



# Key Technologies and Problems in Deployment of 5G Mobile Communication System

Arun Kumar  
Research Scholar  
JECRC University  
Jaipur, India

Manisha Gupta  
Associate Professor  
JECRC University  
Jaipur, India

## ABSTRACT

With growing demand in high data speed and increase in number of subscriber which is estimated to increase by 30% in the year 2020. So, the present technology like 3G, 4G cannot support this hence there is a requirement of developing next generation mobile network which is to be called 5G network. The main aim of the paper is comprehensive study about the challenges in 5G and its possible solution. Here focus on the problems like better signal coverage, high data speed greater than 1Gbps, cognitive in 5G and other key technologies is also discussed.

## Keywords

Femto Cell, Ultra Dense Network, QAM-256, Smart Antenna, Cognitive Radio, Bdma, Faster than Nyquist (FTN), Linear Spectrum Sensing.

## 1. INTRODUCTION

5G stands for a fifth generation mobile communication. In future 5G will use integration of many technologies that will provide the data rate and 2 – 8GHz frequency band is used. The design and rollout of fourth generation mobile communication system are in progress in all over the world as well as in India. Already a mobile company called Samsung has designed a 5g mobile by using 64-transceivers that has achieved a speed of 1Tbps and they claimed that they are first the world to do so. The transmission frequency used was 28 GHz. [1]. Many other telecommunication industries. Research institute (METIS) and University throughout the world are investigation for the 5G. With the implementation of 5G the new scope of research has opened up for many researchers, engineers etc. The main vision of 5g is to develop a mobile communication network free from existing wireless hurdle and give a feeling of real wireless world. A 5G network has a evolutionary view and revolutionary view. In former view the 5G network will contain cognitive radio, high order modulation system, and many other intelligent error correcting codes. And in latter view the 5G network is capable to give a high quality of service at anywhere, at any time and to anyone [2]. As the application of mobile communication like entertainment to online gaming to billings, banking household application etc is increasing day by day, so the next generation network (5G) should be capable of providing a high quality of service, high data speed, excellent coverage to fulfill the demand of the next generation of mobile subscribers. The vision of 5G can be only achieve by combining various radio access technology, LTE, HSPA with 5G and not by developing a new technology to replace them.

## 2. KEY ISSUES FOR DEPLOYMENT OF 5G NETWORK

### 2.1 Data Coverage

The indoor coverage is one of the most important hurdle in 5G mobile communication and research has already proved that more than 70% of data traffic and 50% of voice traffic originates from indoor area but the signal coverage in indoor area is so poor as compared to out-door area [3]. To provide a quality of service, better coverage, connectivity in highly densely populated area is also one of the major challenges in mobile communication system. A lot of solution was proposed by various researchers to overcome the coverage issues like by dividing a build into a small cell, by using repeaters, cell splitting approach etc but the solution is complicated with issue like high investment in extra infrastructure, regular maintenance etc thus practically it is not affordable.

### 2.2 Ultra Dense Network

To over-come the problem in high densely populated area ultra dense network is suggested. Ultra dense network maintain a constant connectivity, data speed in highly populated area. It will be one of the key technologies that will play a very important role in next generation network as data traffic will be increased at a huge rate. This network can be achieved by deploying a pico cell, umbrella cell etc.

### 2.3 High Data Rate at Constant Speed

One of the factor that define the performance of the system is the speed but the present data-rate offered by a mobile communication is not constant and reliable which creates lot of problem when it comes to browse high bandwidth content like HD video, online gaming, while travelling in train, buss etc. so, efficient, reliable high speed data network is demand. In fact by reducing the transmission distance between transmitter and receiver, the data rate, capacity can be increase but in 5G the demand of data rate is 1TBPS, hence a very advance technology is needed. The two possible techniques that can be help to increased the speed are: use of high order modulation system (QAM-256) and Smart antenna as used by Samsung.

### 2.4 Vertical Handover

A hand over is a process in a mobile communication system in which ongoing call will be connected from one base station to another base station without terminating the call. Without handover the mobility is not possible to achieve in mobile communication system. Vertical handover enables the automatic connection of one network to another network [4].



But in the present scenario the vertical handover is not intelligent in mobile communication which has to be improved drastically.

## 2.5 Interference Issue in 5G Mobile Communication

The 5G network will be the integration of different technologies and it also uses high order modulation techniques. Multipath interference, Co-channel interference, PAPR, fading etc are the key issues that need to be solved for the successful implementation of 5G technology. A proper network interference management has to be developed in order to address these issues. Some techniques to overcome these issues are discussed [5].

## 3. KEY TECHNOLOGIES IN 5G MOBILE COMMUNICATION

### 3.1 Femto Cell

Hence in 5G Network, the indoor issue can be solved by deployment of femto cell in the indoor unit area and in those places where signal coverage is a real issue. A femto cell is inexpensive, small and low-power base station whose radio range is 10 - 15 meters. Due to the smaller transmission distance between transmitter and receiver, femto cell can provide an efficient increase in speed, capacity, coverage and also increase the battery life. Femto cell can be configured in three different ways: the first is Orthogonal deployment: where Femto Cell uses one fragment of spectrum and Macro cell uses other fragment of spectrum. The second deployment is co-channel deployment where both macro and femto cell access all channels and in third deployment, the whole bandwidth is split into two parts where one part is used by macro cell and other part is used by both [6]. Since, Femto cell shares a frequency from the same spectrum which is being used by the macro cell base station. So there will be interference between: Femtocell and Macro cell, Femto cell to UE and Macro Cell to UE but now testing on femto cell has proved that this interference hurdle can be taken care and it will not affect the communication. Now commercial femtocell is available in the market.

### 3.2 QAM 256

Till today modulation system is defined as process of transmitting a message with the help of carrier but now the definition of modulation is changed. The efficiency, performance of communication system depends upon the choice of modulation system. Hence by choosing a reliable modulation and better filtration technique one can achieve a high speed. For QAM-256, each symbol represents a 8 bits which is transmitted and it can generate a mobility speed of 40Mbps and additionally it can provide a 33% efficiency as compared to QAM-64 [7]. This means with the use of QAM, the data rate is tremendously increased. One of the disadvantages of high data rate is distortion between the two symbols which is also called inter-symbol interference (ISI) but ISI can be reduced by using an equalizer which increases the complexity in transmitter and receiver part of communication system.

### 3.3 Smart Antenna

In general antennas are not smart but the antenna system is smart. The adaptive beam steerable antenna is used in those places where we want to increase the capacity at a limited spectrum. Ericsson has developed some array antenna that operate at a frequency of 900, 1800, 1900 MHz frequency

band. The efficiency and performance of communication system is greatly affected by fading and co-channel interference. Smart antenna is one of the best and most promising techniques that can increase the capacity and speed by reducing the effect of fading and co-channel interference. A smart antenna consists of number of array of antenna, these elements of array are combined to form a movable beam pattern whose main beam follows a desired user [8]. Smart antennas in 5G use a BDMA concept:

#### 3.3.1 Concept of BDMA

In order to accommodate the increasing capacity with limited spectrum there are many multiple access technologies like FDMA, TDMA, CDMA and OFDMA. In BDMA, the mobile communication communicates with the user. In this concept, the beam of antenna is divided that follows the user thus achieving the multiple access which in turn increases the capacity, speed etc. The mobile base station and the user are in LOS (Line of sight) so that they know each other's position. The communication between user and base station is achieved by allocating an orthogonal beam to each other [9].

### 3.4 Faster-Than-Nyquist (FTN)

The FTN is one of the most promising techniques based on non-orthogonal transmission scheme that will efficiently utilize the spectrum efficiency thus increasing the data rate. In FTN the signal is transmitted at the faster rate which may also introduce the ISI. The FTN can also consider for multiple carrier transmission. In FTN the input signal is encoded and modulated which uses M-ary scheme and finally the signal is passed to FTN mapper which can be designed by using a up-sample of factor  $n$  and pulse shaper [10].

### 3.5 Cognitive Radio

The technology like 5G and Cognitive are considered to be one of the future technologies for mobile communication. In fact, the 5G is a combination of 4G+Cognitive. The CR uses the same spectrum efficiently by finding the unused spectrum and allocating the unused spectrum to desired user (secondary user) because the CR has a prior knowledge about the used and unused spectrum. CR should be SDR so that it can be realized according to our needs [11].

#### 3.5.1 CR Spectrum Sensing Technique Match Filter Detection

In match filter detection, the decision has to be given whether the spectrum is present or not. The main function of match filter is to reduce the level of noise and increase the component of original signal. So at a receiver a decision can be made out. The disadvantage of Match Filter is that it is very difficult to figure out the unknown signal, so many times it may not give desired result, power consumption is also more in CR and a dedicated sensor is needed for all primary users [12].

#### Energy Detection Sensing

In this sensing, there is no requirement to have advance knowledge about the existence or non-existence of signals. The decision is taken after comparing the predetermined threshold level with the received signal [11].

#### Cyclo-Stationary Sensing

In this method the unknown signal is detected by exploiting the cyclo-stationary features of received signals. A signal is said to be cyclo-stationary if its autocorrelation is a periodic function of time  $t$  [11].



### 3.6 Linear Spectrum Sensing

In this system, the transmitter performance is enhanced without interrupting the current transmission. In linear spectrum sensing, the interference is minimizing for primary user. The receivers consist of match filter follow by tapped line where a number of antennas can be installed. One of the disadvantages is the complexity in the receiver design [13]

### 3.7 Device to Device Communication

It means one device can directly communicate with any-other device without involvement of any other network. The main goal is to increase the speed, connectivity, coverage etc. Many hurdles like resource allocation, D2D deployment of heterogeneous network, D2D time session are still to be investigate. [14].

### 3.8 Ultra Wide Band

UWB stands for the ultra wide band use for short range wireless communication. UWB Wireless communication provides a fundamentally different approach to wireless communication as compared to traditional narrow band systems. According to the FCC, UWB is any signal that has a fractional bandwidth equal to or greater than 0.20 or has a bandwidth equal to or greater than 500 MHz With the use of UWB, a speed of 480mbps is achieved at the range of 2-3 meter and 53 mbps can be achieve at the range of 10 meter [15].

### 3.9 All IP Network

All Ip Network is a packet based network at which all the data is transmitted in a same way and it will be independent of the access technology. It support a mobility which provide a consistent and ubiquitous provision of services. As services delivery moves to all-IP, all services, whether residential or business, become IP streams, with their primary differences related to bandwidths, tolerable packet losses and latencies. Transport of business services and residential services over a single metro network becomes viable, despite very different QoS requirements. Network expansion costs can be minimized and service velocity maximized [16].

### 3.10 Cloud Computing

Cloud computing, or in simpler shorthand just "the cloud", also focuses on maximizing the effectiveness of the shared resources. Cloud resources are usually not only shared by multiple users but are also dynamically reallocated per demand. This can work for allocating resources to users. Cloud computing is one of the most growing technology in mobile communication. It provide to access a resource at any time with minimum management effort from any device and location.[17].

## 4. CHANNEL ESTIMATION IN 5G MOBILE COMMUNICATIONS

In order to know the information about multipath interference, channel fading, power decay etc it is very important to obtain accurate information about the channel. There are different method for the estimation of the channel like pilot channel estimation which is spread over time and frequency domain, blind channel estimation which extract the channel information from the data symbols, semi-blind channel estimation which is a combination of prior known symbol and observation of unknown data[ 18].

## 5. APPLICATION OF 5G

- Communication at anytime, anywhere and by anybody.
- Single unified global network.
- Device with Ai capabilities. High speed greater than 1 GBPS.
- Compatible with new and existed technology.
- Prediction of natural calamities like earth-quake, tsunami etc.
- Concept of telemedicine is really achieved.
- A battery can be charge without a charger.

## 6. CONCLUSION

The year 2020 will be the one of the most important year for telecommunication world. This technology expects to deliver a great quality of service almost in every field of communication. The key challenges and technologies for 5G mobile technology is discussed in this paper. Already most of the industry, research institute, and university are doing lot of research and talking about the deployment of 5G by the year 2020. The country like Korea, Japan and many European countries are playing on front foot to promote the research in 5G mobile communications. At the same time they are many developing Countries where deployment of 4G mobile technology itself is a big issue and peoples are not aware of 5G and no research regarding 5g is going on neither in research institute nor in Academic. So at this scenario the whole world is ready for 5G is a big question to be asked or alike 4G the 5G will become only technology for developed word which simply cannot fulfill the vision of 5G that is communication for all, at anytime and anywhere.

## 7. ACKNOWLEDGEMENT

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