are fixed.

In another case, if a transmitter is in fixed position and receiver is in moving position or both are in moving position than maintaining connectivity between source and destination is again a challenging task.

Third generation standards are

- W – CDMA
- CDMA – 2000
- TD _ SCDMA

E. Fourth Generation Networks

Why we need the fourth-generation (4G) technology[11], It overcomes the problem of interactive multi-media services like video teleconferencing. To have Scalability of mobile networks.

New features of 4G

- The overall network is based on the packet-switched network
- Bandwidth is upto 100 Mbps

Now a day the focus of customer is shifted. Earlier the customer wants different types of services but in current time user not only want multiple services but also high quality of service.

Third generation network provides multiple services but the quality of service is average, for example, the high definition video quality is not good as compared to the fourth generation network. Fourth-generation networks are internet protocol-based network [12] it can give the service to heterogeneous network like wired network, wireless network and optical network. Data transmission speed is also high and a good security level is also maintained. The public and private network configuration are also easy in 4G network.

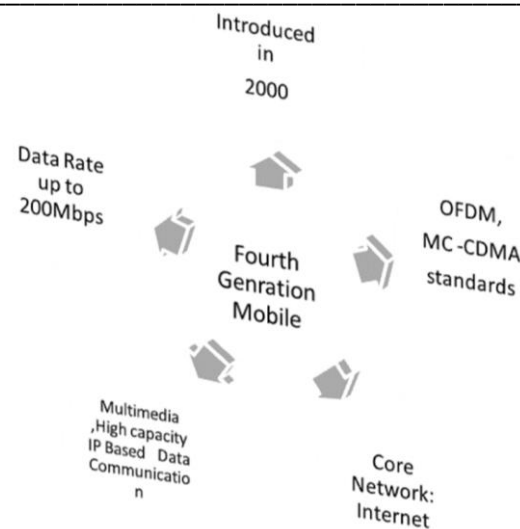


Figure3: Fourth Generation Network

The fourth-generation network has also the capability to upgrade the new upcoming version.

F. Fifth Generation Networks

The fifth-generation network supports multiple technologies and each module work autonomously. The core of the fifth-generation network supports all type of hydrogenous network. The next-generation mobile communication networks are based on the multi-technology concept. Software play important role in the network management task. The fifth-generation network supports multiple technologies and each module work autonomously. The core of the fifth-generation network supports all type of hydrogenous network.[13]

5G technology is a mixture of all internet protocol platforms, nanotechnologies and cloud computing. Fifth-generation architecture also networks support different switching methods, bandwidth, communication with multiple data rates and radio access.[14]

- Started in 2010
- Complete wireless solution
- Broadcast data in Gbps
- HD quality
- Support interactive multimedia
- Combination of LAN/WAN/PAN

The fifth-generation system fulfils the requirement of the faster-growing world which required multiple technologies are to be integrated into a sing device. And the device should support the older technologies and new upcoming technologies. Fifth-generation devices are reconfigurable as per the user requirement and handle the various radio frequencies. It also contains the software-defined radio modulation methods. Most of the software is needed for the communication are easily download from the internet and installed. The core of 5G technology deals with various wireless networks and choose a suitable network for the user. The user also uses various wireless communication medium according to need. Fifth-generation devices are manufactured by using latest technologies like nanotechnologies which are having less power requirement and high accuracy. Cloud computing is a

very good supporting tool in the fifth-generation network IP allotment technique gives a wide range to accept the incoming calls.[15]

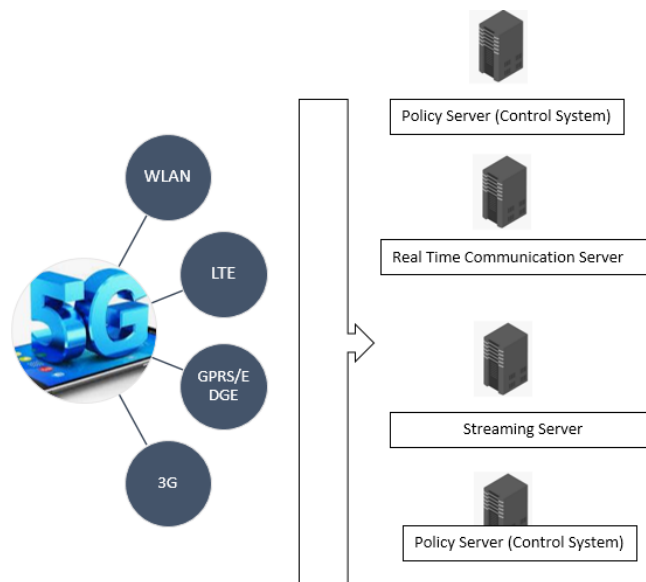


Figure 4: Fifth generation network architecture

The 5G network devices and communication terminals are managed any critical condition arrive dynamically .different value-added services are easily added at network operator side to improve the grade of service.[16]

The 5G network devices are having the ability to find out the location of the call, sense spectrum used by an adjacent network device, frequency change, manage output power and change the parameter and its characteristics.Cognitive radio is a transceiver can do the analysis and make the decision on existing dynamic conditions. it also can modify the system as per the user requirement.[16]

Cognitive Radio (CR)-New ways of Using Spectrum

Latest mobile communication are devices are having new frequency band wider spectral bandwidth per frequency channel but it also had provision for large frequency band this is done because of insufficient resource of a mobile communication network.In the mobile communication network, the delectated frequency spectrum is allotted and the licenses are given to the operator. Due to limited spectrum availability, the new challenge is how to increase the spectrum availability[17]. The problem of unavailability of the spectrum is partially solved by using a new concept known as cognitive radio for cellular network.

Cognitive radio is a new area for research for farther studies. Cognitive radio technology permits different other technologies to share the same spectrum efficiently by adopting the unused spectrum and also adopt the transmission scheme as per the requirement of technologies.The dynamic radio resource management is completed is distributed fashion and relies on software define radio. [18]

Software Defined Radio(SDR)

SDR(software-defined radio)[19] is newly introduced technology having very good computing speed so that multiband and multi slandered base station and terminals can be developed.The upcoming terminals are having the ability to adapt the air interface to the available radio access technology.[20] SDR improves the following factors

- Base stations are developed by using software-defined radio. Software-defined radio helps to improve the multiband and multiprocessing function of base station and terminal.
- It will increase the network capacity at a specific time
- The operator can reconfigure the network according to need
- It can add the number of modems at the base transceiver station
- Due to software-defined radio, the hardware cost is reduced
- Reconfiguration become easy
- Reconfiguration can be done by downloading certain software
- Power requirement is reduced
- Cost is reduce
- The speed is increased
- Application development cost and time will be reduced

Multiple technologies are used for the communication these technologies follow different standards so that they are not portable to each other and it is difficult to work on the heterogeneous system.Fifth-generation systems give the solution for the above problem. The core of the fifth-generation system is design such a way that not only it will reconfigure the system as per user need but also make the devices compatible with each other. For example, IEEE 802.21 standards are focused on handoff facility between various heterogonous networks.It describes the standers about vertical handoff methods in media independent handover.[21]

It arranges the hardware and software mechanism such a way that in which the hardware and software devices are compatible with each The interpretability technique gives the following advantages to the system[22]

- Minimal investment
- Users have a choice to select a network

The network selection is done based onthe following parameter

- Quality of service
- Channels available status
- Handoff portability
- Traffic load balance between two adjacent network
- Effective sharing of network
- Network congestion problem

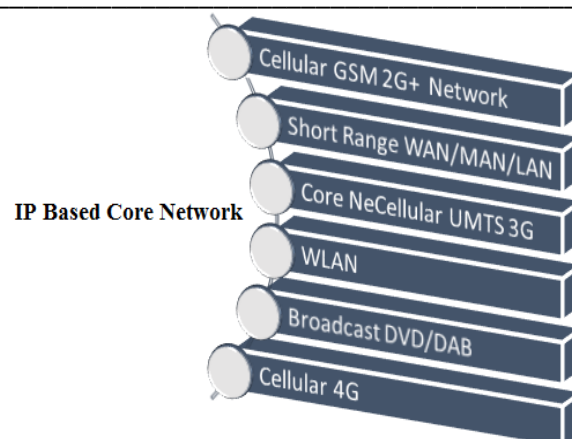


Figure 5: Reconfigurable-Interoperability between several types of wireless access network

Initial network selection is critical processes. It is the basic function of interpretability process between two different types of network. [22]. A right selection of network results in lower blocking probability and improved quality of service to the user. The call handling capacity of the network is also increased and it can be achieved by reconfigurable and interpretability processes. The sharing of core architecture plays an important role to enhance the quality of service. Handoff flexibility in the fifth-generation system is improved employing vertical handoff and inter network handoff. The handoff parameters are reconfiguring according to the newly selected network. INH (Inter-Network Handover) mechanism decide according to the dynamic condition of handoff parameters. The inter radio parameter select the proper network belongs to the heterogynous network available around the existing call network. The utilization of hardware is reduced and the cost factor is improved [23]. Due to sharing of network user get the same the benefit of roaming facility in the newly selected network this is possible because of interoperating of networks. The call charges are charged according to the roaming or non-roaming facility. The identification is done in both the network that is an old network and newly selected network.

Adaptive Coupling-Reconfigurable Integration

Interoperability is the outcome of the integration of multiple heterogeneous networks. Radio accesses technology to increase the spectrum width by sharing the bandwidth of the existing network and selected networks. In high-level integration, the vertical handover is done by exchanging the data and resources between the different users. If the other selected network is heavily loaded and tritely coupled than their will delay while giving the service. While reconfiguring the network the loosely coupled mechanism is used so that there is a possibility to get better service. [24]

Network Energy Efficiency

Power consumption for network devices is a key factor who decide the grade of service. New hardware design technology focused on power consumption by the device. Most of the network devices the power source is a diesel generator. Now a day diesel generators are replaced by solar power sources due to this the overall cost of the system is reduced, solar power resources also reduce the size of network system setup. The upcoming mobile communication systems minimize the power consumption by minimizing the transmission power and power consumed by the signal [25].

Machine-Type Communication

In the current scenario of wireless communication connectivity is not a sensitive issue for interconnection of mobile to base station or base station to the mobile device.

Small batteries with mobile devices are giving very good power backup. These batteries are available at low cost and larger life. Machine type communication mechanism increases the availability of mobile devices. The 4G systems are using this technique in many application like data transfer of surveillance camera. 5G core is design such a way that the improvement in the area of connection setup and signal power[26]

Nanotechnology

Nanotechnology is working on the nanometer scale like 0.1nm to 100nm. the concept of nanotechnology depends on nanoscience. Nanotechnology is also known as MNT(molecular nanotechnology) [27]

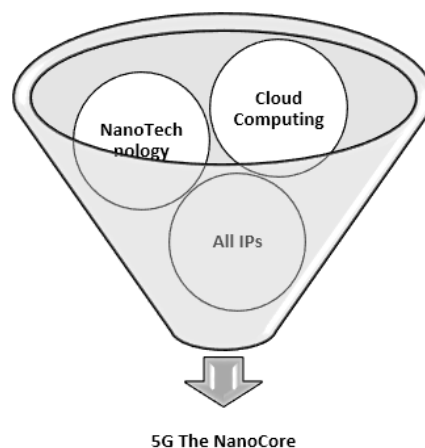


Figure 6: Nanotechnology

MNT mainly contribute in the area of power requirement by the communication device it reduced the consumed power. It also increases the computation Power of the device.

Nanotechnology is having more impact on the following things

- In wireless communication, mobile devices are more intelligent and high computational power. Many application can be embedded in the current mobile devices
- Nanotechnology is improving the multimedia application
- It is also used in fields like transportation and medicine
- Digital signal processing is again area related tonanotechnology increases the speed of 5g devices.

All IP Network

AIPN (All IP Network) [9] is a substitute to fulfil the demand of the wireless communication network.

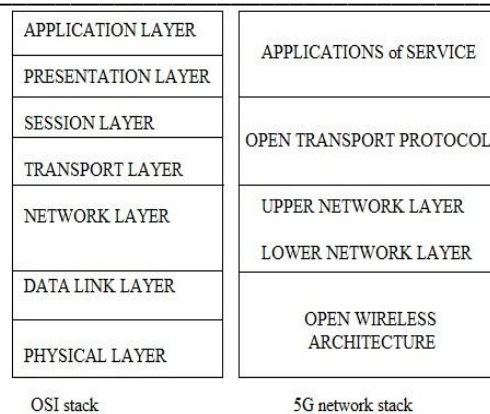


Figure 7: All IP Network AIPN

Radio access technology solves this problem by sharing the radio spectrum among the multiple networks the packet switching technology enhances the speed of data transmission and reduce the overall cost of the system.[28]

The advantages of All IP Network are as mention below

- Access to a variety of different wireless system
- Communication options are available for users
- Universal access
- Performance is improved
- Speed is increases
- Cost is reduced
- Wide spectrum is available for user

The AIPN is facing the different challenges form hackers like the security of data and virus problem.

Cloud computing

Cloud computing[10] is newly invented technology provides global access to userdata at any point of communication with the help of internet. The resources like network data storage devices, different servers, different application and different services are shared within multiple heterogeneous networks. These devices are accesses remotely from any network system The core of 5G systems are design such a way that it supports all features of cloud computing technology. In multi-core technologies, the subscriber is accessing its private account throw cloud computing technique.

Cloud computing technology provides the features

- Single point access
- User-friendly service
- On-demand service
- Sharing of resources from multiple networks
- Reduced Network conjunction

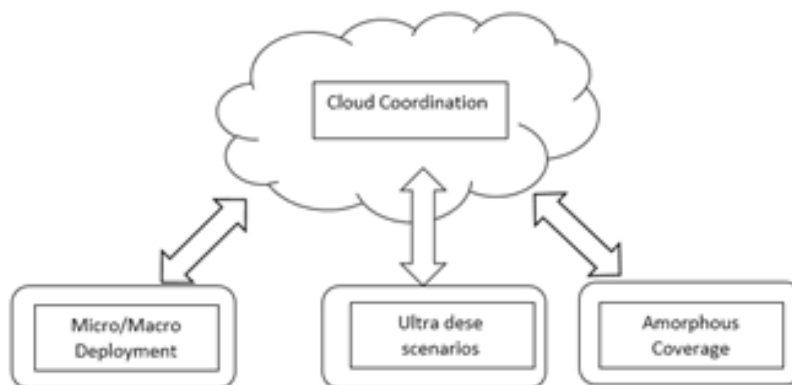


Figure 8:Cloud computing in 5G Network

5G technology provides a unique solution for different network systems. 5G systems are working on multiple technologies and spectrum, the reconfiguration ability of 5G core helps to reduce the hardware resources by sharing the hardware with another network.

Power requirement is a sensitive issue because in mobile phone multiple applications are running and power demand is more to fulfil this power requirement the network devices are manufactured with the help of nanotechnology.

The Nanodevices are manufactured in such a way that they consumed a minimum amount of power so that they can work on solar resources.

The devices like modulator, demodulator, signal generator, coding protocol and link layer protocol design on the reprogrammable devices like

- FPGA (Field-programmable Gate Array)
- Digital signal processor (DSP)
- Microprocessor and Microcontrollers.

Generatio n	Parameters					
	Year	Standards	Operati ng frequen cy	Data Rate	Audio and multimedi a simultaneo usly	Benefits
1G	1981	FDMA	900Mhz	2.4kbp s	No	Voice call
2G	1991	FDMA/TD MA	25Mhz	64 Kbps	Yes	Voice call, massages
2.5G	1995	IS-95	25Mhz	144 kbps	No	Video conferen cing,

Generatio n	Parameters					
	Year	Standards	Operati ng frequen cy	Data Rate	Audio and multimedi a simultaneo usly	Benefits
						GPS
3G	2000	UMTS	25Mhz	2 Mbps	Yes	Mobile TV
4G	2019	LTE	100 Mhz	20Mb ps	No	High resolutio n video
5G	2018	NR	30 GHz to 300GHz	100 Mbps	No	High- resolutio n video

Table:1 Comparison Of Mobile Network Based OnCore Parameters

The transmission and reception are done with help of RF signal via antenna the received RF signal is converted into RF frequency and processes the data[11].

At transmitter end If the frequency is converted into an RF signal. The analog to digital converter (ADC) and digital to analog converter (DAC) are used at respective transmission and reception sections. The application software installs at transmitter and receiver are takes care of processes like modulation demodulation channel allotment convert Digital to analog and analog to digital section. Handoff is another important issue solved by using dynamic handoff technique applicable to horizontal handoff and vertical handoff.

- 5G network bandwidth is 1Gbps
- Globally accessible
- Suitable for online application
- Available at low cost
- Good quality of service
- Radio resource management
- Improved handoff method
- Voice over IP enabled services.
- 5G systems are designed on an open platform.

4. CONCLUSION-

The world is heavily pushed towards the use of mobile communication network. All types of mobile generations played an important role to overcome this situation. Online shopping, online teaching-learning and much more application are executed by using these network. This work finds out the

gaps and utility of different generation of mobile communication network, which helps the researcher to choose the appropriate mobile communication network for the user

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