

## 5 G - Wireless Technologies

**Bharati Patil\*, Shobhana Patil, Ashwini Pawar, Priti Jadhav, Sayali Shinde, Bharati Bhamare**  
 Computer Science, Dr. D. Y. Patil Science & Computer Science College, Akurdi, Pune, Maharashtra, India

### ABSTRACT

#### Article Info

Volume 7, Issue 3

Page Number: 570-577

#### Publication Issue :

May-June-2021

#### Article History

Accepted : 10 June 2021

Published : 15 June 2021

Fifth generation wireless technology is give us dynamic speed and much more efficiency. It would create massive improvements in wireless technology's word. The need of 5G technology increases day by day with no. of problems like plethora users, high speed, receiver complexity etc. Nowadays 4G is going on but as a user and devices are going to increase day by day then in future there is a lot of traffic in 4G spectrum. Moreover, at that time we need a new technology, which is 5G. There is some cellular or telecommunication industries which has already implemented in some countries like united states, South Korea Sweden, Turkey, Japan, china etc. This technology is still in progress under expert. So many wireless researchers and academicians are going to work for this technology enhancement.

**Keywords :** AMPS (Advance Mobile Phone Service), NMT (Nordisk Mobil Telephone), TACS (Total Access Communication System), TDMA (Time Division Multiple Access), CDMA (Code Division Multiple Access) WCDAMA (Wideband Code Division Multiple Access)

### I. INTRODUCTION

5G is the 5th generation of mobile networks, a significant evolution of today's 4G LTE networks. 5G has been designed to meet the very large growth in data and connectivity of today's modern society, the internet of things with billions of connected devices, and tomorrow's innovations. 5G will initially operate in conjunction with existing 4G networks before evolving to fully standalone networks in subsequent releases and coverage expansions.



**Figure 1.** The Connected Community

In addition to delivering faster connections and greater capacity, a very important advantage of 5G is the fast response time referred to as latency.

Latency is the time taken for devices to respond to each other over the wireless network. 3G networks had a typical response time of 100 milliseconds, 4G is around 30 milliseconds and 5G will be as low as 1 millisecond. This is virtually instantaneous opening up a new world of connected applications.

Every new wireless technology gives faster speed and more functionality. First generation wireless technology for first cell phone. Second-generation wireless technology gives text first time. 3rd generation wireless technology gives online platform and 4th generation technology which is nowadays every one using is deliver speed 1st generation wireless network introduced around 1980's up to 1990. This network give voice only cellular calls with speed up to 2.4 Kbps. AMPS, NMT, TACS this is all those technologies, which used in this network. In 1st generation analog bandwidth used. First time any network able to make calls. First generation network is first wireless network. There is also some drawback of this network. There is no room for spectrum enhancement. Also, privacy is less in 1st generation network capacity of calling is also less in 1st generation

Second generation wireless technology is GSM based. Difference between 1G and 2G is analog signal used in 1G where digital signal used in 2G. This technology introduced around 1991. TDMA, CDMA technology that is used in 2G. 2G gives speed around 64 Kbps. Quality of sound is increased in 2nd generation network and noise is reduced. First time SMS (short message service) and Email is established by 2nd generation network. There is also drawback of 2nd generation network. In this network signal easily dropped. 2G is based on digital signals and these digital signals are so weak so there for some time signal not reach up to tower. This generation network has low data handling capability

Third generation technology introduces around 2000. WCDMA/CDMA is technology, which is used in 3G. Maximum speed of 3G is around 21.6 Mbps. In this network, quality of digital voice signal is increased. Third generation is use large bandwidth. In this network first time able, to do video conferencing also this network support TV to internet. There is also some drawback of 3rd generation network. Main drawback is cost because establishing of 3rd generation is so high. its require more band width. For proper connection, more number of towers is required so initial cost of 3rd generation wireless network is so high.

Fourth generation wireless network is packed switched wireless system with wide area coverage and high efficiency. 4G is more cost effective and high-speed network. Its provide speed around 20Mbps. Frequency band is used 2 to 8 GHz; this is the main advantage of 4th generation wireless network high speed. This network has low cost per bit and good spectral efficiency. Fourth generation of wireless network provide high quality of service and high security. There is also some drawback of this network. Battery consumption while using 4G is so high. This network is hard to implement. Signal dropped so many times because it has high frequency. It need complicated hardware and very expensive to implement. It also required more number of towers.

But as more user come online 4G reach up to its limit in future and that's why need of 5G occurs. It will be able to handle thousand time more traffic compare to today's network and able to give speed ten times more. It will able to give more functionality and revaluation in some field like virtual reality, automation driving, internet of things, online robotic surgery many more. Right now five brand new technologies immersing as a foundation of 5G.

## II. 5G ENABLE

5G will enable instantaneous connectivity to billions of devices, the Internet of Things (IoT) and a truly connected world. 5G will provide the speed, low latency and connectivity to enable a new generation of applications, services and business opportunities that have not been seen before.

There are three major categories of use case for 5G:

**A. Massive machine-to-machine communications** also called the Internet of Things (IoT) that involves connecting billions of devices without human intervention at a scale not seen before. This has the potential to revolutionise modern industrial processes and applications including agriculture, manufacturing and business communications.

**B. Ultra-reliable low latency communications** mission critical including real-time control of devices, industrial robotics, vehicle-to-vehicle communications and safety systems, autonomous driving and safer transport networks. Low latency communications also opens up a new world where remote medical care, procedures, and treatment are all possible

### C. Enhanced mobile broadband

Providing significantly faster data speeds and greater capacity keeping the world connected. New applications will include fixed wireless internet access for homes, outdoor broadcast applications without the need for broadcast vans, and greater connectivity for people on the move.

For communities, 5G will enable the connection of billions of devices for our smart cities, smart schools and smart homes, smart and safer vehicles, enhance health care and education, and provide a safer and more efficient place to live.

For businesses and industry, 5G and IoT will provide a wealth of data allowing them to gain insights into their operations like never before. Businesses will operate and make key decisions driven by data, innovate in agriculture, smart farms and manufacturing, paving the way for cost savings, better customer experience and long term growth.

New and Emerging technologies such as virtual and augmented reality will be accessible by everyone. Virtual reality provides connected experiences that were not possible before. With 5G and VR you will be able to travel to your favourite city, watch a live football match with the feeling of being at the ground, or even be able to inspect real estate and walk through a new home all from the comfort of your couch.

5G will keep us connected in tomorrow's smart cities, smart homes and smart schools, and enable opportunities that we haven't even thought of yet.

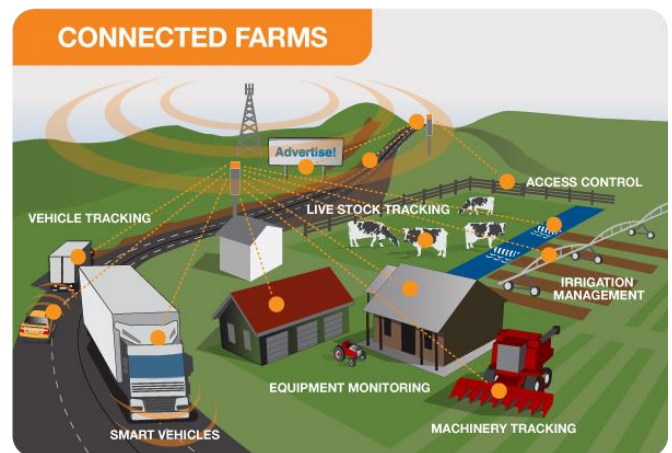


Figure 2. Connected farms

5G Enhanced Mobile Broadband and IoT will revolutionise agriculture and farming.

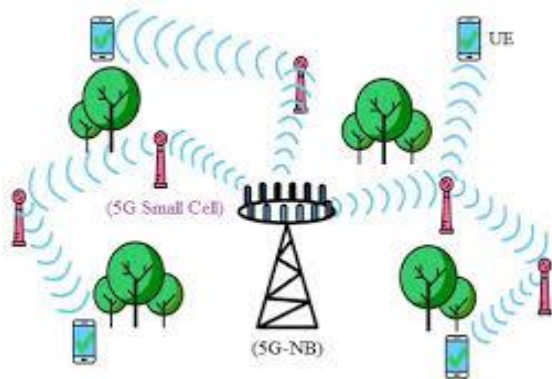
## III. MANUSCRIPT

All wireless electronic communication devices use specific frequency band, which is called spectrum.

Typically it's up to 6GHz but nowadays this frequency spectrum get more crowded because day by day number of user and devices are increase so high. Carrier going to send a large amount of data on same range of frequency spectrum. System going to provide slow service and more drooped connection. The solution is open some new range of frequency and here millimeter waves comes into picture. Range of millimeter waves is up to 300 GHz. This section on spectrum is never been used before.

**A. Small cell :-**

If this new range of spectrum will be, open that mean more number of bandwidth foe more number of users. However, there is one main drawback of millimeter waves. These waves cannot travel through walls or any other obstacles. These waves easily observe by weather. Therefore, for solution need of small cells occurs.

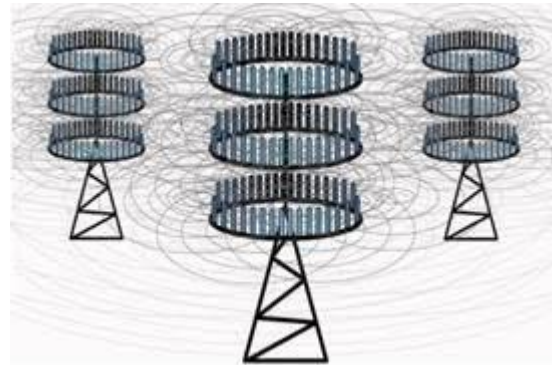


**Figure 3.** Small Cell

Today wireless network travel large high power cell tower to broadcast signal, over long distance. Where, millimeter waves not able to travelling through obstacles, which means if devices are behind the any obstacles they lose signal. Small cell networks solve that problem. Using thousands of small tower mini base station. These small cell mini base stations are much closer together then traditional tower. So small cell able to transmit signal around the obstacles. This is specially use in cities. As user moves around the

obstacles this device, get automatically switched from one nearest small cell to another nearest small

**B. Signal Interface of MIMO :-**



**Figure 4.** Signal interface of MIMO

MIMO stand for multiple inputs multiple outputs. Today's cellular base stations have dozen port of antenna for handling cellular traffic. Where MIMO base station can support 100 ports of antennas. This can improve today's network capacity by factor of 22 or more. MIMO comes with its own drawback. MIMO antennas able to transmit information in all direction at ones and this entire signal get a serious interface, which brings a new technology Beam forming.

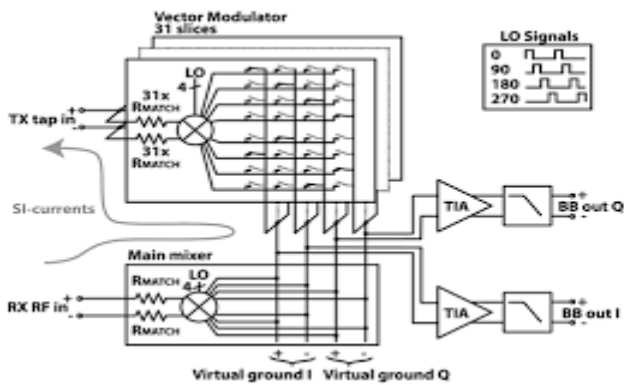
**C. Beam forming:-**



**Figure 5.** Beam Forming

first massive MIMO collect that data and send to specific user with specific data sending algorithm that means Beam forming through which direction of data is where user want to send it which brings new technology full duplex communication.

**D. Full Duplex:-**

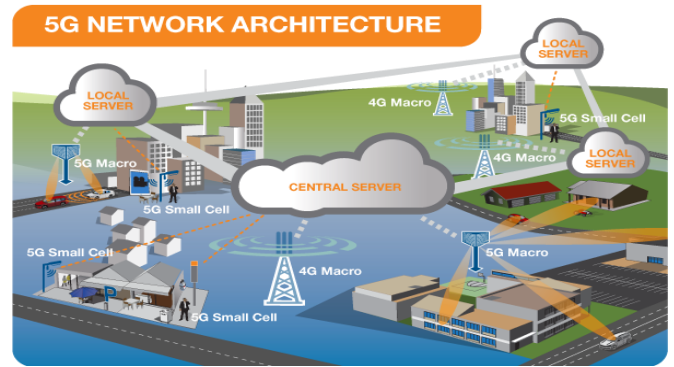


**Figure 6.** Full Duplex

Either in one scenario data can transmit or receives. This is call half-duplex communication like walky-talky. Today’s cellular base stations have same that problem. This is because of reciprocity principle. If you transmit data on radio frequency then it travel forward or backward on same frequency. So two devices are send data at a same time so error occurs because of reciprocity principle. For solution researchers use silicon transistor to create high speed switches. This silicon transistor allows two users to transmit data at ones.

**IV. HOW 5G WORKS**

Most operators will initially integrate 5G networks with existing 4G networks to provide a continuous connection.



**Figure 7.** Working of 5G

5G network architecture illustrating 5G and 4G working together, with central and local servers providing faster content to users and low latency applications.

A mobile network has two main components, the ‘Radio Access Network’ and the ‘Core Network’.

**A. The Radio Access Network**

It Consists of various types of facilities including small cells, towers, masts and dedicated in-building and home systems that connect mobile users and wireless devices to the main core network.

Small cells will be a major feature of 5G networks particularly at the new millimetre wave (mm Wave) frequencies where the connection range is very short. To provide a continuous connection, small cells will be distributed in clusters depending on where users require connection, which will complement the macro network that provides wide-area coverage.

G Macro Cells will use MIMO (multiple inputs, multiple outputs) antennas that have multiple elements or connections to send and receive more data simultaneously. The benefit to users is that more people can simultaneously connect to the network and maintain high throughput. Where MIMO antennas use very large numbers of antenna elements they are often referred to as ‘massive MIMO’,

however, the physical size is similar to existing 3G and 4G base station antennas.

## B. The Core Network

The mobile exchange and data network manages all of the mobile voice, data and internet connections. For 5G, the 'core network' is being redesigned to better integrate with the internet and cloud based services and also includes distributed servers across the network improving response times (reducing latency). Many of the advanced features of 5G including network function virtualization and network slicing for different applications and services, will be managed in the core. The following illustration shows examples of local cloud servers providing faster content to users (movie streaming) and low latency applications for vehicle collision avoidance systems.

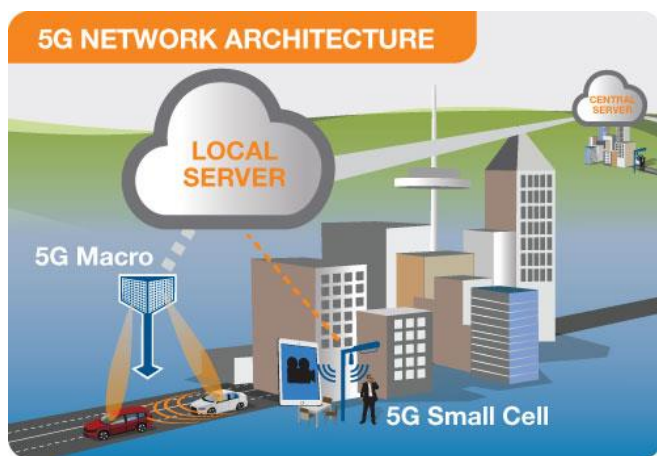


Figure 8. Network Architecture

Example of a local server in a 5G network providing faster connection and lower response times

**C. Network Slicing** – enables a smart way to segment the network for a particular industry, business or application. For example, emergency services could operate on a network slice independently from other users.

**D. Network Function Virtualization (NFV)** - is the ability to instantiate network functions in real time at

any desired location within the operator's cloud platform. Network functions that used to run on dedicated hardware for example a firewall and encryption at business premises can now operate on software on a virtual machine. NFV is crucial to enable the speed efficiency and agility to support new business applications and is an important technology for a 5G ready core.

## V. HOW DOES 5 G DELIVER CONTINUOUS CONNECTION, GREATER CAPACITY, AND FASTER SPEED AND RESPONSE TIMES?

### Better Connection - always connected

5G networks are designed to work in conjunction with 4G networks using a range of macro cells, small cells and dedicated in-building systems. Small cells are mini base stations designed for very localised coverage typically from 10 metres to a few hundred metres providing in-fill for a larger macro network. Small cells are essential for the 5G networks as the mmWave frequencies have a very short connection range.

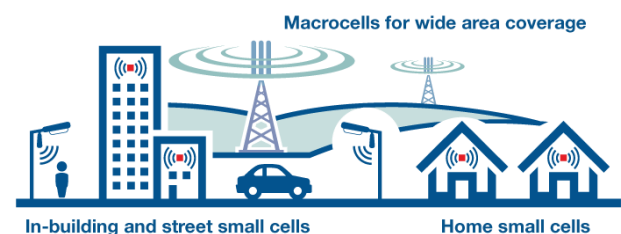


Figure 9. Small cells for 5G network

### A. Increased Spectrum – greater capacity, more users and faster speed

In many countries, the initial frequency bands for 5G are below 6 GHz (in many cases in the 3.3-3.8 GHz bands) and similar frequencies to existing mobile and Wi-Fi networks. Additional mobile spectrum above 6 GHz, including the 26-28 GHz bands often referred to as millimetre (mm) Wave, will provide

significantly more capacity compared to the current mobile technologies. The additional spectrum and greater capacity will enable more users, more data and faster connections. It is also expected that there will be future reuse of existing low band spectrum for 5G as legacy networks decline in usage and to support future use cases.

The increased spectrum in the mmWave band will provide localised coverage as they only operate over short distances. Future 5G deployments may use mmW frequencies in bands up to 86 GHz.

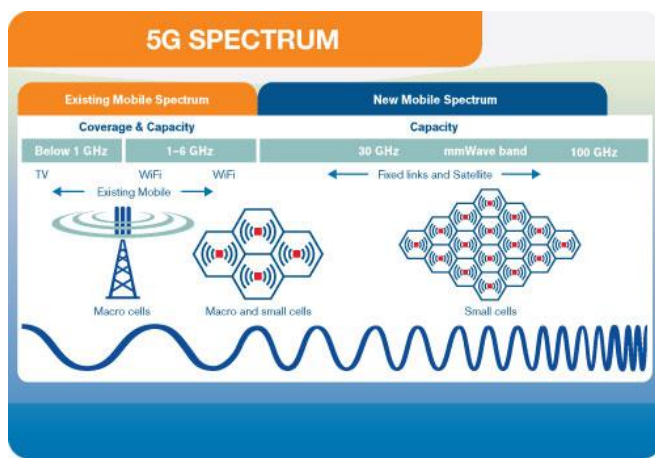


Figure 10. 5G spectrum

### B. Massive MIMO

Multiple element base station - greater capacity, multiple users, and faster data. 5G will use 'massive' MIMO (multiple inputs, multiple outputs) antennas that have very large numbers of antenna elements or connections to send and receive more data simultaneously. The benefit to users is that more people can simultaneously connect to the network and maintain high throughput. The overall physical size of the 5G massive MIMO antennas will be similar to 4G, however with a higher frequency, the individual antenna element size is smaller allowing more elements (in excess of 100) in the same physical case. 5G User Equipment including mobile phones and

devices will also have MIMO antenna technology built into the device for the mmWave frequencies.

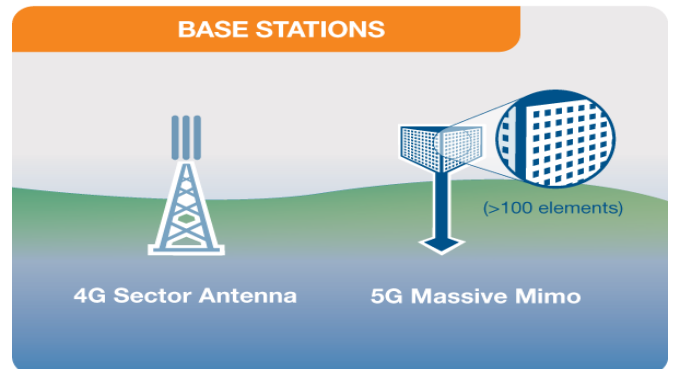


Figure 11. Base Station

4G sector base station and 5G base station with a new multi element massive MIMO antenna array. The overall physical size of the 5G base station antenna is expected to be similar to a 4G base station antenna.

### C. MIMO - Beam Steering

Beam steering is a technology that allows the massive MIMO base station antennas to direct the radio signal to the users and devices rather than in all directions. The beam steering technology uses advanced signal processing algorithms to determine the best path for the radio signal to reach the user. This increases efficiency as it reduces interference (unwanted radio signals).

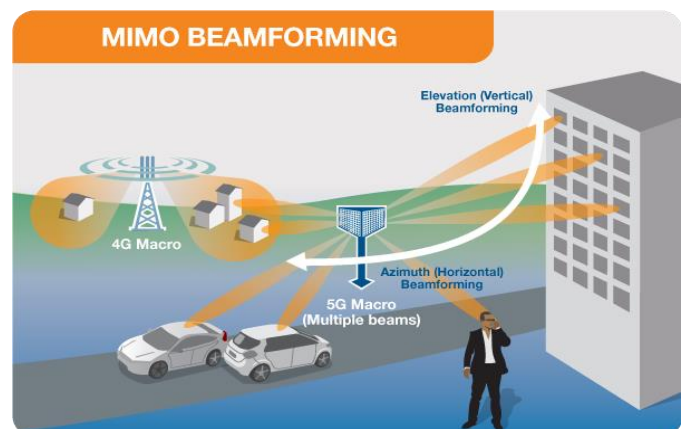


Figure 13. MIMO Beamforming

Massive MIMO antenna and advanced beam steering optimises EMF and increases efficiency

## VI. CONCLUSION

5th generation technology going to revaluation in wireless technology. Experts are still working on this five technology. Millimeter waves, small cell, massive mimo, Beam forming, full duplex this all technologies are still in progress. It would also include some new technologies. All of this system work together it would be a challenge. If expert figure it out then 5G services could arrive in next five years.

## VII. REFERENCES

- [1]. 5G, Wikipedia, the free encyclopedia <https://en.wikipedia.org/wiki/5G>
- [2]. Google helped a lot in making this research paper; we got lot of information of news paper called "THE HINDU" .

### Cite this article as :

Bharati Patil, Shobhana Patil, Ashwini Pawar, Priti Jadhav, Sayali Shinde, Bharati Bhamare, "5 G - Wireless Technologies", International Journal of Scientific Research in Computer Science, Engineering and Information Technology (IJSRCSEIT), ISSN : 2456-3307, Volume 7 Issue 3, pp. 570-577, May-June 2021. Available at Journal URL : <https://ijsrcseit.com/CSEIT2173126>