

Improving Quality of Service Using Filters in Universal Filtered Multi Carrier: A Performance Analysis

Madhumitha J¹, Srinivas J²P.G. Student, Department of Electronics and Communication Engineering, CEG, Anna University, India¹U.G Student, Department of Computer Technology, MIT, Anna University, India²

ABSTRACT:UFMC is a potential candidate for 5G Wireless Systems. It is a combination of two 5G competitors, the Filtered OFDM and FBMC (Filter Bank Multicarrier) modulations. Being a candidate waveform innovation for 5G frameworks it combines the characteristics of OFDM with the merits of FBMC. In this paper, we are proposing a technique to succeed the puzzler of Inter Carrier Interference (ICI) in the orthogonal recurrence division multiplexing (OFDM) framework. In the proposed plot, the Universal-Filtered Multi-Carrier (UFMC), a sifting operation is connected to a train of successive subcarriers with a specific end goal to remove out-of-band side-lobe levels and in this manner limit the potential ICI between neighbouring users in the event of offbeat transmissions. In this way, we initially plan Universal Filtered Multi-Carrier (UFMC) Modulation system in MATLAB and after that break down its BER execution under various channel lengths and contrast its execution and computerized channels using different filters.

KEYWORDS:OFDM, FBMC, UFMC, 4G, 5G, Inter Symbol Interference, Bit Error Ratio, multicarrier.

I. INTRODUCTION

The telecommunication industry is witnessing rapid growth in the last few years. This growth started building generations from 1G to 5G. All these generation have witnessed various wireless technologies, data rates, capacities, modulation techniques in comparison to the other generations. OFDM is an applied wave-form design principle. Both LTE and IEEE 802.11 (Wi-Fi) use OFDM as a basic signal format to carry the information using the air as medium. Every single subcarrier in an OFDM framework is modelled using a rectangular window in time-domain prompting sine-shaped subcarriers in frequency domain. In this way, one of the fundamental normal for OFDM is tied in with partitioning the spectrum into various parallel orthogonal sub-bands with most astounding conceivable efficiency, applies just if there should be an occurrence of impeccable conditions. These conditions are for culminate frequency synchronization and tight time-alignment inside the duration of the cyclic prefix. Channel bank based multicarrier separates the spectrum into various orthogonal sub-bands and applies a filtering mechanism to every last subcarrier inverse to OFDM. Along these lines, with FBMC the side-projections gets weakened and in this manner the Inter-Carrier Interference issue is far less essential than with OFDM. In this manner, a framework applying the usefulness of FBMC is abundantly suited to a potential 5G framework. Along these lines, we have finished up to regulate a multicarrier-signal format called UFMC utilizing the positives of FBMC while avoiding its drawbacks

II. RELATED WORK

In [1], the paper outlines an efficient resource allocation (RA) algorithm for packet-oriented Universal Filtered Multi-Carrier (UFMC) communications with bit interleaved coded (BIC) modulation and thus optimizing the coding

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 11, November 2017

rate, bit loading and power distribution within the sub-bands and the subcarriers of the BIC-UFMC system maximizing the good-put (GP) metric.

The paper [2] proposes a universal filtered multicarrier (UFMC) latent optical network for offbeat multi-services-over-fibre to overcome the constraints of a customary discrete multi-tone (DMT). The channel performance regarding error vector magnitude was contrasted by including a planning timing offset with regular DMT and UFMC signals. In [3], the performance of universal filtered multi-carrier (UFMC) system is discussed. Specifically In particular, the UFMC signals are produced with DolphChebyshev filtering. In [4], a filter optimization method is proposed for suppressing out-of-sub-band (OOSB) emission in universal-filtered multicarrier (UFMC) systems is proposed. In [5], the relaxation of timing and frequency alignment requirements is taken into account for supporting applications like Machine Type Communications (MTC) and the Internet of Things (IoT). This paper contains a first uplink comparison scenario where traffic with Relaxed Synchronicity (RS) is embedded into synchronous traffic.

III.SYSTEM ANALYSIS

The 4G technology has a promising impact on its users with faster Network Connectivity and better Internet Services. But, technically, the subcarriers of the OFDM 4G technology face shortcomings like Intercarrier Interference, Inter Symbol Interference, and Synchronisation. So, to enhance the connectivity and for easier access at the user end, the 5th Generation technology is under research. But, the technology for 5G is still under ambiguity. The various potential candidates for 5G includes filtered-OFDM, GFDM, FBMC, UFMC. Of them, the performance of UFMC has been considered better than the other techniques in terms of Complexity, filter length, Synchronisation. etc., UFMC is Universal Filtered Multicarrier Systems. In this paper, we have implemented the entire processing of UFMC, the separate modulation and demodulation modules into account. Further, the system modelling is followed by Performance Analysis of the QoS parameters of the system namely, the Bit Error Rate, the length of the filter and the type of filter to be used, to enhance the throughput of the system. In this paper we have taken ICI into consideration and we have minimized its interference effects in 5G networks using UFMC to increase the quality of service. The total band is filtered in f-OFDM (filtered OFDM) and each and every sub carrier are filtered in FBMC, while sub bands are filtered in UFMC. This grouping of subcarriers allows one to reduce the length of the filter. Also, UFMC can use QAM, which works with MIMO techniques.

IV.PROPOSED APPROACH

A. SYSTEM IMPLEMENTATION AND PERFORMANCE ANALYSIS

The entire band of sub-carriers (N) is divided into equal sized sub bands. Each sub band has a fixed number of subcarriers and note that not all sub bands need to be employed for a given transmission. An N-point IFFT for each and every sub band is computed and zeros are inserted for the unallocated carriers. Each sub band is filtered by a filter of length L. Now the responses from the different sub bands are summed. This filtering is done to reduce the out-of-band spectral emissions. Different filters per sub band can be designed, however, in this example, the same filter is used for each sub band. A Chebyshev window with side lobe attenuation which is parameterized is employed to filter the IFFT output/sub-band. Comparing the figures shown, the spectral densities of the UFMC scheme is observed, and it is found that UFMC has lower side lobes. This permits a higher use of the designated spectrum, prompting expanded spectral productivity. This paper likewise features the fundamental UFMC recipient handling, which is FFT-based, as in OFDM.

The sub band filtering extends the receive time window to the next power-of-two length for the FFT operation. Every alternate frequency value corresponds to a subcarrier main lobe. In few scenarios, subcarrier-equalization is used for equalizing the joint effect of the channel and filtering of the sub band. In this, only the sub band filter is equalized because no channel effects are modelled.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 11, November 2017

B.SYSTEM OVERVIEW

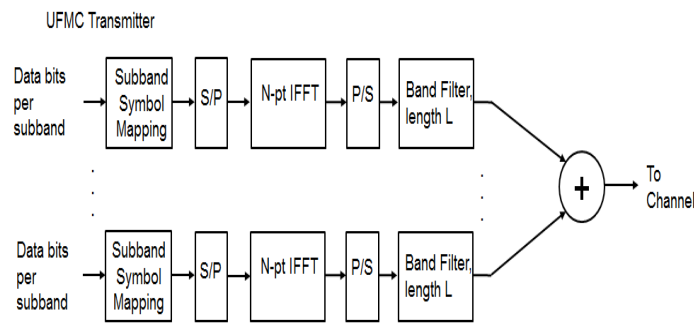


Fig. 1 UFMC Transmitter

The transmitter side of the UFMC is shown in Fig. 1 Data bits per sub-band is sent for symbol mapping. The signals are then transmitted through Serial to Parallel Converter. Here, the data are converted from serial form on a single wire to parallel form on multiple wires. The signal is now converted from frequency domain to the time domain signals where N-pt IFFT is performed and is converted back to parallel form using parallel to serial converter. The filter is applied to the signal with a specified filter length. Here, for the first Performance parameter, the Filter length, DolphChebychev filter is used. The signal is transmitted through the AWGN channel.

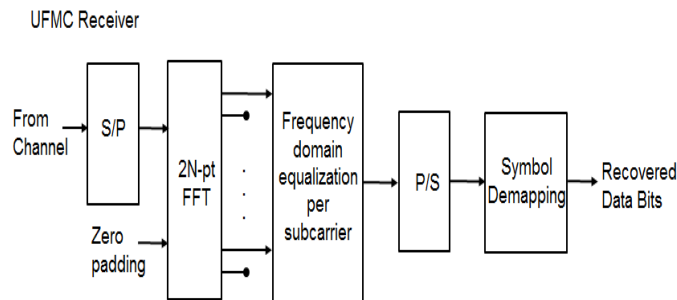


Fig. 2 UFMC Receiver

The receiver side of the UFMC is shown in Fig 2. The data signals received from the transmitter is sent for demodulation. The signal is first converted to parallel form for 2N-pt FFT using a serial to parallel converter. This is further converted from time domain to frequency domain using 2N-pt FFT. Frequency Domain Equalization is performed for each subcarrier. After this, the filtered signals are now converted back to parallel form for further processing. The signal is de-mapped and the data is reconstructed at the receiver end.

V. MAIN MODULE

Algorithm used for Implementation:

The following algorithm is used to construct a UFMC System for Chebyshev filter with a desired filter length and find the BER and PAPR.

1. The system parameters like size of FFT, sub band size, subcarrier size, offset, bits per subcarrier are defined.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 11, November 2017

2. The DolphChebychev window design parameters, namely the filter length and side-lobe attenuation factor is specified.
3. The input bits are mapped to a QAM constellation.
4. Inverse Fast Fourier Transform(IFFT) is applied to the QAM mapped symbols.
5. Sub band filtering (UFMC) is implemented by convolving the IFFT output with the prototype filter for each sub band.
6. The Power Spectral Density for individual sub bands are plotted.
7. The Peak to average power ratio is computed.
8. The signal is transmitted in the AWGN channel.
9. 2N point FFT is performed at the receiver end and the down-sampling is performed.
10. Equalisation is performed after OFDM demodulation.
11. The signal is de-mapped and Bit Error Rate is computed.
12. Hard decision is performed and errors are measured.

The above process is repeated for different filter lengths, different types of filters and the BER performance is analysed.

VI. EXPERIMENTAL RESULTS

The Simulations were performed in MATLAB. Here, the data to be transmitted is modulated in QAM. In each symbol, the number of sub bands are taken as ten, while in each sub band, twenty subcarriers are considered. The parameters considered for this processing has been tabulated in Table I. The data is transmitted in an AWGN channel. The data is demodulated and the performance metrics are analysed. The DolphChebychev filter is used for analysis. When we analyse the performance of the system using different filter lengths, namely $L=20, 43, 60, 80$ and 100 , we observe that as we increase the order of the filter, the frequency response of the signal is improved in the main lobe while the spectral leakage gets reduced in the side lobes as shown in Fig . However, the practical implementation would increase the complexity of the system.

The second parameter which has been observed is the Bit Error Rate. Here, with the increase in the length of the filter, the Bit Error Performance is observed to be better. The results are as shown in Table II. Further, the third parameter evaluated was the type of filter used. The performance analysis of various types of digital filters were tested. Hanning, Hamming, DolphChebychev Filters were analysed with a filter length of $L=60$. It was observed that DolphChebychev filter shows better main lobe and side lobe spectral performance as shown in Fig. 3

PARAMETER	VALUE
Sub band size	20
Number of sub bands	10
Sub band offset	156
Filter length	20-100
Side lobe attenuation	40 dB
Bits per sub carrier	4
SNR	15 dB

TABLE I Simulation Parameters

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 11, November 2017

FILTER LENGTH=40 and 100

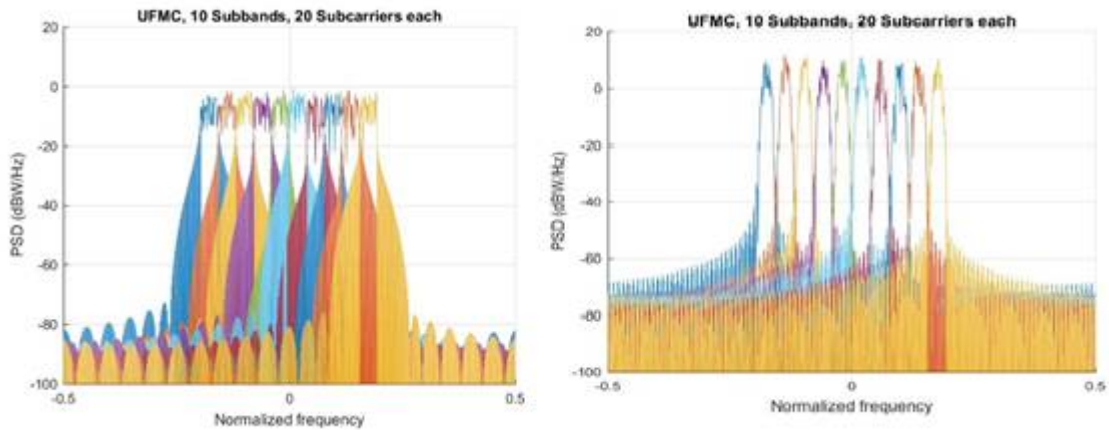


Fig. 3 Side lobe distortion when filter length is L=40 and L=100

In fig 3 we find that Peak-to-Average-Power-Ratio(PAPR) for UFMC =8.1275dB; UFMC Reception, BER=0.13875 at SNR=15dB

S.No	FILTER LENGTH	BER
1	20	0.13875
2	40	0.06125
3	60	0.011
4	80	0.006
5	100	0.00

TABLE II : BER OBTAINED FOR VARIOUS FILTER LENGTHS

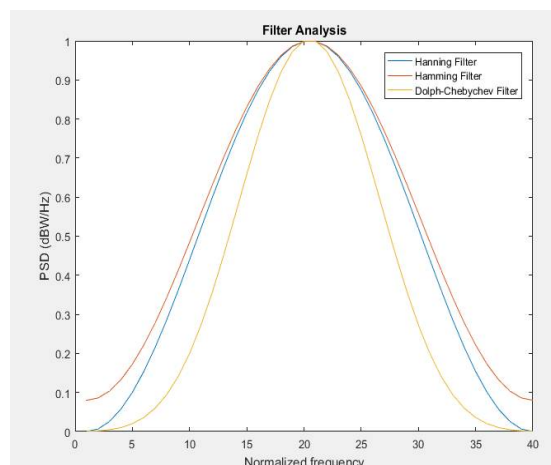


Fig. 4 Filter Performance Analysis

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 11, November 2017

VII. CONCLUSION

UFMC is the potential candidate for 5G wireless systems. Some of the advantages of UFMC are good spectral efficiency, less overhead is required compared to FBMC. It is well suited for short burst transmissions. It is more robust to transceiver imperfections such as Carrier Frequency Offset(CFO) and Timing Offset(TO). This technique has been designed both at the transmitter and the receiver end and is implemented using QAM modulation in MATLAB. The performance was analysed by varying the filter lengths, the type of filters and the Bit Error Rate and the results have been observed. It has been observed that there would be a reduction in the side lobe levels with an increase in the filter length thus reducing the out-of-band transmission. Further, BER has been observed and the results are tabulated in Table II. Finally, the system was analysed with the different types of Filter and DolphChebychev has the best performance compared to the other filters.

REFERENCES

- [1]C. Vitiello *et al.*, "Two-step resource allocation for BIC-UFMC wireless communications," *2016 International Symposium on Wireless Communication Systems (ISWCS)*, Poznan, 2016, pp. 378-382.
- [2]S. M. Kang, C. H. Kim, S. M. Jung and S. K. Han, "Timing-offset-tolerant universal- filtered multicarrier passive optical network for asynchronous multiservices-over-fiber," in *IEEE/OSA Journal of Optical Communications and Networking*, vol. 8, no. 4,2014, pp. 229-237
- [3] SuiyanGeng, Xin Xiong, Linlin Cheng, Xiongwen Zhao and Biao Huang, "UFMC system performance analysis for discrete narrow-band private networks," *2015 IEEE 6th International Symposium on Microwave, Antenna, Propagation, and EMC Technologies (MAPE)*, Shanghai, 2015, pp. 303-307.
- [4] Y. Chen, F. Schaich and T. Wild, "Multiple Access and Waveforms for 5G: IDMA and Universal Filtered Multi-Carrier," *2014 IEEE 79th Vehicular Technology Conference (VTC Spring)*, Seoul, 2014, pp. 1-5.
- [5] Ming-Fu Tang and Borching Su, "Filter optimization of low out-of-subband emission for universal-filtered multicarrier systems," *2016 IEEE International Conference on Communications Workshops (ICC)*, Kuala Lumpur, 2016, pp. 468-473
- [6] G. Wunder *et al.*, "5GNOW: non-orthogonal, asynchronous waveforms for future mobile applications," in *IEEE Communications Magazine*, vol. 52, no. 2, February 2014, pp. 97-105.
- [7] P. Del Fiorentino, C. Vitiello, V. Lottici, F. Giannetti and M. Luise, "A robust resource allocation algorithm for packet BIC-UFMC 5G wireless communications," *2016 24th European Signal Processing Conference (EUSIPCO)*, Budapest, 2016, pp. 843-847.
- [8] X. Wang, T. Wild, F. Schaich and S. ten Brink, "Pilot-Aided Channel Estimation for Universal Filtered Multi-Carrier," *2015 IEEE 82nd Vehicular Technology Conference (VTC2015-Fall)*, Boston, MA, 2015, pp. 1-5.
- [9] I. Stupia, V. Lottici, F. Giannetti and L. Vandendorpe, "Link Resource Adaptation for Multiantenna Bit-Interleaved Coded Multicarrier Systems," in *IEEE Transactions on Signal Processing*, vol. 60, no. 7, July 2012, pp. 3644-3656
- [10] M. N. Tehrani, M. Uysal and H. Yanikomeroglu, "Device-to-device communication in 5G cellular networks: challenges, solutions, and future directions," in *IEEE Communications Magazine*, vol. 52, no. 5, May 2014, pp. 86-92
- [11] K. Doppler, M. Rinne, C. Wijting, C. B. Ribeiro and K. Hugl, "Device-to-device communication as an underlay to LTE-advanced networks," in *IEEE Communications Magazine*, vol. 47, no. 12, Dec. 2009, pp. 42-49.
- [12] Gerzaguat *et al.*, "The 5G candidate waveform race: a comparison of complexity and performance", *EURASIP Journal on Wireless Communications and Networking (2017) 2017:13*,
- [13] J. Lee, H. Shin and M. Z. Win, "Secure node packing of large-scale wireless networks," *2012 IEEE International Conference on Communications (ICC)*, Ottawa, ON, 2012, pp. 815-819.
- [14] Hung-Yun Hsieh and R. Sivakumar, "On using peer-to-peer communication in cellular wireless data networks," in *IEEE Transactions on Mobile Computing*, vol. 3, no. 1, Jan-Feb 2004, pp. 57-72.