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COMPARTIVE ANALYSIS OF 5G MULTICARRIER WAVEFORM WITH INTENSITY MODULLATION DIRECT DETECTION

Vandana C. Naitam[1], Prof. Sanjay Ganar[2]
M.Tech Student, Professor
Anjuman College of Engineering & Technology, Nagpur, Maharashtra, India

ABSTRACT
In today's era the wireless communication is growing day by day with a tremendous rate. In the previous communication methods there were several shortcomings like the cost of the communication setup was more and many more. But with the advent of wireless communication we started to use the wired medium less for communication like we shifted from telephones to cell phones. Today the smart phones and mobile phones are getting developed day by day because of improvements in the traffic of mobile data. As far as the twenty first century is concerned the data rates and speed of mobile communication network is increasing day by day. Earlier Long Term Evolution (LTE) is the standard for the fourth generation cellular mobile communication systems. In order to increase the speed and capacity of mobile telephone network LTE is the last step towards fourth generation (4G). GFDM is the waveform contender for the 5G technology. It is having a lot of advantages over the LTE based systems. GFDM outperforms the OFDM by providing low out of band emission. Along with this the spectral efficiency of the GFDM is better than that of OFDM. The GFDM also provides the best bandwidth utilization as it uses only one CP in it. The major thing that is required to add here is it also provides the low peak to average ratio (PAPR). In the present paper various aspects of wireless communication and along with that current technology that are being used are discussed.. The separate analysis of AWGN channel with maximum ratio combining and selection combining is done along with the analysis of the Rayleigh channel with maximum ratio combining and selection combing in this. The BER of the pulse shaping filter such as Raise cosine (RC), Gaussian and Square Root Raised Cosine (SRRC) are also calculated
Keywords: GFDM, OFDM, BER, SER,

1. INTRODUCTION

Fake 5G is required to meet the low latency, high data rate, connection density and other demands of applications that requires enhanced mobile broadband, ultra-reliable and low latency connection and massive machine type connection . The capacity of the channel required for such communication is limited by noise, attenuation, distortion and intersymbol interference, which can make the transmitted information irrecoverable at the receiver. In order to compensate for channel capacity, multicarrier signaling techniques such as OFDM replaced CDMA in 4G systems 5G systems have higher expectation in terms of spectral efficiency and data rate, hence new multicarrier signaling techniques such as GFDM are being investigated because of its advantages of lower out of band radiation and better spectral efficiency while retaining the flexibility and simplicity of OFDM

A typical communication system shown in figure 1 consist of the transmitter which contains components that helps in coding, modulating and shaping a signal, a channel through which the signal is transported and a receiver which helps to demodulate, equalize and decode the signal back to the generated data.

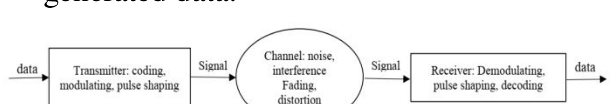

Figure 1 : Simplified Physical Layer of Communication System

In this project, the modelling and simulation of OFDM and GFDM system was carried out using MATLAB.

The two system were compared by analyzing their signal spectrum, constellation diagram, eye diagram and comparing their bit error rate and symbol error rate at different signal to noise ratio. The result showed that GFDM is better in terms of spectral efficiency, though OFDM performed better in terms of BER, it was observed that a better equalization method would improve GFDM BER. The major disadvantage of GFDM is the increased complexity in design

2. LITERATURE REVIEW

In the paper of Arman Farhang et al. [6] discussed that Generalized Frequency Division Multiplexing is taken into consideration when we talk about the new candidate waveforms of fifth generation (5G) communication systems. This decision is taken on the basis of several facts that prove GFDM can replace the previous OFDM communication systems. Cyclic prefix is one the reason for GFDM in place of OFDM. GFDM is using only one cyclic prefix to the aggregation of the symbols whereas in case of OFDM the CP is added to every subcarrier. GFDM is more bandwidth efficient because of this approach. There is a transceiver proposed which uses the FFT at the transmitter side and IFFT at the receiver side. With the help of DFT and IDFT matrices we can reduce the computational complexity. The new less complex receiver structure for Zero Forcing (ZF), Matched Filter (MF) And Minimum Mean Square Error (MMSE) receivers is also proposed. A table is given while calculating the complexity of computations which shows that the mathematical complex multiplications required in the earlier proposed transmitter are more as compared to the new proposed transmitter. Similar number of complex multiplications are calculated for GFDM receiver in the form of tabulation and compared with the earlier approached techniques. The complexity is less in the new approach. The comparison of results is also given graphically which proves that results obtained have lower computation cost.The progression in our new technologies should not be abrupt. It is not desirable for the users as well as for the manufacturers. The reason for that is they need to change their systems completely in order to fulfill that progression. In the earlier used technologies because of the presence of clock compatibility in between WCDMA and LTE, the manufacturers were able to build less expensive and multi standard devices. GFDM is the waveform which can be selected for the 5G communication network. Ivan Gasper et al. [7] described that it is able to implement the Long Term Evolution (LTE) master clock for the 5G PHY layer. Along with that the time - frequency structure of the nowadays cellular systems can also be implemented on it. There are two separate paths that are followed for the coexistence of 4G and 5G waveforms. In order to improve the flexibility of the GFDM an approach of positioning subcarriers is also introduced. While implementing two of its approaches for the paper the first approach shows that GFDM signal is best fitted in the LTE grid while configuring it. This reduces the latency of the GFDM by the factor of 15. The second approach shows that the latency of signaling in 5G may be smaller by the current LTE systems. This can be 10 times smaller than it. The second approach is used for the coexistence of 4G and 5G signals Zahra Sharifian et al. [8] discussed that circular pulse shaping is used in GFDM in order to make the system compatible

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with the new applications of 5G networks like Machine To Machine communications (M2M) and Internet of Things (IoT). Like other systems suffer from the problem of high Peak to Average Power (PAPR), GFDM also suffers from this problem. With the help of iterative expansion a polynomial based companding technique can be used. The GFDM transmitter can be regarded as a synthesis filter bank which uses circular filtering while implementation of it. From the simulations it can be analyzed that in case of OFDM the PAPR value is little less as compared to GFDM. The reason is that the GFDM signal is the addition of exponential terms that is limited with the main lobe of Raised Cosine (RC) filter and OFDM is the addition of exponentialterms that are limited with a rectangular window. After analysis we reached at a conclusion that PAPR reduction ability of GFDM are inversely proportional to each other. In order to get a multiplexing technique that should be potent enough opposite to the frequency selective channels, the combination of generalized frequency division multiplexing and Walsh Hadamard transform (WHT) is used as per Nicola Michailow et al. [9] opinions. This is proved by comparing the bit error rate of the GFDM with the WHT-GFDM under the frequency selective channels. The main target of WHT is not to replace the existing coding rather than this it is targeted to enhance the trustworthiness of the burst transmission in frequency selective channels. Along with these advantages it also provides the low out of band radiation. The receiver is supposed to be MMSE receiver. At one side when the FSC's are less in number, it does not improve the system performance and there is that much noise enhancement provided by the frequency domain equalizer that can be neglected. And at the other side results proves that at low SNR value MMSE receiver can effectively reduce the noise enhancement and also do betterment of BER performance at high SNR value. The robustness of GFDM against the fading multipath environment can be increased by the application of space-time coding at the transmitter side under the minimal level complexity at the receiver..

3. METHODOLOGY

The designed transmitter block diagram for the OFDM and GFDM system is shown in figure 2.1a and 2.1b respectively. The function of each block and implementation is given in the table below

Components	Function and Implementation
Binary Source	The binary source generates random bits of 1 and 0s. For the project, we use the randsrc() function of MATLAB the binary sequence of length $L = 2^{16}$.
Mapper	The mapper converts the binary sequence to symbols, where a symbol is 1 or more binary data. For the project, we use the qammod() function of MATLAB and user can choose to use QPSK (2 bits per symbol) or 16QAM (4 bits per symbol). The length of the symbol sequence is L/number of bits per symbol. The result is parallel into N number of subcarriers and K number of blocks for OFDM, meanwhile for GFDM, it is converted to N, M number of symbols and K using the reshape() function. For both cases N = 256, with 128 null subcarriers while for OFDM M = 1, K = number of symbols/N. For GFDM, K and M are variable and can be set by user.
IFFT Block	The IFFT block helps to modulate each subcarriers on a different frequency. This was implemented using the IFFT() function of MATLAB.
Digital Pulse Shaping	The GFDM design includes a Digital Pulse Shaping block. For the project, I use a Raised Root Cosine Filter to reduce the out of band radiation.
Cyclic Prefix Adder	The CP block adds a variable length of CP to the signal, for OFDM it adds this to each blocks of 1 subsymbol, while for GFDM it adds to each block of M subsymbols. The CP acts as guard band to reduce intersymbol interference and to make it easy for the receiver to perform single-tap equalization.

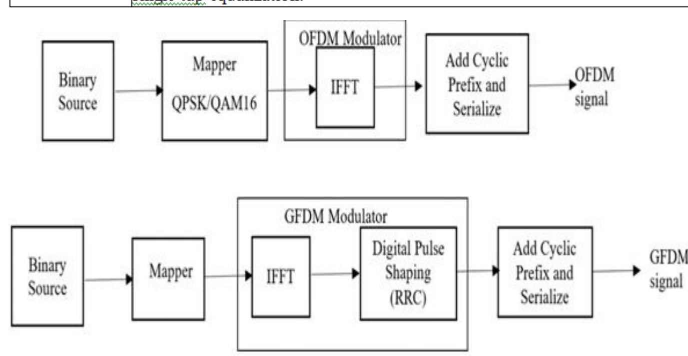
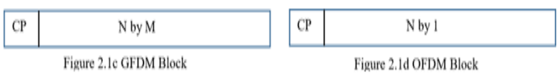


Figure 2 a) Ofdm transmitter b) GFDM transmitter

The signal format for the OFDM and the GFDM block before serializing for transmission is shown in figure2.1c,d below, N is the number of subcarriers, K is the number of blocks and M is the number of sub symbols, CP. denotes the length of cyclic prefix

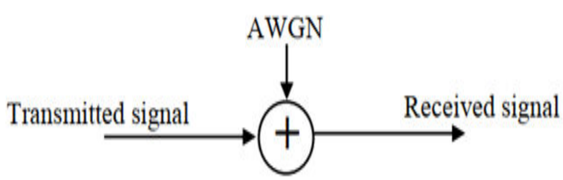
Figure 3.1 c) signal format for the OFDM and the GFDM block



3.2 Channel Model

For this project, and Adaptive White Guassian Noise (AWGN) was used to model the channel. AWGN models the random process of noisy signals that affects desired signal in channel. The noise was generated using matlab randn() function. The effect of this channel is the linear addition of white noise to the signal.

The channel capacity of an AWGN channel is given by C = ½ log(1 + P/N) where N is noise density and P is signal power



3.2 .GFDM and OFDM Receiver

The designed receiver for the OFDM and GFDM signal is shown in figure 2 respectively. The function and implementation of each block is discussed in the table below

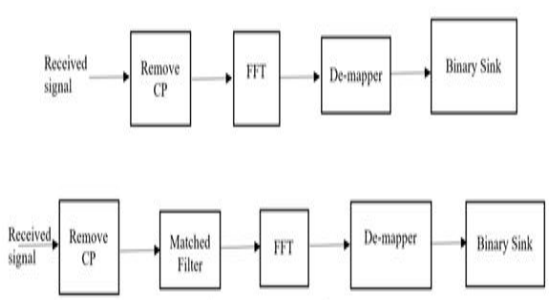


Figure 3.Ofdm receiver b) GFDM rceiveer

4. RESULT & CONCLUSION

A comprehensive analysis and comparison of the OFDM system and the GFDM system was carried out by several methods as described below. Signal Spectrum Comparison of the generated OFDM and GFDM signals

Figure 4 shows the signal spectrum of the OFDM and GFDM signal. It can be observed that the side bands energy is greatly reduced in GFDM than in OFDM with about 15dB difference, the effect of this is a reduction in Out of Band (OOB) radiation, and hence multiple carriers can be orthogonally multiplexed with minimum interference between adjacent carriers. Figure 3.1b shows the effect of the number of blocks on the spectrum of the GFDM signal without CP, from the plot we can observe that the OOB radiation is lesser for 2 blocks than for 32 blocks. This is an advantage for GFDM, whose number of blocks can be varied. For OFDM, the number of blocks is maximum.

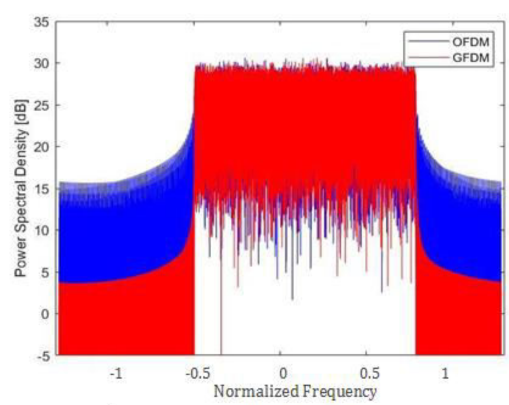


Figure 6.1a GFDM vs OFDM spectrum

Effect of Cyclic Prefix on Spectral Efficiency of the OFDM and GFDM signal The spectral efficiency indicator for OFDM and GFDM is less than 1 considering their requirement for cyclic prefix which introduce additional overhead. Figure 3.2 shows the spectral efficiency indicator for OFDM and GFDM signals. It can be observed that for both SEI reduced as CP length increases, but this variation is higher in OFDM than in GFDM, hence, GFDM has a better spectrum efficiency than OFDM in agreement with 4

REFERENCES

[1] Y. Cho, J. Kim, W. Yang and C. Yang, "MIMO-OFDM Wireless Communications with MATLAB", John Wiley & Sons, Asia, 2010.

[2] S. Zhou and Z. Wang, "OFDM for Underwater Acoustic Communications", John Wiley & Sons, Chichester, UK, 2014.

[3] L. Hanzo and T. Keller, "OFDM and MC-CDMA: A Primer", John Wiley & Sons, Asia, 2006.

[4] S. Muller and J. Huber, "A NOVAL PEAK POWER REDUCTION SCHEME FOR OFDM", in Proceedings of the International Symposium on Personal, Indoor and Mobile Radio Communications, pp.1090-1094, Finland, September-1997.

[5] E. Re, R. Fantacci, S. Morosi, and R. Seravalle, "Comparison of CDMA and OFDM Techniques for Downstream Power-Line Communications on Low Voltage Grid", IEEE Transactions on Power Delivery Vol. 18, Issue 4, pp. 1104 -1109, October-2003.

[6] A. Farhang, N. Marchetti and L. Doyle, "Low Complexity Transceiver Design for GFDM"IEEE Transactions on signal Processing, Vol. 64, Issue 6, pp.1507-1518, March-2016.

[7] I. Gasper, L. Mendes, M. Matthe, N. Michailow, A. Festag and G. Fettweis, "LTE-compatible 5G PHY based on Generalized Frequency Division Multiplexing", in Proceedings of the 11th International Symposium on Wireless Communications Systems, pp. 209-213, Spain, August- 2014.

[8] Z. Sharifian, M. Omidi, A. Farhang and H. Sourck, "Polynomial-Based Compressing and Iterative Expanding for PAPR Reduction in GFDM", 23rd Iranian Conference on Electrical Engineering, pp. 518-523, Iran, May-2015.

[9] N. Michailow, L. Mendes, M. Matthe, I. Gaspar, A. Festag and G. Fettweis, "Robust WHT- GFDM for the Next Generation of Wireless Networks", IEEE Communications Letters, Vol. 19, Issue 1, pp. 106-109, November-2014.

[10] [M. Matthe, L. Mendes and G. Fettweis, "Space-Time Coding for Generalized Frequency Division Multiplexing", 20th European Wireless conference, pp. 1-5, Spain, May- 2010.

[11] M. Matthe, N. Michailow, I. Gaspar and G. Fettweis, "Influence of Pulse Shaping on Bit Error Rate Performance and Out of Band Radiation of Generalized Frequency Division Multiplexing", IEEE International Conference on Communications Workshops, pp. 43-48, Australia, August- 2014.

[12] R. Datta, N. Michailow, S. Krone, M. Lentmaier and G. Fettweis, "GENERALIZED FREQUENCY DIVISION MULTIPLEXING IN COGNITIVE RADIO", in Proceedings of 20th European Signal Processing Conference, pp. 2679-2683, Romania, October-2016.

[13] A. RezazadehReyhani, A. Farhang and B. Farhang-Boroujeny, "Circularly Pulse-Shaped Waveforms for 5G: Options and Comparisons", IEEE Conference on Global Communications, pp. 1-7, USA, Feburary-2016.

[14] M. Matthe, L. Mendes and G. Fettweis, "Generalized Frequency Division Multiplexing in a Gabor Transform Setting", IEEE Communications Letters,

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A peer reviewed international journal
www.ijarst.in
ISSN: 2457-0362

Vol. 18, Issue 8, pp. 1379-1382, August-2014.

[15] A. Ijaz, L. Zhang, P. Xiao and R. Tafazolli, "Towards 5G Wireless Networks - A Physical Layer Perspective", Intechopen, December-2016.

[16] Z. Zhong and J. Guo, "Bit Error Rate Analysis of a MIMO-Generalized Frequency Division Multiplexing Scheme for 5th Generation Cellular Systems", IEEE International Conference on Electronic Information and Communication Technology, pp. 62-68, China, August-2016.