Some Investigations on 5G Mobile Technology

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Abstract: **In mobile communication there is very fast development from 1G to 4G. In 1G, 2G, 3G FDMA, TDMA and CDMA were used respectively. 4G uses multiple access technique in OFDM. Now 5G is going to implement. There are many limitations of present mobile communication like call drop, mobile radiation, and data rate. We tried to review that how these limitations overcome in 5G as per available literature.**

***Keywords*- WCDMA, OFDM, LTE, UMTS, BER**

INTRODUCTION

It is expected that the wireless network capacity will be enhanced 1000 times to the year of 2020 to meet the requirement of the increasingly growing data traffic. [5] The mobile communication developed so much in terms of speed and data rate .The four generations of mobile communication evolved very drastically. In case of 1G(generation) communication the geographical area is divided into cells (typically 10-25km), each served by a "base station." Cells are small so that frequency reuse can be exploited in nearby (but not adjacent) cells. This allows many more users to be supported in a given area. All 1G systems were analog systems popularly known as early cellular phone technology working in the frequency band of 150 MHz. In 2G voice transmission is done through used digital signals and had a speed up to 64 kbps. It also provided the facility of Short Message Service (From now on, referenced as SMS) and used the bandwidth range of 30 - 200 KHz. 2nd generation communication includes the following Mobile technologies: General Packet Radio Service (GPRS), Code Division Multiple Access (CDMA), Global System for Mobile Communication (GSM) and Enhanced Data Rates for GSM Evolution (EDGE). Some key benefits of 2G Network over its predecessors was that, Digital Encryption was supported by 2G systems which had higher penetration efficiency thereby being more efficient on network spectrum. [12] Moreover, 2G introduced several data services for mobile, the most prominent one being the famous SMS text messages. After 2G was launched, the previous mobile telephone systems were coined as 1G Systems. Although it has been eons since its inception, 2G networks are still used in many parts of the world. In 3rd generation mobile communication, the UMTS (Universal Mobile Telecommunications System), is a completely different technology from GSM and its enhancements. It usually works on 2100 MHz and the big difference from 2G is in how different users share access to the radio channel - in case of 3G it's WCDMA: Wideband Code Division Multiple Access - a single 5 MHz channel is shared for all connected mobile phones and each phone has a special code assigned for decoding its data. While, in 4th generation network called LTE (Long Term Evolution), works in a very different manner than 2nd and 3rd generations. Shared access is done by OFDMA - the available channel is divided into sub channels (also called subcarriers) and each of them is treated separately; groups of those subcarriers are assigned to different mobile phones.[9] Also LTE is designed as a data-only network so all of the traffic is IP-based and there are no more circuit-switched connections. In present the mobile system that we are using has some limitations like Data rate, call drop, radiation and bandwidth. How these limitations will be overcome in 5G, we have gone through the available literature in following sections.

1. BANDWIDTH

Bandwidth required to transmit a signal has a very important role in deciding the channel capacity. The spectrum of a signal in the range of frequencies that it contains, and is termed on absolute bandwidth of the spectrum, but most of the energy in the signal is contained in a relatively narrow band of frequencies. This band is referred to as the Bandwidth [10]. In case of 1G we used FDMA as multiple access technique. In FDMA entire Bandwidth is divided into number of bands and allotted to different users. In FDMA all users are allowed to access the same base station or satellite on same time but at different frequencies. In 2G we used TDMA, every user got its own slot in which he used to transmit the information. All users are allowed to access the same base station or satellite in same frequency but different time slots. In CDMA every user is allowed to use the entire Bandwidth. All users can transmit the information at same time and frequencies but with different codes. Due to which there is a interference among users and channel capacity of CDMA system depends on that interference. In 4G we use OFDM as multiple access system. OFDM divides the available bandwidth into N orthogonal sub-channels by adding a cyclic prefix(CP) to each OFDM symbol, the channel appears to be circular, if CP length is longer than the channel length [13].OFDM and OFDMA are the modulation technique strategy and multiple access strategy adopted in LTE (Long Term Evolution). In 4G cellular network the spectral efficiency of OFDM is

limited by the need of a cyclic prefix (CP) and by its large sidelobes. [7] Another requirement for 5G wireless systems is the probability to ensure low-latency communication. To reduce latency at physical layer, a single-carrier modulation seems to be preferable, since it avoids block processing of the data that introduces additional delays. A tuneable OFDM system with an adaptive choice of the length of data block would be an option. The tuneable OFDM a sort of adaptive scheme with parameters chosen based on the instantaneous operating conditions. In this case allotment is based on present requirement.

2. DATA RATE

Data service in current cellular network is growing exponentially. [2] It increased drastically due to use of facebook, whats up etc and this demand is increasing continuously. To fulfil this requirement high data rate supporting system is required, so that channel capacity is high. Every transmission medium has a fixed bandwidth. The rate at which data can be transmitted over a given communication path or channel under given condition is referred to as the channel capacity [10]. There are many factors which affect the channel capacity of a system like data rate, bandwidth, noise and error rate. Signal fading due to multipath propagation is dominant source of impairment in wireless communication system [14] causing high bit error rate (BER). For high capacity data rate, bandwidth of transmission media should be high and noise level, error rate and required bandwidth of transmitted signal should be less. The channel capacity is fixed by considering all above parameters for successful communication. Hence fifth-generation networks will have to support very large data rates and this high data rates can get by combining number of technologies like (1)- by using more than one antennas i.e. MIMO we can reduce the level of noise or interference. (2) By using multi-carrier the effect of multi-path fading is less and adaptive modulation is easily implemented.[7]

If the maximum separation between two co-channel cell Ds is based on a co-channel interference reduction factor which is expressed as

$$q=Ds/R \quad \text{-----(a)}$$

where R is the cell radius.[7]. So from above expression (a), if we are using smaller cells then the capacity of system increases. Recently, there has been a growing interest for mm-wave communications for supporting short-range cellular communication. It is anticipated that mm-wave will be used on short distance in 5G [9].

3. CALL DROP

When we are moving in a car or train and during that time talking with somebody in mobile phone suddenly call disconnects automatically due to less C/I ratio. This is call drop. When a car is moving and during talk Doppler of channel is related with carrier frequency and mobility. In case of rich scattering environment and unidirectional antennas, the value of Doppler shift for carrier frequency 3-60 GHz with mobility of 3-350 km/h is from 10 Hz to 20 KHz. Since in moving vehicle the incoming signal to the mobile is from all directions having different value of Doppler shift and this is termed as Doppler spread. Reason is in present terrestrial wireless system their working range in microwave frequency that is from several hundred MHz to a few GHz millimeter wave.

A solution of this is to concurrent utilization of microwave and mm wave frequencies could go for 5G [6] where mm-wave frequencies can be used for payload data transmission from small-cell BSS while the control plane would operate at microwave frequencies from BS. In case of millimeter wave the beam are concentrated at source and destination due to that angular spread incoming signal returns and later it will be largely compensated by Automatic Frequency Control (AFC) loop in the receiver. The result of this, time domain variation of mm-broadband channel is likely to be much less than unidirectional antenna in a rich scattering environment.

4. RADIATION

While Signals at lower frequencies can penetrate more easily through buildings, millimeter wave signals do not penetrate most solid materials very well. High levels of attenuation for certain building materials (eg, brick and concrete) may keep millimeter waves transmitted from outdoor base stations confined to streets and other outdoor structures, although some signals might reach inside the buildings through glass windows and wood doors. The indoor coverage in this case can be provided by other means such as indoor millimeter-wave femtocell or Wi-Fi solutions. It should be noted that next-generation Wi-Fi technology using 60 GHz millimeter wave is already being developed in IEEE 802.11ad.

Foliage losses for millimeter waves are significant and can be a limiting impairment for propagation in some cases. At 80 GHz frequency and 10m foliage penetration, the loss can be about 23.5 dB, which is about 15 dB higher than the loss at 3 GHz frequency.

CONCLUSION

In present mobile communication system there are number of limitations like effect of mobile radiation, call drop, data rate, coverage and bandwidth. We have gone through the available literature and tried to find out how these problems

will be solved in 5G. It is found that in 5G system by using tuneable OFDM, millimeter wave and Multiple Input and Multiple Output systems above said problems can be minimized as per literature.

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