THEORETICAL PHYSICS TO IMPROVE RADIO FREQUENCY IN 5 GENERATION

Dr. Talib Al-Sharify 1, Dr. Ali Ihsan Alanssari 2, Dr. Mushtaq Talib Al-Sharify3, Dr. Itimad Raheem Ali 4

1Al Rafidain University College, College of Engineering Sciences, Hay Al-Mustansiriya, P. O. Box 46036, Baghdad, Iraq
2Al Nisour University College, Department of Computer Engineering Techniques, Iraq
3Radio Engineering and Radio Electronics Systems department, Radiophysics, Electronics and Computer Systems Faculty, Taras Shevchenko National University of Kyiv, Kyiv, Ukraine
4 Lecturer, University of information technology and communications Graphics and multimedia tools; Baghdad, Iraq, itimadra@uoitc.edu.iq

*Email: mushtaq.talib2005@gmail.com, alsharify@univ.kiev.ua.

Abstract. The development in the world of telecommunications and user require to increase the data capacity, make us to research how we can to develop a system to increase the data packet and efficiency. The purpose of the research is to improve the efficiency of transceiver path data in highways. The aim of the research is to improve the quality of communication and the accuracy and efficiency of the data transmitted to meet user requirement.

Key words: QoS, EME, 5G, 4G, Antenna, Radio frequency.

1. INTRODUCTION
The world of mobile communications is witnessing the development of technology in the modern world and the demand for increasing the speed and efficiency of the network in public areas, interior areas and even in highways to the formation of a new generation called 5G by 3GPP [1].

Introducing a new system with the last ten years and generally from year to year. From GSM 2G systems in the 1990s to 3G UMTS in the first decade of the 21st century to 4G LTE these days. Every time a new system is defined, new services emerge and distinguish such a system from wireless communications, as LTE is the evolution and increase data traffic everywhere. Therefore, the researchers start to developed on new radio frequency generation "5G" systems from several years ago and the first question "main feature" of the new system was. So the main areas for researcher in new fifth generation system is dedicated: "mobile broadband, increasing data capacity, increasing user experience and allowing applications" and to provide all of this the system must be fully updated while maintaining communication between network components, as so as discussed in our research.

The fifth generation (5G) was developed by theoretical physics using electromagnetic energy (EME) to increase transmission distances and network coverage [2, 3], also in closed or densely populated
areas such as hospital, cafes, sports venues and in public transport and metro platform stations, also to control Robert biomedical and first aid.

The main purpose is to create a new architecture that achieves network resilience, scalability, increased service efficiency (QoS) and also its impact on the environment and health [3]. There is no sufficient clue of how this value is calculated. The main objective of this paper is to analysis physical layer for radio frequency and determine throughput of 5 generations.

The significant increase in the number of basestation in the fifth generation and its impact on health [4] has been analysed and proved that there is relatively little impact with previous generations in telecommunications. Some scenarios for network coverage in the fifth generation as in Figure 1.

Send and receive data at end - to - end device. Contains a lot of flexibility with the flexibility of communication architecture in the fifth generation has been proven realism [5].

Theoretical physics - radiofrequency has been developed into a new radio based on EME as network coverage has become wider and reaches all enclosed areas (Figure1). The fifth generation will be the best solution for the world's population increase for a long time in all respects [6].

The fifth generation (5G) is the modern generation in telecommunications. The idea was to increase data transmission by change the frequency value and increase bandwidth of data, as we know that the wavelength is proportional to the frequency directly and the speed of light inversely, therefore, the increase in frequency leads to increased data packets, also increased the rate of data exchange in transmission lines, but in turn leads to short wavelength and high number of enodeB in result we have an increase in cost.

On the other hand, we are looking for the best telecommunication networks for user require, for example Transportation networks and other things of modern life, modern sensors must use a large band of data, which poses great challenges in terms of wave propagation and attenuation among them and here we are talking about millimeter waves [7].

We have already mentioned that the wavelength will become short and the waves will not reach long distances. With small cell 5G will have low cost can be distributed within cities and public areas. Let us remember for a moment that short-term waves cannot bypass all types of barriers and therefore will be placed in public places with the appropriate capacity to help cover the area and population in this region.

The fourth generation (4G) of telecommunication has already started using Su-MIMO and MU-MIMO, but the fifth generation has developed a massive MIMO system based on its main benefits,
spectral efficiency, which focuses on the use of spatial multiplexing of many terminals in time/frequency slot, as well as in energy efficiency based on direct wave amplification. Massive MIMO is a large number of MIMO Antenna System with all its characteristics and adaptive control system.

In the fourth generation the use of the beamforming system [3] appeared continuously but in the fifth generation was developed to 3D-Beamforming where it will be different and with high potential despite its adoption on the same principle radiation pattern. 3D-Beamforming will send and receive radio frequencies by the user's location in the three directions (x, y, z) and cancel any other possibility. On other hand, the energy sent to the receiver will be higher and the band of data will be higher.

Let us clarify one of the other benefits in the fifth generation is full duplex where it is possible to send and receive data in the same channel, which gives us double capacity and high data traffic.

2. RADIO ACCESS NETWORK (RAN)

The multiplicity of cell types in the 5G network and the combination of technologies and frequencies have led to one of the biggest challenges in the world of radio signal propagation and this has required adaptation and complexity of the 5G network.

The new models used in the 5G make the radio-frequency propagation process viable. However, planning and cells location has become very difficult. The large number of nodes will make the ideal locations very difficult to choose a locate for base station. As well as transmission operations between the companies distributed to the communications lines will increase the complexity.

Attenuation, interference and allocation of capabilities lead to increased allocation of dynamic resources to improve performance and automate program control. The coordinated multipoint (CoMP) necessary for radio frequency and diversity in 5G cells, including those requiring of high-speed data in 4G, all of that will be the engine of the modulation scheme.

We don't forget that the transfer of the user from one network to another (handover) gone to the discontinuation of the use of data capacity in one and run in the other cell, therefore we need to improve the network structure to ensure the security and the possibility of unloading, privacy and use of the network to provide the possibilities of maintenance of the connection or add an additional user equipment (UE). One of the advantages of the 5G is the preparation of radio access technologies (RAT) and in return to maintain the overall environment with user requirements and high performance.

| Table 1. Compression between Mobile generation |
|----------------------------------------------|
| **Comparison** | **2G (GSM)** | **3G (WCDMA)** | **4G (LTE, WiMAX)** | **5G** |
| Access system | TDMA, CDMA | CDMA | OFDM | OFDM, BDMA |
| Switching type | Circuit switch (SC) for voice, and Packet switch (PS) for data. | PS except for air interference | PS | PS |
| Internet service | Narrowband | Broadband | Ultra Broadband | Wireless worldwide web |
| Bandwidth | 25MHz | 25MHz | 100MHz | 10 GHz to 300 GHz |
| Advantage | Multimedia features (SMS, MMS), internet, and SIM introduced | High security, International roaming | Data traffic, handover | Extremely high speeds, low latency |
| Latency | 500 ms | 100 ms | 50 ms | 1 ms |
3. ELECTROMAGNETICS ENERGY SURVEY IN 5G
The capacity and coverage of the 5G network include high bandwidth and contain different cell size such as Macrocell and smallcell. Whereas the 5G is based on two systems with the same Electromagnetics energy (EME) value used in 4G and at the same time increase the value of data and / or increase the number of users:
- Indoor / smallcell;
- outdoor / Macrocell.
In Macrocell networks we will have multi-beam and different transceiver regions. It can be seen that the 5G Macrocell transmit signals using 3D-beamforming vertically and horizontally separately, thus taking advantage of spectrum, power and allowing more simultaneous data flows. In either case, the radio frequency would be a more fixed beam orientation, so the EME would be the same as before. There will be not dis-effect on the environment and the efficiency of EME devices will increase.
In 5G networks the efficiency will be higher especially in public places with EME and reduce transmission distances which reduces attenuation.

4. NEW RADIO (NR) ACCESS TECHNOLOGY 5G
One of most development in fifth generation is NR [8, 9]. NR is developed by 3GPP to build a standard version of air interface 5G network. The frequency band for NR in 5G divided to two ranges, frequency range 1 (FR1 = 6 GHz) and frequency range 2 (FR2 = 20 GHz till 60 GHz) also FR2 is named by millimeter wave range (mm wave range), therefore; NR 5G include different subcarrier as showed in table 2:

| Subcarrier Spacing (KHz) | Slot duration (ms) | CP (µs) | Frequency Range |
|-------------------------|--------------------|---------|----------------|
| 15                      | 1                  | 4.7     | FR1            |
| 30                      | 0.5                | 2.35    | FR1            |
| 60                      | 0.25               | 1.17    | FR1 and FR2    |
| 120                     | 0.125              | 0.58    | FR2            |
| 240                     | 0.0625             | 0.29    | FR2            |

\[ Channel \ BW = Maximum \ transmission \ bandwidth + guardbands on both side \]
\[ Channel \ BW = N_{RB} \times NumOfSubcarrier \times Subcarrier \ Spacing + GuardBand \times 2 \]
\[ Channel \ capacity \approx spectrum \times NumOfAntenna \times \log_2(1 + SNR) \]

From the above equations we can demonstrate the actual increase in the BW amount and additional channel capacity of the data packet. Also, we can to attention of used the same band for 4th and 5th
5

generation but in 5th generation its will be more compatibility and better used frequency band width and increase layers’ number then the RB will be increase also slot per time duration. So that help us to calculate throughput for LTE and 5G:

\[
\text{Throughput}_{LTE} = N_{PRB} \times 1000 \times \text{Number of Antennas}
\]

(1)

\[
\text{Throughput}_{5G} = \sum_{\mu=0}^{5} \sum_{n=1}^{v_{\text{layers}}} M^n \times f^n \times R_{\text{max}} \times \frac{12 \times N_{PRB}^{n,\mu}}{T_s^{\mu}} \times (1 - FR^n)
\]

(2)

\(n\): number of band carriers

\(R_{\text{max}}\): 948/1024

\(M^n\): Maximum modulation order, [2bits for QPSK, 4bits for 16QAM, 6bits for 32QAM, 8bits for 256QAM]

\(f^n\): Scaling factor, can take any value from 1, 0.8, 0.75, and 0.4

\(\mu\): 5G NR Numerology “number of symbols sent in a given time”.

\(T_s^{\mu}\): Average OFDM symbol duration in a sub-frame for \(\mu\) value,

\(N_{PRB}^{n,\mu}\): Maximum Resource Block Allocation in bandwidth

PRBs (Physical Resource Blocks)

\[\text{Figure 2 throughput in 5G}\]

\[\text{Table 3. characteristic used in example.}\]

| Characteristic          | 5G NR                  |
|-------------------------|------------------------|
| Radio frame             | 10 ms                  |
| Subframes in a frame    | 10                     |
| Slots in a frame        | 20 (each 1 ms)         |
| Resource blocks         | 100 or more            |
| Carrier aggregation     | 16                     |
| Subcarrier spacing      | Flexible: \(2^n\times15\) kHz (\(n\) = -2, 0, 1, ..., 5) |
| Carrier bandwidth       | Variable, maximum per Cubic Centimeter is 400 MHz |
| Frequency bands         | 30 GHz                 |
| 3D-Beamforming          | With and without DL/UL reciprocity |
| Modulation              | QPSK, 16 QAM, 64 QAM and 256 QAM |
| MIMO                    | Up to 8x8              |
In figure 3 The data bit rate for each user in our example used different type of modulation to improve the best type of modulation as show in 256-QAM. Now we will be compare between different type of radio frequency to improve 3D-beamforming at 256-QAM.

In figure 4 The vector diagram for our example used different frequencies band 7 GHz, 14 GHz, and 28 GHz. Therefore; the models in different configurations and frequencies and see that the 256-QAM
advanced radio signal model obtained during tuning and modulation is better than other models and will improve the quality of 5G mobile networks. Also, the improvement in the fifth generation and the evolution in network capabilities. Hence, we can conclude the decrease in the time of transmit a single slot, increase the number of antenna with add new technology of massive MIMO and 3D-beamforming, by used radio frequency signal in 5G; the result in figure 2-4 taken from (2) and table 2, 3 can improve data throughput for different number of user. 5G are able to achieve the following:

- Increase data transmission speed.
- Improve capacity of mobile network.
- Develop of wireless equipment.

From the direct contact between the machine (M2M) and the machine, this led to:

- Improve data throughput transmission.
- Decrease latency for End to End devices, table 2.
- Optimize wide band network, figure 4.
- Improve wider network coverage for smallcell/indoor and Macrocell/outdoor.

Also from compare with our result in [10, 11, 12], the mobile connectivity in 5 Generation better than 4G:

1- 10 times
   • decrease in latency
   • increase in connection density
   • experienced throughput

2- 3 times
   • more spectrum efficiency (bits per Hz).

3- 100 times
   • traffic capacity
   • network efficiency (network energy).

The switch to 5G will mean longer battery life for devices, lower costs, enhanced cellular footprints, higher throughput, enhanced capacity, low latency, and virtually no packets dropped.

5. THEORETICAL PHYSICS

All telecommunication systems obey the laws of theoretical physics. Therefore; when we search to develop advantage of telecommunication there we need to increase data rate, propagation radio frequencies for indoor or outdoor, range of antenna transmission and other facilities. The fifth generation relied on certain laws in choosing the type of antennas:

1. The radio frequency band for transmission;
2. Width of the band.

Lower frequencies reach farther distances. It can also be used on the highway and to control the robot in first aid.

At higher frequencies will allow to increase the data rate. Radio signals travel more quickly which means you can send data faster - that's what we need as technology advances and applications get richer. Higher frequencies have the added benefit of requiring smaller antennas (because the size of the antenna depends on the wavelength, and the greater the frequency - the lower the wavelength). Conversely (the higher the frequency, the lower the signal penetration capacity).

The fifth generation took care of the advantages and disadvantages mentioned in the frequency bandwidth and according to the laws of theoretical physics and thus relied on the two types of frequencies mentioned earlier.

6. CONCLUSION

This paper presented the theoretical physics to improve radio signal which clearly that type of new generation of mobile technology. Also to improve data transmission speed, broadband and direction when bandwidth became rise from radio frequency band that it makes minimum loss of time transmission according to new type of massive MIMO and 3D-beamforming. We presented many configuration formulae that improved all theoretical physics capabilities of NR in 5G for user
equipment. At the result increase Quality of Service (QoS) by increase data rate which led to increase subcarrier spacing and reduce time duration for each transmit slot, therefore increase bandwidth.

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