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Review on Physical Layer Waveform Designing For 5G Wireless Technology

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Abstract: *There has been major paradigm shift in cellular technology due to increase demand of mobile internet and Internet of things leading to the challenging requirements that includes very high carrier frequencies with high spectral efficiency and massive no of antennas for unlimited connectivity among the users. The multiple access techniques for waveform design has gained momentum at each cellular generation and has been key technology to distinguish different wireless systems. The 1G based on frequency division multiple access, transformed into Time division multiple access for 2 G, code division multiple access standard for 3G and orthogonal frequency division multiple access has become a dominant approach for Wi-Fi and LTE cellular standard. It is natural that transition to 5G requires enhanced technologies in signaling and multiple access formats. This paper presents overview of the proposed multiple access techniques for 5G mobile communication systems. Several contenders like universal time domain windowing OFDM, filter bank multicarrier FBMC, universal filter OFDM (UF-OFDM),Non orthogonal multiple access, Chaotic Cognitive radio OFDM systems are discussed and compared in terms of spectral effectiveness and Bit error rate performance.*

I. Introduction

As the demand for wireless communication services by user is increasing day by day due to the addition of numerous wireless devices, leading to rise of multiple input Multiple output systems. It involves massive no of antennas at access points to separate channels in fading environment. This results in the increase of efficiency of spectrum and reduces interference among users. Only small amount of information is accepted by Single input single output antenna while large amount of information is carried by multiple input multiple output systems. One of the important topic of 5g is designing of the physical layer waveforms for MIMO systems [1]. Usual wireless systems use OFDM as the multiple access technique but they suffers from problem of High Peak to Average power ratio (PAPR) and low spectral efficiency due to the addition of cyclic prefix. Therefore new physical layer waveforms has been proposed in coming sections to overcome the limitations of CP based OFDM systems [2].

II. Literature survey of Proposed Schemes

Universal time- domain windowed OFDM

In reference [3], author proposed UTW-OFDM for next generation systems by offering back compatibility with conventional CP-OFDM based techniques. This is based on universal time domain windowing at transmitter side as compared to short duration windowing in conventional systems. By keeping windowing length according to no. of OFDM symbol length, out of band emissions which are caused due to discontinuity between the adjacent symbols are reduced by this technique.

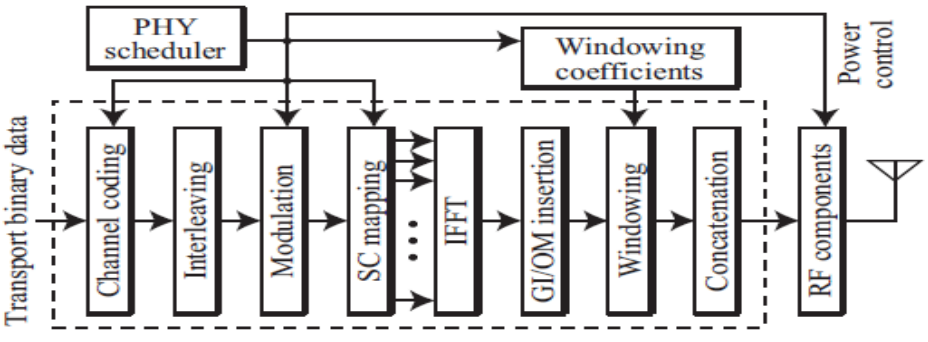


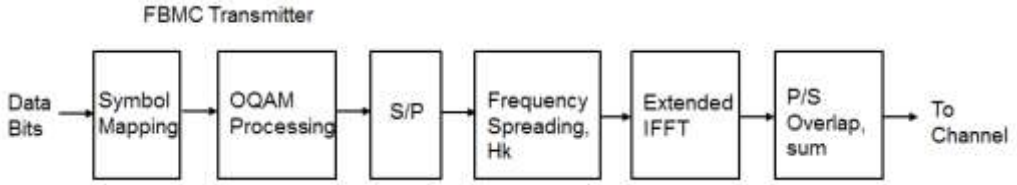
Fig. 1. Block diagram of proposed UTW-OFDM transmitter.

In the proposed scheme as shown in figure 1, the transmitter binary data is first modulated, channel coding is done and then data is translated to subcarrier using physical layer scheduler. GI and OM is inserted to minimize the effect of delay spread by increasing margin between adjacent symbols. The GI and OM are generated with the help of forward and backward duration of symbols.

The performance of this system is evaluated using computer simulations under the effect of Spatial Channel Model Extension by setting various parameters like resolution bandwidth as 100 KHz, sampling frequency 7.68 MHz and by using Blackman window with window duration equals 128. This scheme has a very low OOBE with improvement factor of 44 dB in presence of fading channels.

Filter Bank Multicarrier

In paper [4], author showed filter bank multicarrier as a perfect technique for 5 G system. Filter bank multicarrier (FBMC) filters the user signal on per subcarrier basis i.e. each sub carrier is assigned its own filter which provides better sub carrier separation. This technique exploits self equalization feature in which all received signals are combined linearly at the receiver so as to reduces the channel distortion with the help of averaging effect. The consequence of this is reduction in no of subcarriers which results in low PAPR. This feature also reduces the computation complexities as less no of FFT and IFFT operations are required.



Filter bank multicarrier can be implemented with PAM as well as QAM modulation. FBMC-PAM [5] results in high SINR for massive MIMO systems. FBMC- QAM gives better spectral efficiency by increasing the symbol rate and reducing the guard band. By using the two prototype filter instead of one, SINR can be increased effectively.

Universal Filter Multi carrier

In this paper [6] high data rate input data stream is divided into low rate sub-streams in parallel, and then these sub carriers are grouped to form sub-bands. This technique reduces intersymbol interference .Both BPSK and QPSK modulation can be performed. Data can be superimposed onto subcarrier by using IFFT operation and IFFT size depends on no of subcarriers. This reduces out of band emissions by cutting side lobes.

Cognitive Radio based MIMO OFDM system

In this proposed system [7], OFDM is combined with Chaotic cognitive radio system which will sense the unused carrier from the environment and these unused subcarriers are used for transmission of information. Additional feature is utilized by employing Chaotic sequences which are random in nature and thus improves security from Eavesdropper receiver. Security is further enhanced by shifting sub carrier with the help the rearrangement of subcarrier . At the receiver, synchronization is maintained with the help of conjugate chaotic sequence and same subcarrier pattern as that of transmitter. In this paper power spectrum is plotted [8] after chaotic encoding and as well as after chaotic decoding. The proposed system has bit error rate of 0.968 for unidentified receiver and 0.033 for legitimate receiver which is significant improvement.

Non –Orthogonal Multiple Access (NOMA)

NOMA provides the great performance improvement as compared to OFDMA and other conventional techniques. NOMA can be categorized as power domain and code domain NOMA. It allows multiple users to transmit at same frequency and at same time via power domain multiplexing or code domain multiplexing [9]. NOMA offers grant free uplink transmission as compared to existing multiple access technique thus reducing overhead bits and transmission latency time .Different users have different power levels based on their channel environment, thus separating the different users in power domain.

At the receiver side, successive interference cancellation (SIC) is used [10]. The user with high gain cancel the signal of the weak user by SIC, thus decoding its own signal whereas the weak user detects its own signal directly by considering strong user signal as noise .The weak user is assigned more power in NOMA because of low channel gain and high interference to make certain equality. In code domain NOMA different bit sequences are given different sparse codes from user defined codebook. All the code words in one code book are unique and distinct. The code words have little cross correlation and therefore SIC are used at the receiver to

decode the user data among various bit streams. This paper also compares the various NOMA schemes like Multiuser Shared Access, Pattern Division multiple access, Sparse Code Multiple Access. The complexity of SIC technique is found to be less than maximum likelihood detection method whose complications rises exponentially as the number of users increases.

III. Conclusion

In this paper we have discussed and compared various major proposed multiple access techniques of 5G from different aspects like basic principles, key features, complexity, feasibility compared to orthogonal based multiple access techniques. It is expected that above proposed schemes will play an important role in next generation communication and their utilization will depend upon the user requirements like data rate, latency and spectral efficiency and security needs.

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