Study of Orthogonal Frequency Division Multiplexing System Performance

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Abstract— *the purpose of this project is to simulate for OFDM to see how the Bit Error Ratio (BER) of a transmission varies when Signal to Noise Ratio (S/N Ratio) and Multi-propagation effects are changed on transmission channel. A common problem found in high-speed communication is inter-symbol interference (ISI). ISI occurs when a transmission interferes with itself and the receiver cannot decode the transmission correctly. Because the signal reflects from large objects such as mountains or buildings, the receiver sees more than one copy of the signal. In communication terminology, this is called multipath. Since the indirect paths take more time to travel to the receiver, the delayed copies of the signal interfere with the direct signal, causing ISI. This project will focus on Orthogonal Frequency Division Multiplexing (OFDM) research and simulation.*

Keywords— OFDM, Bit Error Rate, 16-QAM, SNR Ratio, Inter Symbol Interference, Multipath

I. Introduction

In recent years the need for high speed data transmission has increased because of rapid advancement of digital communications. 4G has gradually developed over recent years and it has increased the challenges of wireless communication design. It is mainly due to the unfavorable characteristics of wireless environment such as multipath fading, co- channel interference and requirements of increased speed of data transmission. This project will focus on Orthogonal Frequency Division Multiplexing (OFDM) research and simulation. OFDM technique has been widely used in many multicarrier communication systems. It include wireless as well as wired systems. OFDM is basically a special case of multicarrier transmission where a single data stream is transmitted over a number of lower rate subcarriers or sub channels. In an OFDM scheme a large number of sub- channels or sub- carriers are used to transmit digital data. Each sub-channel is orthogonal to each other. They are closely spaced and narrow band. OFDM can be implemented easily, it is spectrally efficient and can provide high data rates with sufficient robustness to channel imperfections.

As communication systems increase their information transfer speed, the time for each transmission necessarily becomes shorter. Since the delay time caused by multipath remains constant, ISI becomes a limitation in high-data-rate communication. OFDM avoids this problem by sending many low speed transmissions simultaneously on different carriers. The objective of this project is to implement OFDM System and to simulate and study its various parameters. Also it will be seen how the bit error ratio (BER) of a transmission varies

When signal to noise ratio (S/N ratio) and multi propagation effects are changed on transmission channel.

II. Principles of OFDM

In an OFDM scheme a large number of sub channels or sub-carriers are used to transmit digital data. OFDM is being used because of its capability to handle with multipath interference at the receiver. In OFDM the large number of narrow band sub-carriers provides sufficiently at channels. Therefore the fading can be handled by simple equalizing techniques for each channel. Furthermore the large amount of carriers can provide same data rates of a single carrier modulation at a lower symbol rate. Figure 1, shows two ways to transmit the same four pieces of binary data. Suppose that this transmission takes four seconds. Then, each piece of data in the left picture has a duration of one second. On the other hand, OFDM would send the four pieces simultaneously as shown on the right. In this case, each piece of data has a duration of four seconds. This longer duration leads to fewer problems with ISI. Another reason to consider OFDM is low-complexity implementation for high-speed systems compared to traditional single carrier techniques.

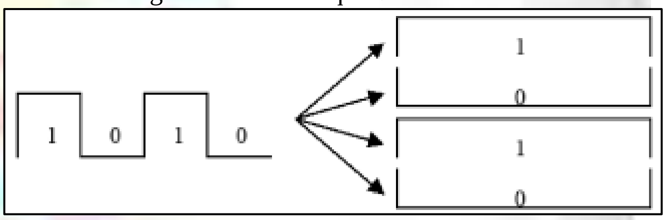

Fig. 1: Traditional vs. OFDM Communication

III. Multipath propagation

Multipath propagation causes inter symbol interference when a wireless signal being transmitted reaches a receiver through different paths. This commonly occurs when reflected signals bounce off of surfaces, when the wireless signal refracts through obstacles, and because of atmospheric conditions. These paths have different lengths before reaching the receiver, thus creating different versions that reach at different time intervals. The delay in symbol transmission will interfere with correct symbol detection. The amplitude and or phase of the signal can be distorted when the different paths are received for additional interference.

IV. Bit error rate

Bit Error Rate is defined as the rate at which errors occur in a transmission system. We can also say that it is the ratio of No. of Errors to the stated number of bits. It is defined as:

BER = (No Of Errors)/ (Total No. of Bits Sent)

A. *Factors Affecting BER*

The bit error rate, BER can be affected by a number of factors:

1) Interference

The interference levels present in a system are generally set by external factors and cannot be changed by the system design. However it is possible to set the bandwidth of the system. By reducing the bandwidth the level of interference can be reduced. However reducing the bandwidth limits the data throughput that can be achieved. Increase transmitter power: It is also possible to increase the power level of the system so that the power per bit is increased. This has to be balanced against factors including the interference levels to other users and the impact of increasing the power output on the size of the power amplifier and overall power consumption and battery life, etc.

2) Lower Order Modulation

Lower order modulation schemes can be used, but this is at the expense of data throughput. Reduce bandwidth: Another approach that can be adopted to reduce the bit error rate is to reduce the bandwidth. Lower levels of noise will be received and therefore the signal to noise ratio will improve. Again this results in a reduction of the data throughput attainable.

V. RESULTS

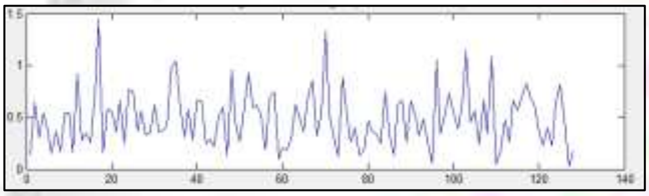

Fig. 2: Transmitting Time Domain Signal for 32 carrier Nc-OFDM

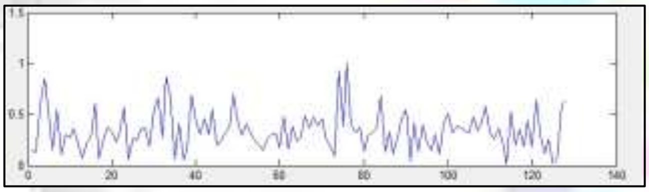

Fig. 3: Transmitting Time Domain Signal for 64 carrier Nc-OFDM

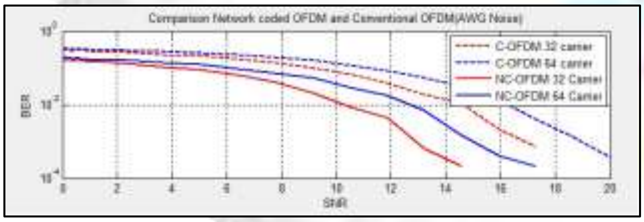

Fig. 4: SNR vs BER

Figure 4 shows the graph of Bit Error Rate versus Signal to Noise Ratio. In this graph the comparison of network coded OFDM and conventional OFDM is made. It can be seen that signal to noise ratio is inversely proportional to bit error rate. The less the BER, the higher is the SNR and hence the better communication quality can be achieved. So it can be seen from the above figure that 32 carrier network coded OFDM system is better as compared to rest shown in figure.

VI. CONCLUSION

A comprehensive study of Orthogonal Frequency Division Multiplexing was done. The signal to noise ratio is inversely proportional to bit error rate. BER increases as we increase the number of certain SNR. The best performance was obtained with 32 subcarriers for network coded OFDM system.

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