



OFDM & Filter Bank Multicarrier Based Dynamic Spectrum

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Abstract: Orthogonal frequency division multiplexing (OFDM), used for sharing the spectrum among different nodes in a dynamic spectrum access network, and imposes tight timing and frequency synchronization requirements. The use of filter bank multicarrier (FBMC), understood alternative, for dynamic spectrum access and examine FBMC Physical layer, Data Link Layer, Network Layer in reliably transmitting data packets at a very high rate, Next to understand the impact of FBMC beyond the Physical layer, distributed and adaptive medium access control (MAC) and Aggregation Algorithm protocol that coordinates data packet traffic among the different nodes in the network in a best-effort manner. The FBMC an order of magnitude performance improvement over OFDM in several aspects packet transmission delays, channel access delays, and effective data transmission rate available to each node. Finally, through extensive simulations, we showed that FBMC outperforms OFDM with an order of magnitude improvement over large distances. FBMC can achieve about smaller end-to-end packet delivery delays and low packet drop probabilities.

Keywords: Dynamic spectrum, filter bank multicarrier and OFDM.

I. Introduction

Orthogonal frequency division multiplexing (OFDM), which uses an orthogonal set of subcarriers, has been proposed for the purpose of sharing the different subsets of these subcarriers among nodes interested in dynamic spectrum access. However, OFDM imposes tight timing and frequency synchronization requirements among different nodes, which are very likely to be difficult to achieve in practice. Any lack of synchronization can result in significant mutual interference among the signals of different transmitters. A somewhat lesser known and understood multicarrier communication system, filter bank multicarrier (FBMC), can overcome the above limitations of OFDM through the use of special transmitter and receiver pulse shaping filters, namely, the square root Nyquist filters [2]. Through the use of these filters, FBMC, in comparison to OFDM, promises more efficient spectrum utilization by minimizing interference across subcarriers.

1.1 OFDM

Orthogonal frequency-division multiplexing (OFDM) is a convenient and flexible choice to achieve high data-rate transmission over dispersive channels, without the need to resort to complicated equalization strategies. Orthogonal

Frequency Division Multiplexing (OFDM) is a convenient technique for dealing with delay spread (frequency-

dependent) channels. An essential feature of OFDM is the cyclic prefix a redundant periodic extension of the message-bearing sine waves, which for proper functioning must be at least as long as the delay-spread of the channel.

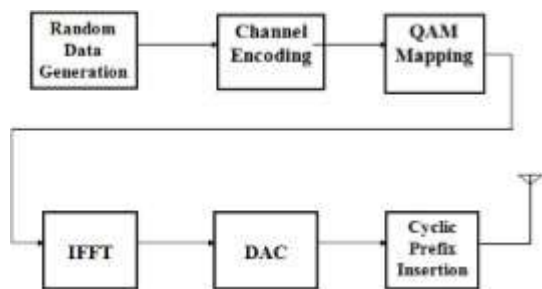


Fig .1 OFDM Transmitter

If the symbol interval can be made large compared with the cyclic prefix then the potential throughput of OFDM

approaches the Shannon limit. Conversely if latency concerns, or a rapidly changing propagation environment, preclude using a long symbol interval.

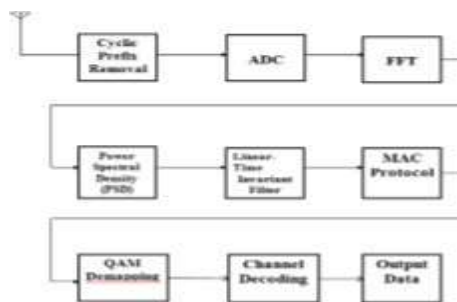


Fig.2 OFDM Receiver



It is based on frequency division multiplexing (FDM), which is a technology that uses multiple frequencies to simultaneously transmit multiple signals in parallel. Each signal has its own frequency range (sub-carrier) which is then modulated by data.

1.2 Filter bank Multicarrier

The FBMC and OFDM simultaneously transmit[2] signals across several subcarriers.

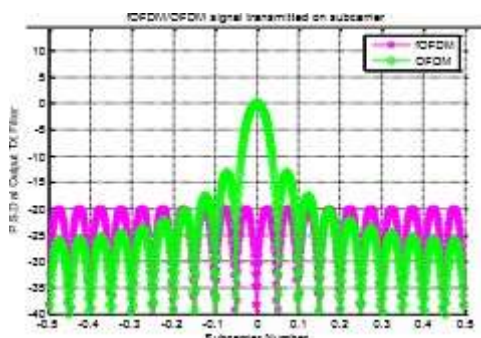


Fig.3 PSD of OFDM/fofDM Signal

Filter bank multicarrier based communication system offers a much higher performing alternative to OFDM for networks that dynamically share the spectrum among multiple nodes.

Assume that there are multiple nodes, possibly belonging to different administrative entities, that compete to utilize the shared frequency spectrum. Nodes belonging to different entities may be associated to different base stations while still sharing the same spectrum OFDM uses rectangular pulse shapes. It is widely used in practice including in the 802.11 Wi-Fi systems shows the power spectral density of an OFDM signal that is transmitted on subcarrier number 0. The first side lobes are just 13 dB below the main peak, and the side lobes near either end of the channel are about 40 dB below the main peak. In 802.11a and other standards, it has been often proposed to replace the rectangular pulse of OFDM by a raised cosine pulse.

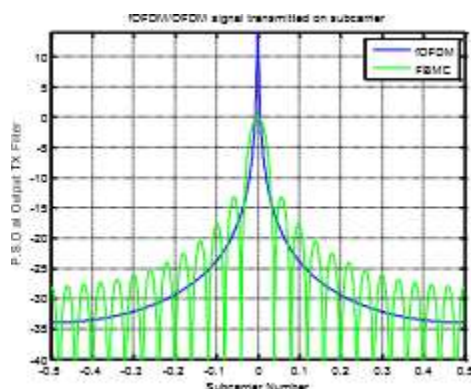


Fig.4 PSD of OFDM/fofDM Signal

This modified OFDM is called Filtered-OFDM (fofDM). The

fofDM exhibits lower side lobes when compared to OFDM. However, for the suggested roll-off factor in 802.11a (2.5%), this improvement is not significant. It compares the PSDs of OFDM and fOFDM. FBMC is 20%- 40% more complex than OFDM. Moreover, when OFDM is applied to multiple access applications, it either performs poorly, one has to add significant complexity to the system to achieve perfect synchronization among different nodes or to apply computationally expensive multiple access interference (MAI) cancellation techniques to improve on its performance.

1.3 Mac Protocol

In the seven layer OSI model of computer networking, media access control (MAC) data communication protocol is a sub layer of the data link layer, which itself is layer 2. The MAC sub layer provides addressing and channel access control mechanisms that make it possible for several terminals or network nodes to communicate within a multiple access network that incorporates a shared medium, e.g. Ethernet. The hardware that implements the MAC is referred to as a medium access controller.

II. Related Work

2.1 Spectrum Pooling

A. Weiss And Friedrich K. Jondral, Universität Karlsruhe proposed an innovative strategy for the enhancement of spectrum efficiency.

This represents the coexistence of two mobile radio systems within the same frequency range. It enables the secondary utilization of already licensed frequency bands as aimed at by several regulatory authorities worldwide. The goal of spectrum pooling is to enhance spectral efficiency by overlaying a new mobile radio system on an existing one without requiring any changes to the actual licensed system.

2.2 Synchronization Techniques for Orthogonal Frequency Division Multiple Access (OFDMA)

Michele Morelli, Member IEEE, C.-C. Jay Kuo, Fellow IEEE, and Man-On Pun, Member IEEE proposed the Synchronization Techniques for Orthogonal Frequency Division Multiple Access. Synchronization represents one of the most challenging issues and plays a major role in the physical layer design. After quantifying the effects of synchronization errors on the system performance, we review some common methods to achieve timing and frequency alignment in a downlink transmission. We then consider the uplink case, where synchronization is made particularly difficult by the fact that each user's signal is characterized by different timing and frequency errors, and

concludes with a comparison of the reviewed synchronization schemes in an OFDMA [8] scenario inspired by the IEEE 802.16 standard for wireless metropolitan area networks.

2.3 Packet Error Rate In OFDM-Based Wireless Lans Operating In Frequency Selective Channels

Olufunmilola Awoniyi and Fouad A. Tobagi proposed the Packet Error Rate in OFDM-based Wireless LANs Operating in Frequency Selective Channels.

In general, packet loss is a function of packet error rate due to transmissions errors in the channel. Packet loss due to transmission errors in the wireless channel can significantly influence the performance of both data and packet voice applications in wireless networks. Packet loss leads to a reduction in TCP throughput for data and a loss in intelligibility for VoIP.

III. Proposed Strategy

While transmitting the data using FBMC, the speed will be increased in the other layers such as data link layer, network, transport, session. FBMC can achieve higher SINR, very low packet error rates and noise will be reduced. It can achieve above 20x smaller end to end data packet delivery delays. we devise a distributed and adaptive medium access control (MAC) protocol that coordinates data packet traffic among the different nodes in the network in a best-effort manner. Moreover, despite their much higher complexity, such OFDM systems are not able to perfectly remove MAI, while FBMC suppresses MAI almost perfectly.

3.1 The FBMC versus OFDM Applied in Physical Layer

- Power spectral density
- Magnitude performance improvement
- Packet transmission delays
- Comparison of Packet Error Rates

3.2 The FBMC versus OFDM Applied In Data Link Layer

The Main tasks of the Data Link Layer is, transfer data from one machine to another machine. The protocol that determines who can transmit on a broadcast channel are called Medium Access Control (MAC) protocol. The MAC protocols are implemented in the MAC sub layer which is the lower sub layer of the data link layer. It produce the full duplex transmission. It is the interconnection of physical and datalink layer. It provides the address of control mechanisms.

3.3 The FBMC versus OFDM Applied In Network Layer

To make it easier to manage the network and control the flow of packets, many organizations separate their network layer addressing into smaller parts known as subnets. Routers use the network or subnet portion of the IP addressing to route traffic between different networks. Each router must be configured specifically for the networks or subnets that will be connected to its interfaces. The network layer accomplishes this via a process known as fragmentation. Observe that MAI cancellation-enabled multiple-access OFDM systems are generally over an order of magnitude more complex than their FBMC counterparts. A router's network layer is usually responsible for doing the fragmentation. Routers communicate with one another using routing protocols, such as Routing.

3.4 Fofdm/Ofdm Signal

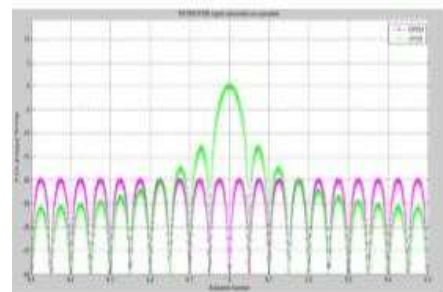


Fig .5 PSD of OFDM/ fOFDM Signal

Fig 5. shows the comparison of OFDM signal and fOFDM signal. The filtered OFDM signal got higher spectral efficiency because it has equal frequency content compared to OFDM. In OFDM signal increases from lower sidelobe to higher side lobe. so it has some noises compared to OFDM.

IV. Simulation Results and Discussions

OFDM is used for high data rate digital signal transmission. But in multiple nodes, it occurs high intersymbol interference and multiple access interference. This simulation is used to reduce these noises and increases the efficient transmission. It increases the speed also 20X data rate efficiency.

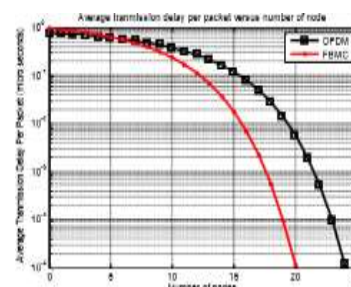


Fig .6 Average transmission delay per packet versus number of nodes

Fig 6. shows a plot of average transmission delay per packet as a function of number of nodes in the network. With 20 or more nodes, FBMC achieves an order of magnitude reduction in the average transmission delay per packet over both OFDM and fOFDM.

V. Conclusion

FBMC can achieve about smaller end-to-end packet delivery delays and relatively low packet drop probabilities in comparison to OFDM. The use of FBMC for best-effort dynamic spectrum access networks, analyzed the mutual interference power across subcarriers used by different transmitters. While transmitting the data using FBMC, the speed will be increased for all the layers such as physical layer, data link layer, network. FBMC can achieve higher SINR, very low packet error rates and noise will be reduced. It can achieve above 50x smaller end to end data packet delivery delays.

VI. Future Work

In Future Transport layer and session layer will be analyzed using Exterior gateway protocol and Address resolution protocol. The speed will be increased above 70 percent and reduce the average transmission delay and to increase the transmission efficiency.

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