Designing of OFDM and FBMC System using Different Modulation Techniques

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Abstract: **The new evolution of the communication system are 4th generation(4G) and 5th generation(5G). The 4th generation has been launched all over the world, and now it is expected that the 5th generation can be introduced by the year of 2020, which will have high spectral and energy efficiency than the 4th Generation. In the 4th generation, OFDM (ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING) technique is used while FBMC (FILTER BANK MULTICARRIER) modulation technique is used that is immune to fading. The fading occurs due to transmission of more than one path at a time. It is also immune to ISI (INTERSYMBOL INTERFERENCE). We will discuss about the FBMC and OFDM techniques in this paper.**

Keywords: **Filter Bank Multicarrier (FBMC), Orthogonal Frequency Division Multiplexing (OFDM), Quadrature Amplitude Modulation(QAM), Quadrature Phase Shift Keying (QPSK), spectrum Analyzer.**

1. Introduction

From early 1970s, mobile wireless organization started its technology, but from the last few years mobile communication is increasing day by day. Now 4th Generation technology is used by the world. The billions of people are using mobile phones.4th generation technology is used by all over the world [1]. As we know that 4G technology is the successor of 3G (3rd generation) technology. OFDM technique is used as the modulation in 4th generation. The main advantage of OFDM is that it provides better services, more data rates and more capacity as compared to the 3G technology [2]. In India,4G was launched few years back. Now 5G(FBMC) Technique will be launched in the coming years. Airtel and Hauwei mobile communication organization provides the services to the customers, conduct the first trial in Manesar, Guru gram. This test provides the services to the high speed data upto 100 times more than 4G [3], [4]. OFDM is a multicarrier technology which uses the FDM concept to reduce the multipath fading effect, Doppler effect and ISI. Cyclic prefix and guard interval is increased by OFDM which also increases the system performance [5]. 3G technology or CDMA (Code division multiplexing) has the disadvantage of inter symbol interference and cross talk. The disadvantage of 3G is reduced or say removed by the 4G (OFDM) technology. In IEEE,802.11 standard wireless LAAN is the set of standard carrying operation which operates in GHZ UNI band. But in 2003, IEEE

802.11 introduced the 802.11g standard which operates in 3.4 GHZ band. The first LTE was introduced in 2007, that is 3G network. Here LTE stands for LONG TERM EVOLUTION. [9]-[12].

Fig. 1. Wireless Communication network

2. OFDM and FBMC system

A. OFDM

OFDM is the Orthogonal frequency division multiplexing method used in communication system. The technique used in OFDM is multicarrier technique. When many user are send on same bandwidth in different carrier frequency in a particular spectrum/bandwidth then this technique is called multicarrier technique [6]. OFDM provides high data rate and reduce the ISI with the help of cyclic prefix. OFDM technique is a technique where particular bandwidth is divided into different subcarriers which are orthogonal to each other. OFDM provides less power consumption, efficient bandwidth and flat response of channel [2].
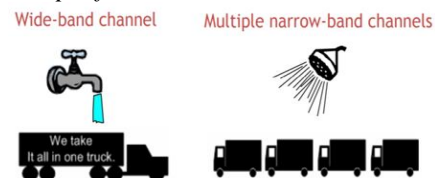
1) Basic concept of OFDM

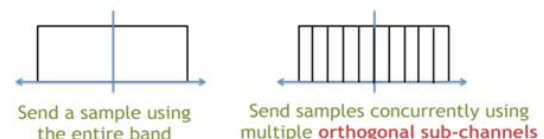Fig. 2. Concept of wide band channel and multiple barrow band channel [7]

Fig. 3. Samples send using entire band and multiple orthogonal sub channels

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OFDM is better because multiple subcarrier can easily carry samples sent at a lower rate and only few subcarriers are affected by the interference [7].

B. FBMC

Filter bank multicarrier (FBMC) transmission technique is the evolved version or say derivative of OFDM. Due to existing growth in the communication system, demand of speed and need of new technology which can provide high data rates. FBMC is the filter implementation which reduces the interference from the input signal and increases the performance of the system [8].
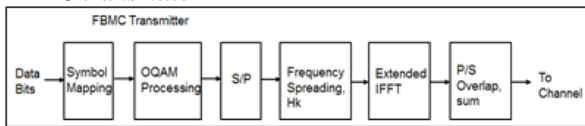
1) FBMC transmitter

Fig. 4. FBMC transmitter

In the transmitter section of FBMC, data rates are mapped with the symbol in the given data rate. The advantage of mapping is reduction in interference. Then modulation is done by the transferring the modulated data over the channel. Then modulated output is given to the digital filter for transmission. Here, Serial transmission is used because it is faster than parallel transmission. there is no need of synchronization.

2) FBMC receiver

In the receiver section, opposite function of transmitter is performed. That is, symbol demapping and demodulation is done. Original signal can be obtained at the end of the receiver.
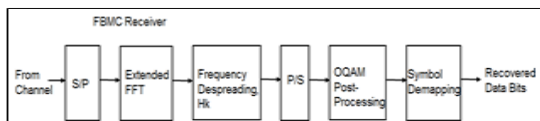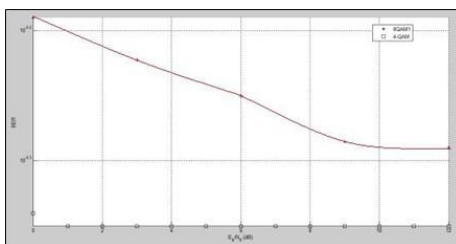

Fig. 5. FBMC Receiver

Fig. 6. SNR of OFDM on QAM modulation technique

C. Simulink setup parameters

Table 1
OFDM and FBMC setup parameters on MATLAB simulink

Modulation	QPSK, QAM,
Channel	AWGN
Forward Error Correction Code	Convolution coding
Bandwidth	80MHz
FFT and IFFT size	256
Cyclic prefix length	36
Sub-carrier spacing	15KHz
Solver type	Ode-45
Eb/No	20dB
Simulation time	20 seconds

3. Simulink result and analysis

The result and analysis of FBMC and OFDM are performed on MATLAB and Simulink. Analyses gives the result in SNR of OFDM technique, spectrum of OFDM using QPSK modulation, spectrum of OFDM using DSSB modulation etc.
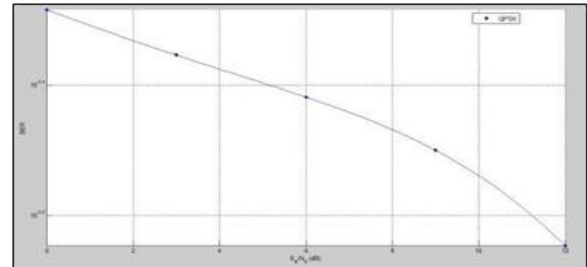

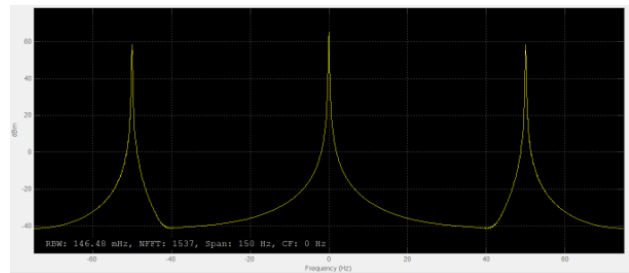Fig. 7. SNR of OFDM on QPSK modulation

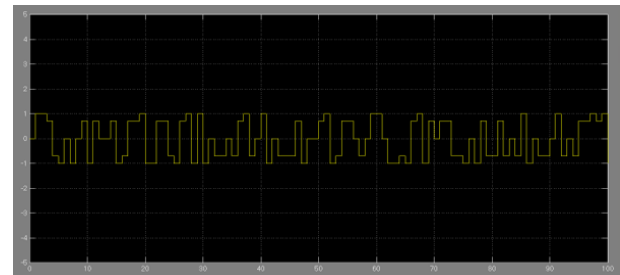Fig. 8. Spectrum Analyzer of FBMC QAM modulation technique
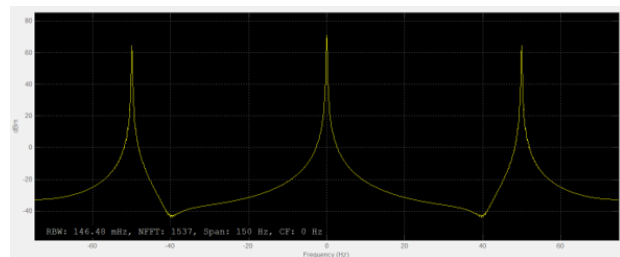

Fig. 9. BER (Bit Error Rate) of OFDM

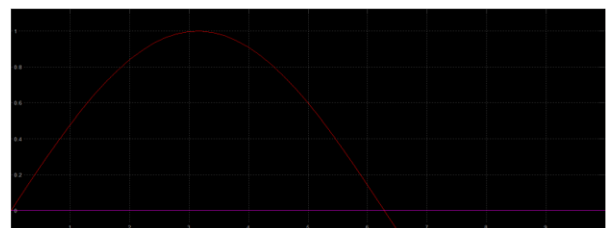Fig. 10. Spectrum Analyzer of FBMC QPSK modulation Technique

Fig. 11. Output of FBMC Sub band

4. Conclusion

In Matlab and Simulink, the implementation of OFDM is time consuming and very complex, but it is easily acceptable by the block of Matlab simulink library. Simulink provides high performance and noise less output as compared to the previous technologies. It is observed that QPSK technology is best for OFDM implementation.

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