BER and Magnitude Analysis of FBMC Transceiver based MIMO System for 5G Technologies

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Abstract: - Using filter bank multi-carrier (FBMC) with Offset-QAM (OQAM) is one combination which achieves this task. In this thesis, we study this modulation, how it is possible to efficiently modulate and demodulate it but also the transcoder (pre-coder, equalizer or both) that can be used when transmitting through multi-tap and MIMO channels. Another modulation, based on FBMC with OQAM, cyclic offset-QAM (COQAM) tries to make a tradeoff between spectral efficiency and simplicity of the equalization and transcoding methods. In this thesis, FBMC based modulation schemes are tested through different scenario: unsynchronized multi-users, unsynchronized uplink, multiple channels, SIMO, MISO and MIMO channels In this paper the studied of MIMO technique for FBMC transceiver for 5G technologies is presented.

Keywords: - Filter Bank Multicarrier (FBMC), Filter Bank, MIMO System, 5G Technology.

I. INTRODUCTION

In every decade, new generation of wireless communication system is launched. The functioning of cellular system for mobile communication is begun in the year 1981 through First generation (1G). This technology based on analog in nature and offered poor spectrum utilization and security features. In the year 1992 based on digital modulation techniques; the Second generation (2G) was deployed. It is primarily meant for voice and very low data transmission. To provide high data rate and to enhance voice security features Third generation (3G) was made available for communication in the year 2001. In third generation (3G) communication system apart from mobile telephone, new modes of communication systems takes place major part, such as WLAN protocols, Bluetooth and 802.11 protocol suits. Third generation cellular mobile communication system offered high speed data rate and greater bandwidth utilization for the users. Fourth generation (4G) was developed in the year 2011, for efficient utilization of available bandwidth, long range connection of the devices and high speed real time data transmission. As this is the 4G era, wireless communication is moving towards providing high speed connectivity to costumers through IP (Internet Protocol) based technology and Long Term Evaluation (LTE) systems. As the requirement for bandwidth increases, the next generation wireless communication will gain more demand compared to present3G and 4G systems. The innovations of new wireless communication systems have their phases of development and decay sooner or later. It is very uncertain whether next generation is beginning new era in the year 2020. Currently fourth generation (4G) cellular mobile communication system was established and publics are experiencing services. Still they are looking towards the deployment of fifth generation (5G) technology to experience more advancement in new technologies. Based on the present research studies 5G technologies for cellular mobile communication systems can come to end result around 2020. Because the development and establishment of any cellular system is requires several years. The 5G cellular mobile communication devices are quick enough to communicate with each other compared with 4G and LTE systems. And also, 5G is relied upon to accomplish enhanced framework limit and throughput. The main aim of 5G research and development is to improve device-to-device communications, at lower cost, lower latency and better implementation than previous generation. This can be enabled by developing sophisticated machines, like advanced field programmable gate arrays and digital signal processors. These hardware devices allow the use of efficient algorithms implementation for communication system. The potential applications of 5G technology is to facilitate to the users for high speed video downloads, vehicle-to-vehicle communications, and general cellular communication systems.

II. FILTER BANK MULTICARRIER (FBMC) TECHNIQUE

OFDM is one particular case of the first category of FBMC. However this category is particularly limiting considering the waveform design if we want to reach full spectral efficiency. We will only deal with OQAM-FBMC with NPR which is a subcategory of the third category. This particular modulation is interesting because of the existence of a computationally efficient implementation algorithm, it is spectrally efficient and allows some freedom in the choice of the filters. According to the Balian-Low theorem [9], it is a necessity to have only the Euclidean orthogonality and not the Hermitian one if we want both spectral efficiency and freedom in the design of the pulse shape in order to have a good low pass and time limited filter

FBMC is also a family of OFDM technique. In the beginning this approach were adopted to support the OFDM technique. The main intention to identify this technique is to overcome the limitations of existing multicarrier modulation schemes. FBMC uses specific pulse shaping filters which generates good confine sub-band in time and frequency domain with the help of filter bank and its poly phase structure. In communication system, digital signal processing signals have high bandwidth in the range of GHz. Most of the presently available FPGA's and DSP Hardware kits are having clock rate in the range of some MHz's. In order to reduce the clock frequency, multiplexing techniques are used to sort out the required data rate at lesser clock frequency. The efficient way of achieving this task, is through adopting filter bank multicarrier modulation (FBMC) technique for sub-band processing of input signals. FBMC is considered as a promising alternative multicarrier technique for future communication systems. The next generation of mobile communications (5G) is ambitious by more spectral efficient wave-forms. FBMC has gained a high degree of interest to provide flexibility for 5G mobile communications system, as a 5G waveform candidate. In the advancement in digital signal processing (DSP) capabilities, research has been carried out to identify alternative to existing multicarrier modulation technique for next generation communication system.

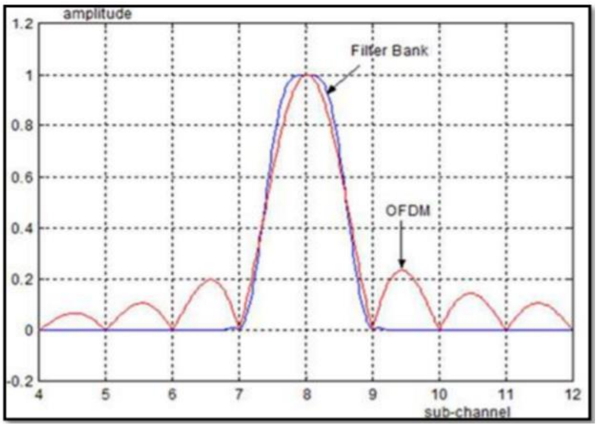

Figure 1: Time domain response of FBMC prototype filter and OFDM technique

Due to the finite transition region at the end of the FIR pass band, small gaps are produced between the sub-bands, which avoid crosstalk and spectral leakage. Analysis filter bank is used at transmitter for sub-band processing of higher band into several lower band signals with the help of decimation filter. After processing of signals, Synthesis filter bank is used at receiver to form a replica of the original signal, using interpolator based on the sub-band channels. Finally, sub-band channels are recombined into a full band output signal.

III. BLOCK DIAGRAM OF FBMC

Most of the investigated and analyzed new communication techniques are algorithmic stage. Hardware and software implementation cost are considered as main parameters required for future mobile communication systems. But, for practical implementation of any wireless communication system are bound by many parameters. These parameters include economic, social, hardware complexity and essential need of users. These constraints can be achieved effective use of resources and technology. Therefore, this thesis mainly deals with design and implementation of advanced and efficient hardware architecture, which may be suitable for the physical layer of future communication (5G) transceiver architecture prototype on FPGA. With this essence, a novel hardware architecture design for future communication (5G) system, based on Filter Bank Multicarrier modulation technique is presented. This technique is being studied and considered these days by recent researches for the future adoptable 5G air interface. It provides enhanced range of spectrum compartment compared to conventional multicarrier modulation technique and allows enhanced mobility management. There are some other alternative and subcategories for FBMC as well.

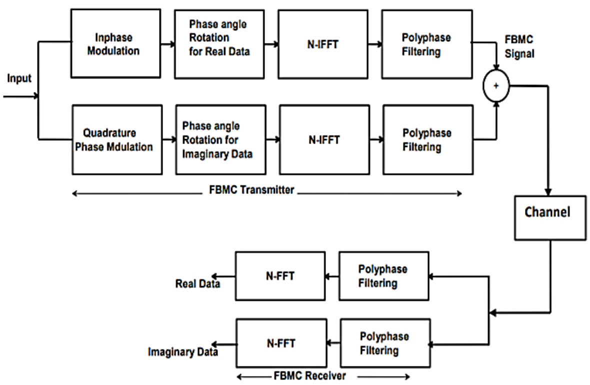

Figure 2: Block diagram of FBMC transceiver

IV. PROPOSED METHODOLOGY

There are different categories of prototyping transmitter for FBMC transceiver. Many FBMC transmitters are designed using NK-IFFTs and it requires more signal processing operations. And also, it requires more computational complexity to reduce the complexity in IFFT and avoid the overlapping of signals in the receiver instead of parallel implementation of NK-IFFTs; we are only utilizing 2 N-IFFTs. Where N indicates number of inputs and K represents overlapping factor of each sub-band. So the range of the impulse response is L= NK. To construct the FBMC signal it performs the Inverse - Fourier transforms (IFFT) both sides and then it performs the poly phase filtering.

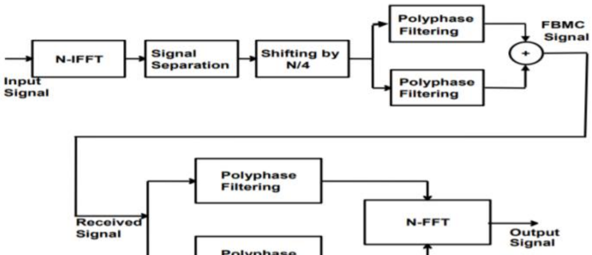

Figure 3: Simplified FBMC transceiver

The multiplication of IFFT with phase rotation vector θ k in frequency domain leads to circular shift of N/4 in time domain, which results in reconstruction of the FBMC signal N-IFFT Signal Separation Shifting by N/4 Poly phase Filtering Poly phase Filtering + FBMC Signal Input Signal Poly phase Filtering Poly phase Filtering Received N-FFT Signal Output Signal by utilizing two poly phase filter modules as depicted in the above Figure 3. To construct the FBMC signal in transmitter, we can use NK-IFFT and Poly phase filters. In receiver, we may use poly phase filtering stage and NK-FFT to recover data. In order to retrieve the original signal back, pipelined FFT Architecture is used. By using pipelined FFT Architecture it is easy to compute higher FFT point by making short variations in the code. Therefore, with this architecture, the complexity level and area utilization get reduces while the speed of communication system improves.

```
BER(m)=noe_o/nod;

dBs = (4:0.1:12);

dBcs = dBs + (dBs(2)-dBs(1))/2;

PAPRdB_1=10*log10(PAPR_o);

count1=0; N_bins1=hist(PAPRdB_1,dBcs);

for b1=length(dBs):-1:1,

count1=count1+N_bins1(b1); CCDF_1(b1)=count1/nloop;
```

V. SIMULATION RESULTS

MIMO-OFDM 2×1 System with filter optimization based FBMC technique discussed in this research work in term of attenuation (dB). From the above graphical representation it can be inferred that the proposed algorithm gives the best performance for FBMC technique.

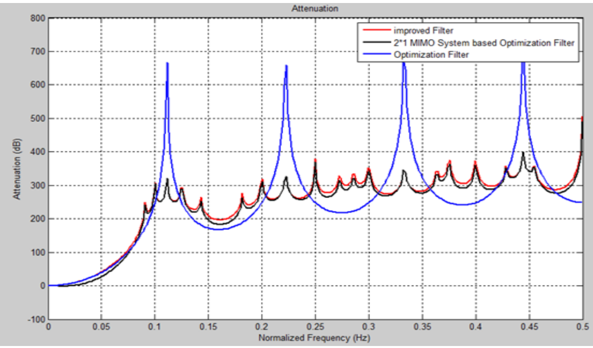

Figure 4: Attenuation Graph of 2×1 MIMO system based Optimization Filter

MIMO-OFDM 2×1 System with filter optimization based FBMC technique discussed in this research work in term of magnitude response (dB) is shown in figure 5.

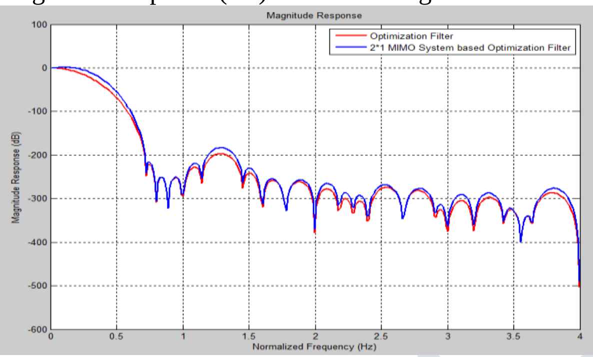

Figure 5: Magnitude Response of 2×1 MIMO system based Optimization Filter

MIMO-OFDM 2×1 System with filter optimization based FBMC technique discussed in this research work in term of bit error rate (BER) is shown in figure 6. The offset quadrature amplitude modulation (OQAM) is increase signal to noise ratio (SNR) compared to OQPSK.

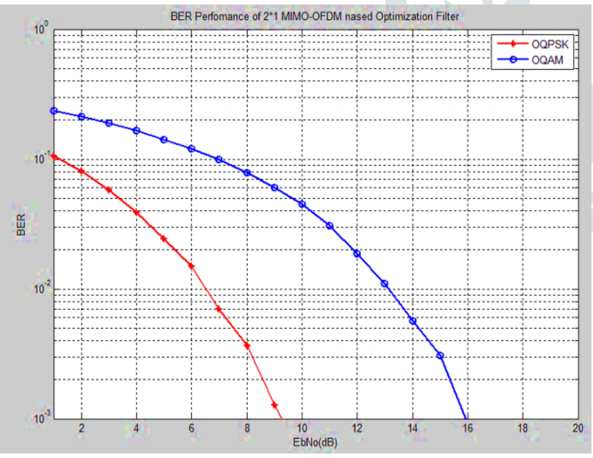

Figure 6: BER Analysis of 2×1 MIMO system based Optimization Filter

MIMO-OFDM 2×2 System with filter optimization based FBMC technique discussed in this research work in term of attenuation (dB) is shown in figure 7.

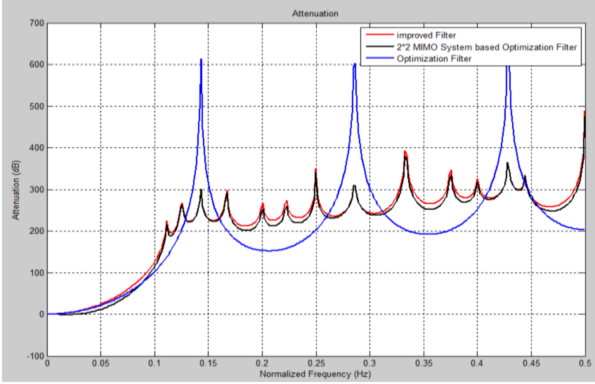

Figure 7: Attenuation Graph of 2×2 MIMO system based Optimization Filter

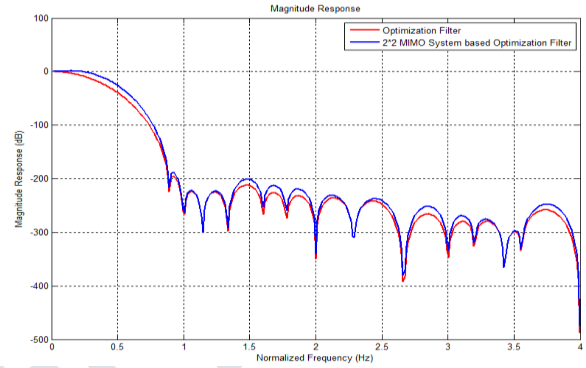

Figure 8: Magnitude Response of 2×2 MIMO system based Optimization Filter

MIMO-OFDM 2×2 System with filter optimization based FBMC technique discussed in this research work in term of magnitude response (dB) is shown in figure 8.

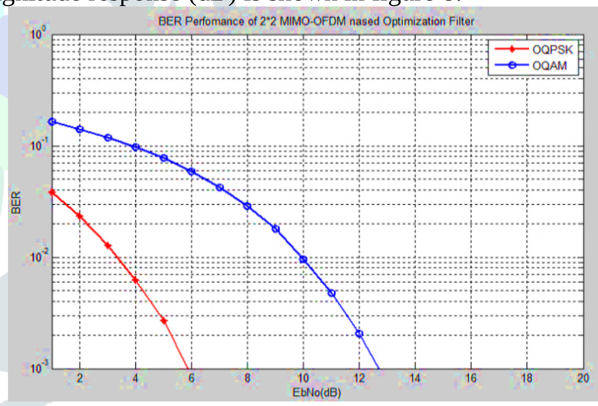

Figure 9: BER Analysis of 2×2 MIMO system based Optimization Filter

MIMO-OFDM 2×2 System with filter optimization based FBMC technique discussed in this research work in term of bit error rate (BER) is shown in figure 9. The offset quadrature amplitude modulation (OQAM) is increase signal to noise ratio (SNR) compared to OQPSK.

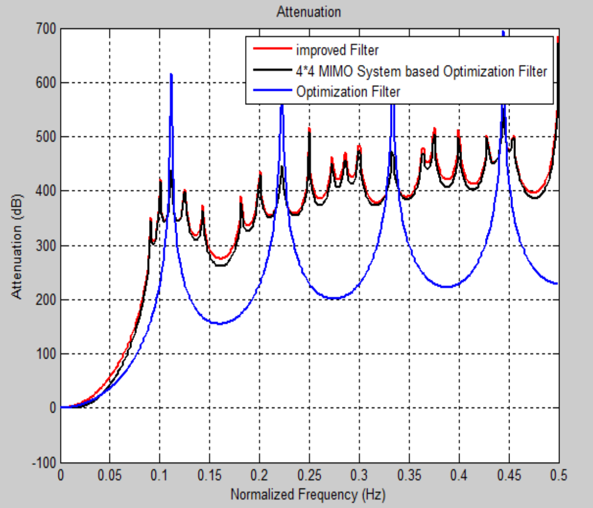

Figure 10: Attenuation Graph of 4×4 MIMO system based Optimization Filter

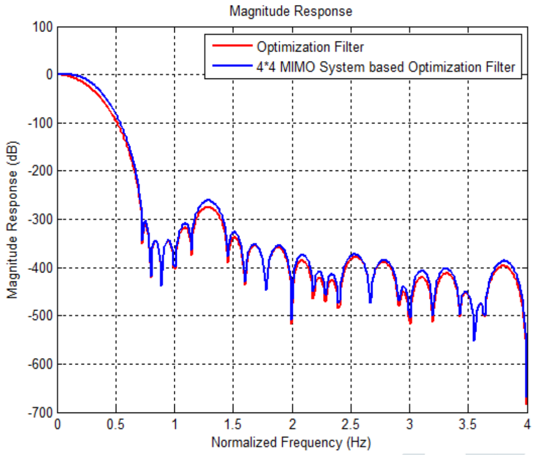

Figure 11: Magnitude Response of 4×4 MIMO system based Optimization Filter

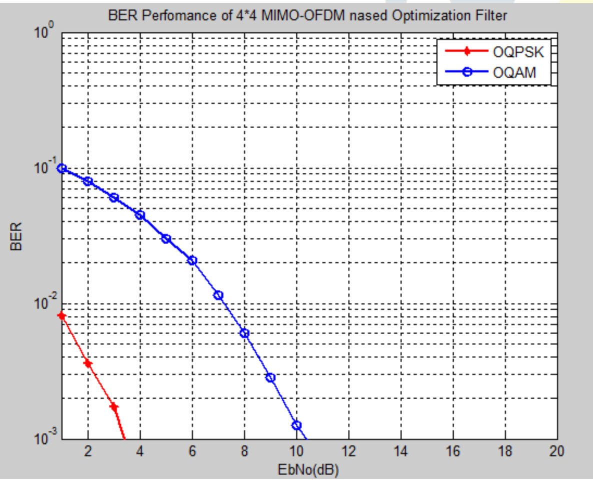

Figure 12: BER Analysis of 4×4 MIMO system based Optimization Filter

VI. CONCLUSION

Both OFDM and FBMC strategies depend on the basic working principles of IFFT/FFT computational engines. However, the procedure of adding CP in OFDM prompts an overhead that adversely impacts on the transmission bandwidth efficiency. Though cyclic prefix is absent in case of FBMC and blend of filter banks prompts greatest productivity and information transmission speed. A similar channel bank can be utilized for transmission and reception in FBMC transceiver architecture which ensures low BER and high performance compatibility in terms latency and throughput. The out-of-band reduction of the prototype filter amplitude curve in FBMC system assures spectral preservation of other subscribers which leads to new physical layer containment for future communication system.

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