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BER Analysis of OFDM System Using Different Modulation and Encoding Schemes

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Abstract-- OFDM (orthogonal frequency division multiplexing) system is one of the most developing technologies in modern mobile communication. OFDM is a parallel transmission scheme, where a high – rate serial data stream is split up into a set of low – rate sub streams, each of which is modulated on a separate subcarrier. Increasing the number of parallel transmission reduces the data rate that each individual carrier must convey and that lengthens the symbol period. In present communication systems, increasing the number of users reduces the data rate that each individual carrier must convey and that lengthens the symbol period. Today's OFDM system attempt to overcome this limitation by application of channel modulation, coding and interleaving schemes. Hence, a performance analysis of OFDM system on the basis of different modulation and encoding schemes in multipath fading and additive white Gaussian noise (AWGN) channels is presented.

1. INTRODUCTION OF OFDM

Orthogonal frequency-division multiplexing (OFDM) is a frequency-division multiplexing (FDM) scheme utilized as a digital multi-carrier modulation method. A large number of closely – spaced orthogonal sub - carriers are used to carry data. In some respects, OFDM is similar to conventional frequency-division multiplexing (FDM)[1]. The difference lies in the way in which the signals are modulated and demodulated. OFDM is a method of the digital modulation in which a signal is split into several narrowband channels at different frequencies. The technology was first conceived in the 1960s and 1970s during research into minimizing interference among channels near each other in frequency[2]. OFDM is used in European digital audio broadcast services. The technologies lend itself to digital television, and are being considered as a method of obtaining high-speed digital data transmission over conventional telephone lines[3].

Many on going research efforts focus on providing efficient and reliable high data rate wireless services in rapidly growing demand for wireless communication. IEEE 802.11, standard for WLAN, was first established in 1997, which can support data rate of 1 to 2 Mbps for the indoor wireless environment. Wired network such as ETHERNET can support data rate as high as 100 Mbps. The original physical layer for indoor W/L communication, 802.11 OFDM was finalized to 802.11a version recently to increase the data rate comparable to ETHERNET. 802.11a data transmission rate ranges from 6 to 54 Mbps.

Orthogonal frequency-division multiplexing (OFDM) is a frequency-division multiplexing (FDM) scheme utilized as a digital multi-carrier modulation method. A large number of closely – spaced orthogonal sub - carriers are used to carry data. The data is divided into several parallel data streams or channels, one for each sub – carrier. Each sub – carrier is modulated with a conventional modulation scheme (such as quadrature amplitude modulation or phase shift keying) at a low symbol rate, maintaining total data rates similar to conventional single-carrier modulation schemes in the same bandwidth. In OFDM, the sub-carrier frequencies are chosen so that the sub-carriers are orthogonal to each other, meaning that cross-talk between the sub – channels is eliminated and inter-carrier guard bands are not required. This greatly simplifies the design of both the transmitter and the receiver; unlike conventional FDM, a separate filter for each sub-channel is not required[4].

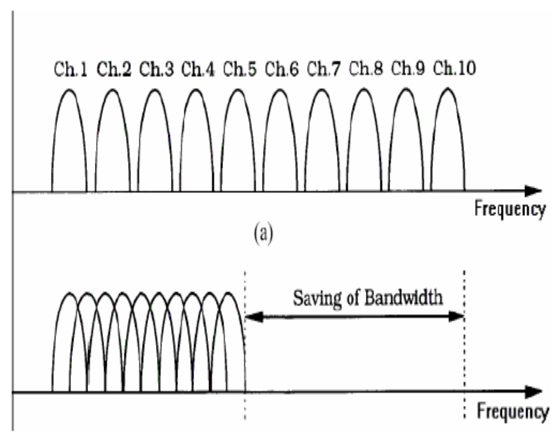

Figure 1. Principle of OFDM.

2. SYSTEM MODEL OF OFDM

An OFDM system has the three main parts: transmitter, channel and receiver. The basic block diagram of an OFDM system is shown in the Figure 1.2.The basic components of an OFDM transmitter are channel coding, QPSK modulator, sub-carrier assignment i.e. OFDM baseband modulator and single carrier modulator. Since OFDM is preferably used for the uplink in a multiuser environment, low-order modulation such as QPSK with Gray mapping is preferred. However, basically high-order modulation (64-QAM) can also be employed. The sub-carrier assignment can be fixed or dynamic. In practice, in order to

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increase the system robustness a dynamic assignment of sub-carriers (i.e., frequency hopping) for each user is preferable. For pulse shaping, rectangular shaping is usually used which results for K users in an OFDM-type signal at the receiver side. In summary, where only one sub-carrier is assigned to a user, the modulator for the user could be a single-carrier modulator[5]. If several carriers are used for a given terminal station, the modulator will be a multi-carrier (OFDM) modulator. At the receiver the main components are the OFDM baseband demodulator, QPSK demapping, channel decoder (with soft decisions) is used for receiving the transmitted signal and then processed this signal to get the original transmitted data.

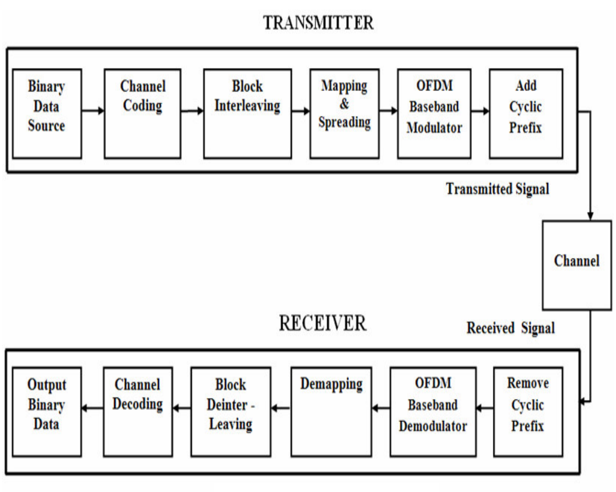

Figure 2. OFDM System.

OFDM overcomes most of the problems with both FDMA and TDMA. OFDM divides the available bandwidth into many narrow band channels. The carriers for each channel are made orthogonal to each other, allowing them to be spaced very close together. The orthogonality of the carriers means that each carrier has an integer number of cycles over a symbol period. Due to this, the spectrum of each carrier has a null at the centre frequency of each of the other carriers in the system. This results in no interference between the carriers, allowing then to be spaced as close as theoretically possible. This overcomes the problem of overhead carrier spacing required in FDMA. Each carrier in an OFDM signal has a very narrow bandwidth (i.e. 1 kHz), thus the resulting symbol rate is low. This will give the signal a high tolerance to Multipath delay spread, because the delay spread must be very long to cause significant inter-symbol interference.

3. OFDM PERFORMANCE ANALYSIS

OFDM performance analysis presented in this section is based on computer simulations. The basic scenario of our simulation is represented by the OFDM transmission system performing through multipath fading and AWGN transmission channel, at sample time (16e-5)/44 and 44 samples per frame. The encoder of OFDM system uses Binary-Input RS Encoder block which creates a Reed-Solomon code with message length 11 and codeword length 15. Modulate or mapped the input signal using the quaternary phase shift keying method, the symbols can be either binary-demapped or Gray-demapped. Similarly, the Binary-Output RS Decoder block recovers a binary message vector from a binary Reed-Solomon codeword vector. For proper decoding, the parameter values in this block should match those in the corresponding Binary-Input RS Encoder block. The simulation results of OFDM system is shown below:

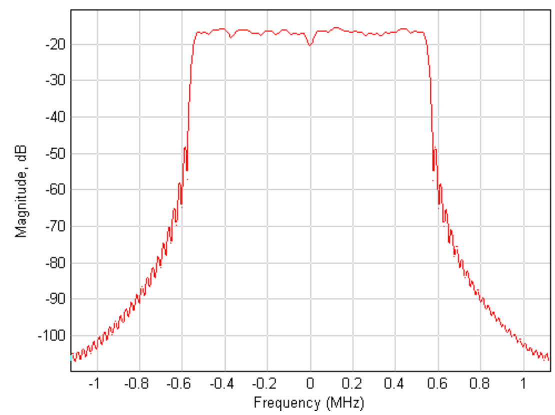

Figure 3. OFDM Transmitted Signal

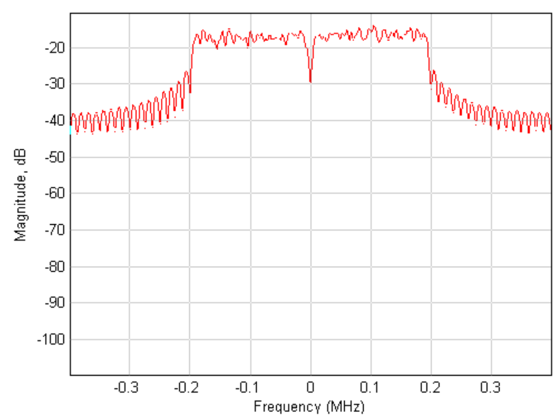

Figure 4. OFDM Received Signal

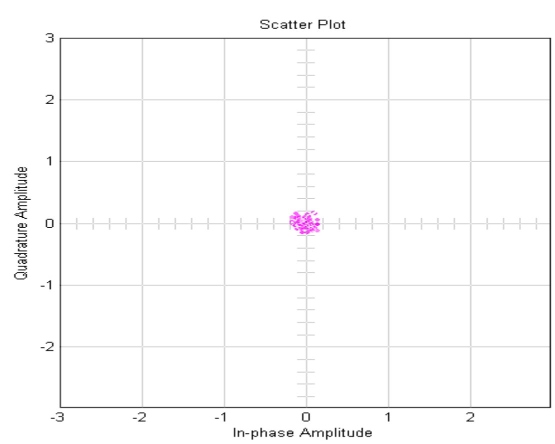

Figure 5. Scatter Plot of OFDM Transmitted Signal

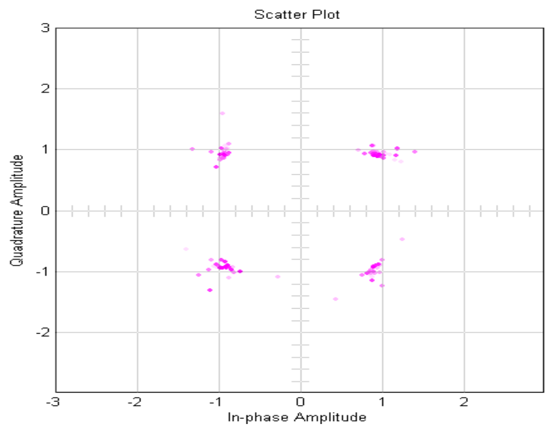

Figure 6. Scatter Plot of OFDM Received Signal

Figure 3 shows the OFDM transmitted signal to the channel. This signal is passed through the multipath fading and additive white Gaussian noise channel. After passing this signal from channel we get the OFDM received signal as shown in Figure 4 which is full of distortions but this distortion is less as compared in the case of CDMA system. Figure 5 shows the scatter plot of transmitted signal of OFDM system. The scatter plot is used to reveal the modulation characteristics, such as pulse shaping or channel distortions of the signal. Similarly Figure 6 shows the scatter plot of OFDM received signal. The scatter plot illustrates the effect of fading on the signal constellation.

4. COMPARISON OF MODULATION AND ENCODING SCHEMES IN OFDM SYSTEM

The comparison of different modulation and encoding schemes proceeds in two steps. First, simple OFDM system is modeled then we compare different type of modulation schemes with this system and get QPSK modulation scheme is best for OFDM system on the basis of BER as below:

Sr. No.	Modulation Scheme	Total Bits	Error Bits	Bit Error rate
1.	4 – QAM	191808	143902	0.7502
2.	16 – QAM	190656	178683	0.9372
3.	32 – QAM	189888	183937	0.9686
4.	**QPSK**	**5.5e + 005**	**2.747e + 005**	**0.4996**

Then compare the encoding schemes by using QPSK modulation and get that RS encoding scheme is best as below:

Sr. No.	Encoding Scheme	Total Bits	Error Bits	Bit Error rate
1.	CRC	2.75e + 005	2104	0.007651
2.	RS	2.75e + 005	1199	0.00436

A comparable bit rate is transmitted over the system and different waveforms and scatter plots are studied. It was found that OFDM only performs well in a multi-cellular environment where a single frequency is used in all cells. This increases the comparative performance against other systems that require a cellular pattern of frequencies to reduce inter-cellular interference

On comparing the waveform of transmitted signal of both the OFDM modulated and encoded system it is clear that improved OFDM system have the more transmission bandwidth than simple OFDM system. By using modulation and encoding schemes the BER of OFDM system also improve and if we make every effort to improve the BER in each system, there is no difference in the attainable BER as long as the same channel is used.

On comparing the scatter plot of OFDM transmitted and received signal it is clear that OFDM system cannot always employ all the received signal energy scattered in the channel. It means the received signal is more faded the transmitted signal. But this fading is decreased by applying RS and CRC encoding techniques.

9. CONCLUSION

It is clear that both simple OFDM and improved OFDM systems have the same transmission bandwidth but in improved OFDM system by using different modulation and encoding techniques the system BER improve and fading effect decreases. But in a transmission system main concern is on efficient transmission i.e. number of error or distortion is less. So improved OFDM is more efficient because it has less BER and less multipath fading effects as compare to simple OFDM system. We conclude that OFDM achieves better BER results by using QPSK Modulation and RS Encoding Scheme.

10. REFERENCES

[1]. OFDM tutorial, Covering Next Generation Computing and Communication Technologies, www.wave-report.com/tutorials/OFDM.htm.

[2]. Design of an OFDM Receiver for High-Speed WLAN. Chien-Fang Hsu, Yuan-Hao Huang and Tzi-Dar Chiueh, National Taiwan University, Taipei, Taiwan 10617

[3]. K. Fazel & S. keiser, "Multi Carrier and Spread Spectrum Systems" 1st ed., England: John Wiley and Sons Limited, pp. 25 – 27, 2003.

[4]. K. Fazel & S. keiser, "Multi Carrier and Spread Spectrum Systems" 1st ed., England: John Wiley and Sons Limited, pp. 29 – 31, 2003.

[5]. K. Fazel & S. keiser, "Multi Carrier and Spread Spectrum Systems" 1st ed., England: John Wiley and Sons Limited, pp. 95 – 98, 2003.

[6]. Design of an OFDM Receiver for High-Speed WLAN. Chien-Fang Hsu, Yuan-Hao Huang and Tzi-Dar Chiueh, National Taiwan University, Taipei, Taiwan 10617

[7]. Ruonan Zhang and Lin Cai, "Packet-level channel model for wireless OFDM systems", IEEE GLOBECOM, pp. 5215 – 5219, 2007.

[8]. K. Fazel & S. keiser, "Multi Carrier and Spread Spectrum Systems" 1st ed., England: John Wiley and Sons Limited, pp. 95 – 98, 2003.

[9]. K. Fazel & S. keiser, "Multi Carrier and Spread Spectrum Systems" 1st ed., England: John Wiley and Sons Limited, pp. 107 – 111, 2003.
[10]. Fangni Chen, Shiju Li, "Proposal of a novel punctured LDPC coding scheme for Ultra Wide Band system", pp. 1 – 4, 2009.
[11]. Wang YAO, Wei LI, Zhiyong LUO and Junyan REN, "Noise Figure in UWB Systems", pp. 364 – 367, 2007.