# Performance analysis of Root Raised Cosine Filter based NOMA system for 5G technology

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***Abstract—***
In view of the increasing data traffic and number of users, it has become imperative to use new technologies for wireless communication system. This is how different generations of wireless communication systems have been shaped. Recently, 5G technology has come into the wireless communication system to meet the present requirements. To meet the challenges, in place of orthogonal multiple access techniques, non-orthogonal waveforms for multiple access techniques gained popularity in the new generation of wireless communication system. In this paper, generalized frequency division multiplexing (GFDM) is simulated over fading channel using root cosines filter. BER performances with various modulation techniques are simulated and their comparative study is shown in the results section. The effect of roll off factor of root cosine filter on the BER performance is also analyzed and discussed in the paper. A significant change has been observed in the performance of BER with the change in roll off factor.



***Keywords— Wireless Communication system, NOMA, 5G wireless technology, GFDM etc***

**DOI Number: 10.48047/nq.2022.20.8.nq221114** **NeuroQuantology 2022; 20(8): 10862-10865**

## I. INTRODUCTION

Data communication systems have a decades-long history and have undergone significant changes over time. We have now entered the fifth generation of the communication system. Voice and text were initially supported in the 1st and 2nd generation of the communication system. In 3G, defining the transition to broadband access, supporting data rates measured in the serval kilobits per second. Until a few years ago, the industry had moved to 4G, which supported data rates of few megabits per second. But with the growing needs, wireless communication systems are transitioning to fifth generation for a tenfold increase in data rates [1].

OFDM, a multiplexed communication scheme, has been widely adopted as the underlying physical layer (PHY) technology in 4G Long Term Evolution (LTE) [2].
However, it has drawbacks such as spectral efficiency loss due to cyclic prefix (CP), frequency leakage due to rectangular pulse shape. This technique also requires the need for reasonable time as well as frequency synchronization to realm the carrier frequency orthogonality [3]. Taking all these into account, numerous substitute techniques have been intensively considered, such as Generalized Frequency Division Multiplexing (GFDM), Filter Bank Multicarrier (FBMC), Universal Filtered Multi Carrier (UFMC) etc., which can be used to overcome these limitations. [4-5]

This paper focuses on the GFDM waveform as a non-orthogonal multiple accesses (NOMA) for 5G wireless communication system. GFDM waveform is a proficient candidate for 5th generation of wireless communication systems, with low out-of-band (OOB) emissions, low adjacent channel leakage ratio (ACLR), low peak-to-average power ratio (PAPR) and has many other advantages such as time, comfort requirements of frequency synchronization and low latency [6-7].

## II. SYSTEM MODEL

In this paper, Generalized frequency division multiplexing (GFDM) based physical layer of wireless communication system is simulated for 5G communication system. This scheme is based on block filtered multicarrier modulation technique. The scheme of simulation of GFDM system is shown in figure 1.

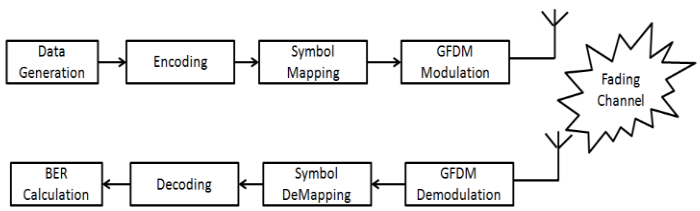


Fig. 1. SCHEME OF SIMULATION OF GFDM SYSTEM

*Data generation:* The binary data for each subband is generated randomly.

*Encoding :*After this, convolution encoding with rate of 1/2 is applied on the data as a error correcting code.

*Symbol Mapping:* The encoded data is mapped with QAM mapping technique. The different modulation order has been applied to see the effect of data rate on the BER.

GFDM modulation : The modulated data is fed to GFDM modulation module to get the non-orthogonal waveform for multiple accesses.

*Channel:* GFDM transmitted signal are then transmitted through wireless antenna system over Rayleigh fading channel. The faded signal with AWGN noise has been generated with given SNR value. Different SNR values, ranging from 0 dB to 25 dB, were applied sequentially for the simulation.

*GFDM demodulation :* This noisy signal is fed to GFDM demodulation module.

*Symbol de-mapping:* The output of the GFDM demodulator is de-mapped using QAM demodulator.

*Decoding :* The demodulated data are decoded through Viterbi detector for error correction.

*BER calculation :* The decoded bits are comparing with generated bits to get BER value.

The simulation has been performed for different scenario. The next section describes the results of simulation and their analysis.

## III. SIMULATION AND RESULT

The simulation has been carried out with the parameters of GFDM based wireless communication system as shown in table 1. Different results for analysis of performance of GFDM are obtained which are discussed below.

TABLE I. SIMULATION PARAMETERS

| Sr. No. | Parameters | Value |
|---|---|---|
| 1 | Modulation | QAM |
| 2 | Modulation Order | [8 16 64 128] |
| 3 | Error correcting coder | Convolution code |
| 4 | Filter type | Root raised cosine filter |
| 5 | Roll off factor | 0.15 , 0.3 |
| 6 | Channel | Rayleigh fading channel |
| 7 | SNR | 0-25 dB |



The figure 2 shows the power spectral density of GFDM system with SNR=25 dB and roll off factor of 0.3 of RRC.

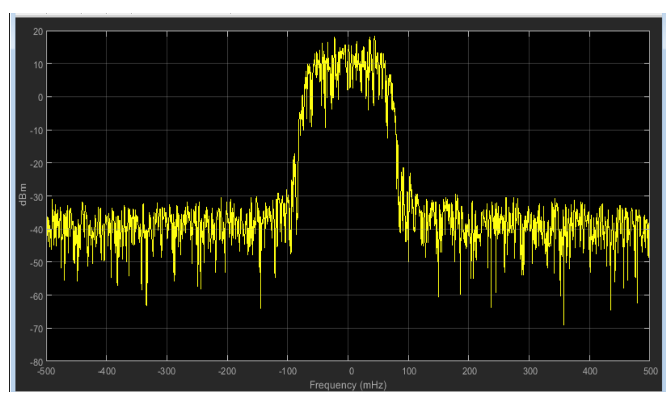


Fig . 2 Normalized spectrum of received signal of the GFDM system with RRC filter with roll off factor of 0.3.

The non-orthogonal spectrum can be observed from the PSD in figure 1. The simulation is further done for finding the effect of RRC roll of factor on BER performance. Figure 3 shows the BER performance of GFDM for roll off factor 0.15 and 0.3.

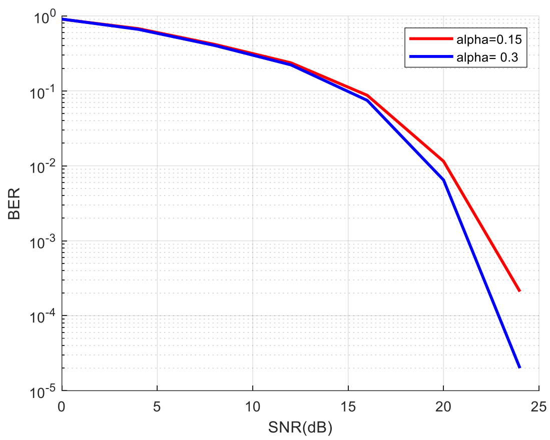


Fig. 3 BER performance of GFDM for QAM-128 with different roll of factors

It is obvious from figure 3, the BER with roll off factor of 0.3 is better than 0.15. Hence the simulation with different modulation order is carried out by keeping roll off factor 0.3. The BER performance of GFDM with different modulation is shown in figure 4.

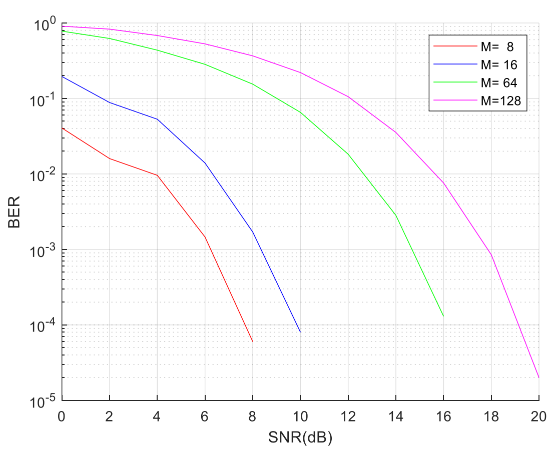


Fig. 4 Effect of Modulation order on BER of GFDM system with roll off factor 0.3.

From figure 4, it is observed that there are significant change in SNR level for maintaining the BER in order of 10-4 . The SNR level of ~ 7.5 dB, 10 dB, 16.5 dB and 19.5 dB are required for modulation order of 8, 16, 64 and 128 respectively.

## IV. CONCLUSION

The simulation of GFDM based wireless communication system has been carried out to analyse the sensitivity of the different parameters of its subsystem. A parametric analysis of BER with respect to the roll off factor of the root cosine filter has performed and found the a order of change in BER at good SNR level. The optimum roll factor of 0.3 has giving the better performance. With this factor, simulation has been carried out further to see the effect of modulation order (data rate), which is showing the behaviour as per the expectations. The BER is degraded with higher modulation order. This study is useful to develop the adaptive modulation scheme for 5G system based on GFDM. In future, studies can be extent to analyse the massive MIMO based GFDM system and focus to mitigate the problem of pilot contaminations.

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