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ANALYSIS FOR QOS AND INTERFERENCE MITIGATION IN FULL DUPLEX 5G WIRELESS NETWORKS

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ABSTRACT

Important research efforts and attention have been received by Full Duplex 5G mobile wireless network from both the academia and industry. This kind of wireless network which provides 5G mobile network for full duplex are predictable to provide self-interference migration framework for a wide range of services that applications and users with a very different requirement for the enhancement of performance and energy savings for mobile, devices with battery powered and video content delivery with different strategies and provides different delay bounded QOS (Quality Of Services). In this research work, a self-interference migration framework for overcoming the challenges in 5G mobile network and also delay bounded QOS. The cancellation of self-interference offers the potential to complement and denser heterogeneous network sustain the evolution of 5G mobile networks which can be utilized by wireless communication system in multiple ways by including increased capacity of network, reliability, decreased path loss, packet loss. Self-interference has an impact on overall 5G network.

Keywords: 5G, wireless mobile communication, delay bound, interference mitigation, quality of services, modulation schemes.

1. INTRODUCTION

5G wireless technology is the new upcoming technology in wireless technology. 5G wireless network will support 1000 times of capacity of current network, Data rate of this network will be 10 Gbps ,cell edge data rate at least 100Mbps and Latency of the network will be less than 1 ms [2][3].

5G wireless technology will be built upon both existing wireless technology (LTE, Wi-Fi , GSM ,HSPA) and new radio access technology(RAT). [2].

a) 5G modulation schemes

Modulation is a scheme for the varying signal to transfer beneficial data over the wireless network. There are three type of modulation; Frequency, amplitude and phase. The signal often repeats itself and is known as frequency, the intensity or power of the signal is the amplitude, and the cycle the waveform is with repeat to time describes the phase. 5G modulation schemes performance issues including peak to average power ratio (PAPR), spectral efficiency and performance in the presence of interference and noise need to be include in any decisions made.

In 2G GSM signal level was constant as a result. It was possible to run the final Radio frequency (RF) amplifier in compression to obtain a high level of efficiency and maximize the battery life.

In 3G and 4G final RF amplifiers cannot be run in compression. As a result PAPR has increased. So efficiency of the RF amplifiers has fallen and shortened battery life. 3G and 4G wireless networks use PSK and QAM Modulations schemes for excellent efficiency and very high data rate but fall in the term of PAPR.

To overcome the PAPR issues, one option being considered for a 5G modulation scheme is APSK (Amplitude phase shift keying). APSK modulate both phase and amplitude. Combines both Amplitude-Shift Keying (ASK) and Phase-Shift Keying (PSK) to increase the symbol-set. Symbol-set is the number of symbol changes, waveform changes across the transmission medium per time unit.16-APSK Constellation Diagram shown in Figure-1.

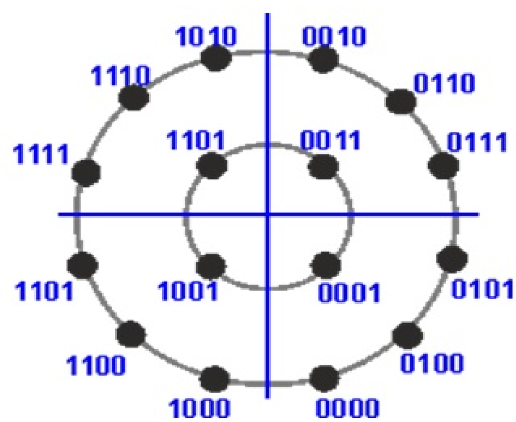

Figure-1. 16-APSK constellation diagram.

b) Massive MIMO (Multiple input multiple output)

MIMO-OFDM (Multiple Input Multiple Output Orthogonal Frequency Division Multiplexing) is one of the upcoming mobile communication schemes, which present well-organized and secured communication network with multicarrier modulation. MIMO-OFDM technique multiple antennas at the transmitter side and the receiver side.[4][5].

Massive MIMO enclose the wide usage of low-priced low-power components, popularization of the MAC (Media Access Control) layer, robustness to intentional jamming and interference and reduced latency. The expected throughput rest on the propagation environment providing asymptotically orthogonal channels for the terminals, and the experiments have not disclosed any

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limitations in this regard so far. MIMO system is shown in Figure-2.

In MIMO system multipath caused interference in network and slows down the wireless signals [1].

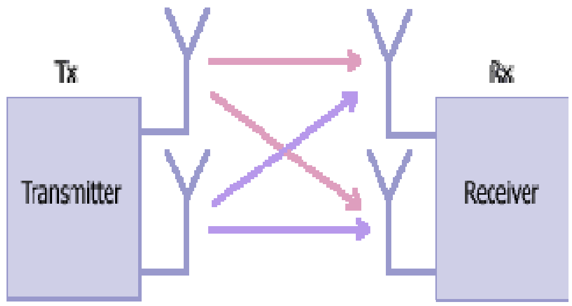

Figure-2. MIMO system.

c) Channel interference

In a wireless communication system the interference at a base station receiver maybe coming from mobile user within the same cell. or from the mobile users in the surrounding cells that is called inter-cell interference and interference with in the same called intra-cell interference. Interference limits capacity and increase the number of dropped cell [6]. For Example, when node1 sending message to node3 in wireless communication channel. During transmission of data if another node2 interfere in that channel. Node2 received some of data that data is not useful for node2.that is call interference of channel.

In Intra-cell interference, the problem of receiver is that the complexity increases with the length of spreading code. Inter-cell interference is divided into two parts: 1) Co-channel interference (CCI) and Adjacent Channel interference (ACI) [7][8].

Co-channel interference occur when cells using same frequency sets. Signal-to-interference ratio in CCI is:

$$\frac{S}{I} = \frac{s}{\sum_{i=1}^{n} Ii}$$

$\frac{S}{I}$ = Signal to interference ratio

s = signal strength received by mobile

$\sum_{i=1}^{n} Ii$ ■ All the power received from interference base station. Ii is the interference caused by the ith co=channel cell.

Adjacent channel interference occur when signals adjacent in the same frequency band. Signal-to-Interference ratio in ACI is [8]:

$$\frac{S}{I} = (d1/d2)^{-n}$$

Subscriber at a distance d1 and interferer is at d2.

$\frac{S}{I}$ = Signal to interference ratio

n = path loss exponent.

2. EXISTING METHOD

Pass-band modulations with Adjacent Channel Interference illustrate the use of baseband demodulators and modulators with frequency up-conversion and down-conversion to simulate pass-band communication system. A method for which an adjacent band tonal signal is been processed with the non-linearity and causes interference for the band of interest. From the existing method, presumptuous a communication system with 16-QAM is used for transmitting in an additive white Gaussian noise (AWGN) with interference in this pass-band, carrier frequency of this system is 2.5e6 Hz , symbol rate 1e6 (symbols/second) and number of symbols in the frame is 2048.

3. PROPOSED METHOD

In this article, we propose Quality of Services (QoS) and interference mitigation in adjacent channel as shown in Figure-3. Adjacent channel interference limits the capacity and frequency of wireless communication channel and it increase the number of dropped cell. If decreases the distance between Base station and mobile station adjacent channel interference also decreases.

We have proposed 64-QAM communication system to transmit the information in an AWGN channel with interference in this pass-band. Carrier frequency we have increased according to our analysis of 5G network.

Transmitting of symbols per second over a channel and frame-length also we have increased in this project.

a) Proposed algorithm

Proposed algorithm for pass-band modulation with adjacent channel interference:

Algorithm:

1. Initialization of factor that describe the parameters such as bandwidth, level of noise, rate of symbol, frequency of carrier, number of samples in one symbol.
2. Calculate sampling frequency in Hz.
3. Calculate the capacity of channel using bandwidth.
4. Initialize measurement tools.
5. Modulate the random data in the baseband with using 64-QAM modulation.
6. Pulse shaping

a. For applying the pulse we used a square root raised cosine filter.
b. Specify a square root raised cosine filter.
c. Design the transmitter filter.
d. Apply pulse shaping by up-sampling and filtering.
e. Plot spectrum estimate of pulse shaped signals.

7. Frequency Up-conversion

a. Generate carrier.
b. Frequency up-convert to pass-band.
c. Plot spectrum estimate.

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8. Channel Simulation
a. Use additive white Gaussian noise channel with adjacent channel interference.
b. Pass-band interference is created by raising an adjacent channel for the third power.
c. Calculate the total signal power.
d. Based on the computed signal power, add the white Gaussian noise band.
e. The adjacent channel interference is been added to the signal.
f. Estimation of the spectrum of the noisy signal is noted and then compared with the original.
9. Frequency down-conversion
a. Down-convert to base-band signal.
b. Estimation of the down-convert signal with the ACI is been done
10. Base-band Demodulation
a. Apply matched filtering
b. Design the receive filter
c. Filter the frequency down-converted signal
d. Estimation of the filtered signals and compare to the filter input.
11. Demodulate the signals
12. To obtain the received symbols without the ACI repeat the above steps
13. Generate Curves for symbol error rate.

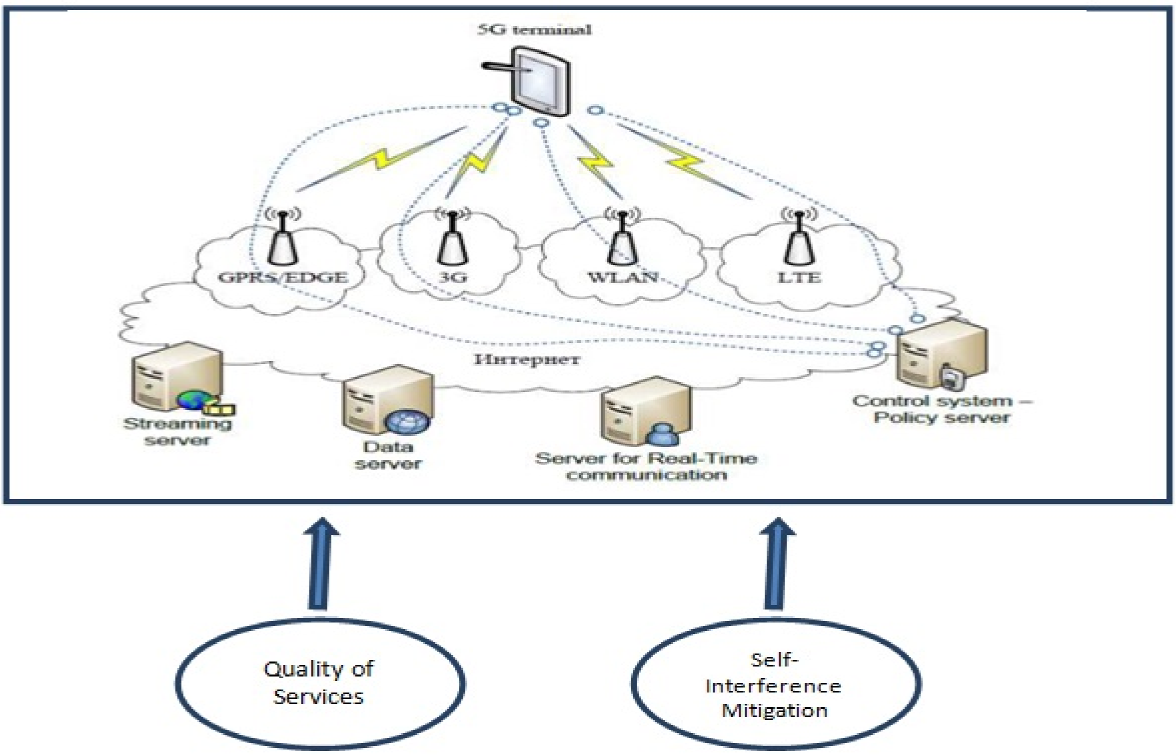

Figure-3. Architecture of proposed system.

4. SYSTEM MODEL

In this system model ,first analyses the Quality of services parameters using channel simulation and put the values of these parameters in pass-band modulation with adjacent channel interference scheme, such as carrier frequency (Fc), symbol rate (Rsym) , quantity of samples per symbol (nSamps) , quantities of symbols in a frame (frame Length), noise level (EbNo) and the modulation order(64-QAM).

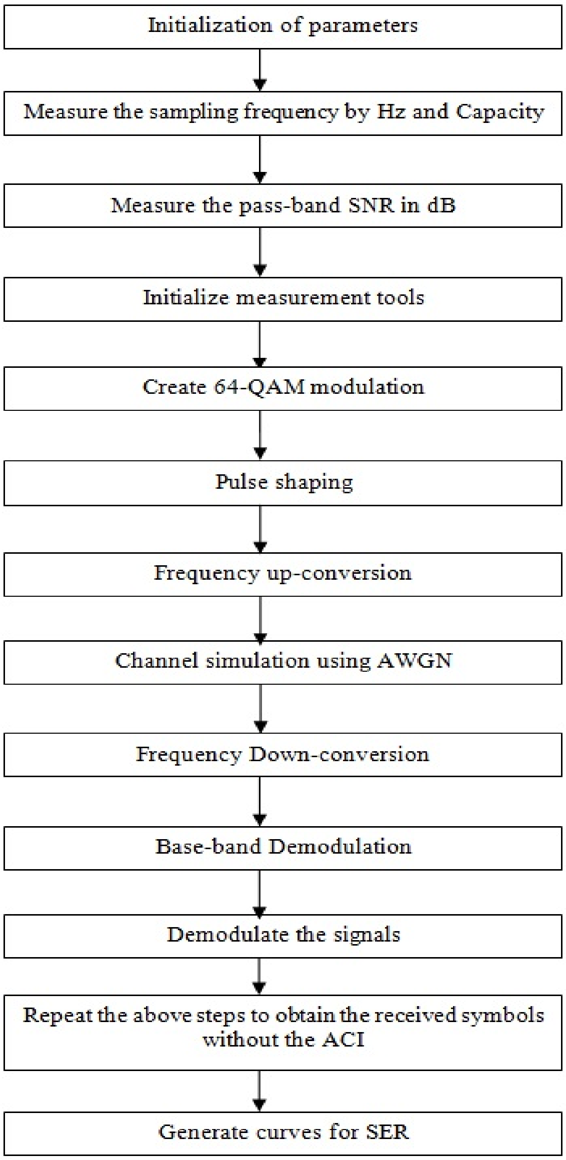

Figure-4. Flow diagram of system model.

After initialization of parameter calculate the sampling frequency (Fs) in Hz and pass-band SNR in dB. As shown in equation (1) and (2).

$$\text{Fs} = \text{Rsym} + \text{nSamps} \quad (1)$$

$$\text{SNR=EbNo+10*log10(log2(M)/nSamps)+10*log10} \quad (2)$$

Create a constellation diagram for received symbol and modulate the random symbol using 64-QAM modulator. A square root raised cosine filter is used for applying the pulse shaping after modulation and estimate plot spectrum of pulse shaped signals than apply frequency up-conversion to obtain the pass-band signal around the specified carrier frequency. Simulation of the communication channel is done by the channel simulator as a pass-band real AWGN channel with an nearby channel interference (ACI) .The pass-band interference is created by increases the adjacent channel for the third power shown in equation (3) and (4).

$$\text{Fint =Fc/3+ 50e3} \quad (3)$$

$$\text{Interference = 0.7*cos(2*pi*Fint*t+ pi/8) ^3} \quad (4)$$

Apply frequency down-conversion to obtain the base-band signal previously to the demodulation. The complex pass-band signal is multiplexed with a complex sinusoidal. In Base-band Demodulation apply matched filtering. The unwanted higher frequency components is removed by the match filter due to frequency down-conversion as shown in Figure-4.

After matched filtering, down-sample and count the number of symbol errors and demodulating the 64-QAM signals to acquire the information symbol. After repeating above steps we obtain the received symbols without adjacent channel interference and update the constellation diagram after receiving the interference free symbol in channel and generate the curves to obtain the SER (Symbol error rate) for the 64-QAM communication system.

5. SIMULATION RESULTS AND ANALYSIS

a) Simulation results

We used channel simulator for analyzing the QoS of Full Duplex 5G wireless network. Simulation results are shown in Table-1.

Table-1. Simulation result for QoS.

F = 28GHz B= 800MHz E= NLOS T-R Separation = 429 m	$\sigma_{\tau}= 10ns$ P_r= $-128.6\ dBm$ PL =158.5 dB
F = 73GHz B= 800MHz E= NLOS T-R Separation = 394 m	$\sigma_{\tau}= 10ns$ P_r= $-127.5dBm$ PL =157.4 dB
F = 73GHz B= 800MHz E= NLOS T-R Separation = 429 m	$\sigma_{\tau}= 10ns$ P_r= $-128.7dBm$ PL =158.6dB
F = 96GHz B= 800MHz E= NLOS T-R Separation = 429 m	$\sigma_{\tau}= 10ns$ P_r= $-128.7\ dBm$ PL =158.7 dB

Table-1 represents Service of Qualities on different frequency (F) , Bandwidth (B) , Environment (E) and T-R separation . σ_{τ} is RMS DS (Root mean square Delay spread), P_r is received power by channel and PL is path loss.

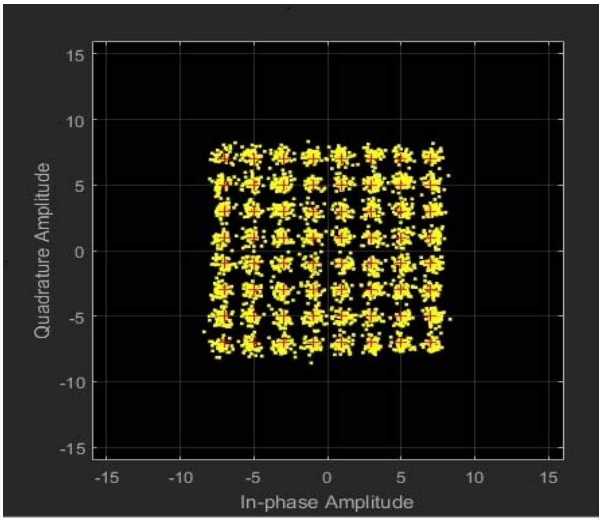

Figure-5. 64-QAM constellation diagram.

64-QAM constellation Diagram in Figure-5 represents 64 possible signal combinations with each symbol representing 6 bit. Transmitting rate is eight times the signaling rate.

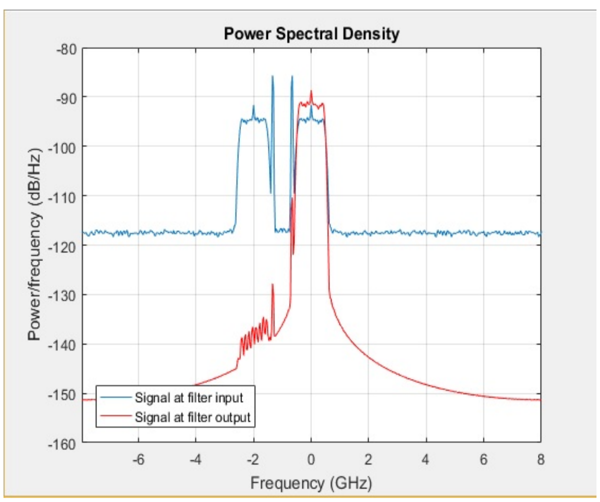

Figure-6. Power spectral density.

In Figure-6, represent power spectral Density that is watts per Hz. Power spectral density is a signal power per unit frequency. Figure-6.8 represents signals at filter input and signals at filter output. This figure shows how many signals can transmit over a network in particular period of time for input signals. Power spectrum density is a power of signals per unit frequency which transmitting in channel. This figure represents the output signals after the filtration of input signals.

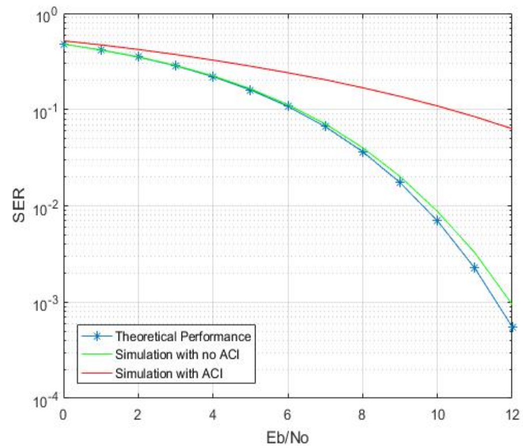

Figure-7. Comparison between SER and Eb/No.

Figure-7, Represents simulation result with no ACI and with ACI. If SER (Symbol Error Rate) decreases, Eb/No increases. Eb/No is closely related to the carrier-to-noise ratio (CNR). It is a normalized signal-to-noise ratio (SNR) measure. Eb = signal energy per user bit and No= noise spectral density.SER is the symbol error rate of channel which is occurs during transmission of symbols because of interference in channel.

b) Analysis

We have analyzed the QoS in this system on the basis of simulation result:

- If T-R separation Distance will increase then propagation time will be decrease.
- If T-R separation Distance will increase then channel received power will be high..
- Bandwidth 800MHz is giving better result.
- If frequency of channel will increase path loss of channel also will increases.

We have developed a pass-band modulation scheme with ACI using 64-QAM and 73 GHz carrier frequency. We have also increased the symbol rate per second in a channel.

6. FUTURE SCOPE

In this article, we have done work on QoS services and pass-band modulation with ACI. Future work of this system is that we can develop same system model for Co-Channel Interference (CCI) and we can work on Effective capacity theory to increase the overall system performance and APSK modulation Scheme of 5G wireless network in future.

7. CONCLUSIONS

In this article we have analyzed QoS for 5G wireless network and we have propose a pass-band modulation scheme with ACI to analyze how to reduce the interference and mitigate the interference from the adjacent channel. The cancellation of Self-interference offers the potential to sustain and complement the

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evolution of 5G mobile wireless network technologies towards and denser heterogeneous network sustain the evolution of 5G mobile networks which can be utilized by wireless communication system in multiple ways by including increased capacity of network, reliability, decreased path loss, packet loss. Self-interference has an impact on overall 5G network. We have analyzed 800 MHz bandwidth and Line of sight (LOS) gives better results. We have also worked on pass-band modulation with adjacent channel interference for 73GHz carrier frequency and 64-QAM modulation scheme.

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