International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 02 Issue: 02 | May-2015 www.irjet.net p-ISSN: 2395-0072

SYSTEMATIC ANALYSIS OF AN OFDM SYSTEM

Sreelekshmi K. R.[1], Subhalekshmi K. R.[2], Jacob Thomas[3]

[1] *M. Tech Scholar, Department of ECE, Believers Church Caarmel Engg. College, Kerala, India*
[2] *M. Tech Scholar, Department of ECE, Believers Church Caarmel Engg. College, Kerala, India*
[3] *Assistant Professor, Department of ECE, Believers Church Caarmel Engg. College, Kerala, India*

---***---

Abstract - *OFDM is becoming widely applied in wireless communications systems due to its high rate transmission capability with high bandwidth efficiency and its robustness with regard to multi-path fading and delay. The use of differential phase-shift keying (DPSK) in OFDM systems avoids need to track a time varying channel; however, it limits the number of bits per symbol and results in a 3 dB loss in signal-to-noise ratio (SNR). Coherent modulation allows arbitrary signal constellations, but efficient channel estimation strategies are required for coherent detection and decoding. Orthogonal frequency division multiplexing (OFDM) provides an effective and low complexity means of eliminating inter symbol interference for transmission over frequency selective fading channels. This technique has received a lot of interest in mobile communication research as the radio channel is usually frequency selective and time variant. Wireless systems are expected to require high data rates with low delay and low bit-error-rate (BER). In such situations, the performance of wireless communication systems is mainly governed by the wireless channel environment. In addition, high data rate transmission and high mobility of transmitters or receivers usually result in frequency-selective and time- selective, i.e., doubly selective, fading channels for future mobile broadband wireless systems. On focusing the simple inter carrier interference (ICI) suppression that linearly combines the inter symbol interference (ISI)-free part of a cyclic prefix (CP) and its corresponding part in an orthogonal frequency-division multiplexing (OFDM) signal to soothe the ICI effect caused by a time varying channel.*

Key Words: *Orthogonal frequency division multiplexing Bit-error-rate, Inter symbol interference.*

1. OFDM

Orthogonal frequency-division multiplexing (OFDM) is a promising modulation scheme mainly due to its robustness against frequency-selective channels. The main idea is to divide a broadband frequency-selective channel into a number of narrowband at sub channels using fast Fourier transform (FFT). To obtain a high spectral efficiency, the frequency responses of the subcarriers are overlapping and orthogonal, hence the name OFDM. This orthogonality can be completely maintained with a small price in a loss in SNR, even though the signal passes through a time dispersive fading channel, by introducing a cyclic prefix (CP). A block diagram of a baseband OFDM system is shown in Figure 1.

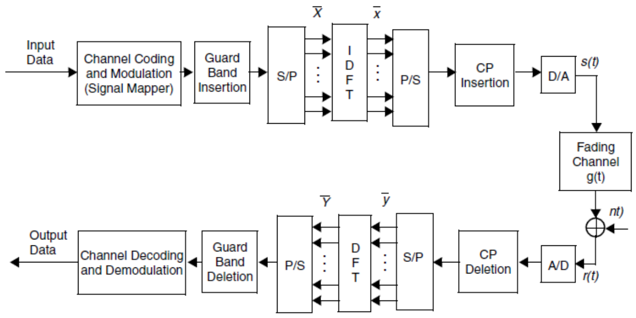

Figure 1: Block Diagram of OFDM System

The binary information is first grouped, coded, and mapped according to the modulation in a signal mapper. After the guard band is inserted, an N-point inverse discrete-time Fourier transform (IDFTN) block transforms the data sequence into time domain. Following the IDFT block, a cyclic extension of time length TG, chosen to be larger than the expected delay spread, is inserted to avoid inter symbol and inter carrier interferences. The D/A converter contains low-pass filters with bandwidth 1/TS, where TS is the sampling interval. The channel is modeled as an impulse response followed by the complex additive white Gaussian noise (AWGN). In contrast with its ability to combat channel selectivity in frequency, OFDM is, however, sensitive to channel selectivity in time. The time selectivity of the channel becomes nontrivial when the system operates in a high-mobility environment. In this situation, the orthogonality among subcarriers will be destroyed, and the loss of orthogonality will cause inter carrier interference (ICI), which may severely degrade bit error rate (BER) performance.

1.1 OFDM in Fading Channel

Orthogonal frequency-division multiplexing (OFDM) is a promising modulation scheme mainly due to its robustness against frequency-selective channels. The main idea is to divide a broadband frequency-selective channel into a number of narrowband at sub channels using fast Fourier transform (FFT). By inserting a cyclic prefix (CP) before transmission, inter symbol interference (ISI) is avoided, and the orthogonality among subcarriers is preserved. As a result, the distortion caused by the channel effect can be equalized merely by a one tap equalizer on each subcarrier. Owing to its immunity against frequency-selective channels, OFDM has become a key air interface for modern wireless communication systems such as digital video broadcasting (DVB), Long Term Evolution Advanced (LTE-A), and wireless local area networks. In contrast with its ability to combat channel selectivity in frequency, OFDM is, however, sensitive to channel selectivity in time. The time selectivity of the channel becomes nontrivial when the system operates in a high-mobility environment. In this situation, the orthogonality among subcarriers will be destroyed, and the loss of orthogonality will cause inter carrier interference (ICI), which may severely degrade bit error rate (BER) performance. The ISI-free part of the CP is linearly combined with its corresponding part in the OFDM signal to suppress the ICI power. This method is motivated by the fact that, in some situations, the length of a CP is much larger than the delay spread; therefore, a considerable number of ISI-free samples exist. For instance, in broadcasting systems, because the length of a CP is chosen to support the worst-case delay spread within its coverage area, the CP length may be much larger than some users delay spreads. Hence, exploiting these unused resources is an important issue. Furthermore, it is worth noting that this scheme can be incorporated with most common ICI mitigation methods; that is, the output of CP combining can be regarded as a new OFDM symbol, whose ICI power is less than the original power, and the other methods can be applied to this new OFDM symbol to further mitigate the ICI effect.

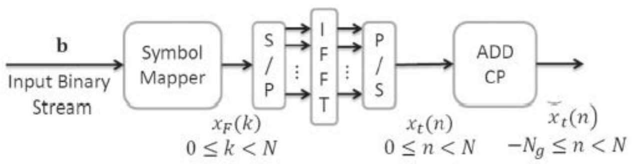

Figure 2: OFDM Transmitter

The block diagram of the OFDM transmitter is shown in Fig 2. Input binary stream b is fed into a symbol mapper. To combat ISI, a CP is inserted before transmission. Further assume that the length of the CP is relatively longer than the maximum delay spread, and there are q samples in the CP that are not affected by the ISI.

1.2Design and Implementation of OFDM Signaling

An inverse Fourier transform converts the frequency domain data set into samples of the corresponding time domain representation of this data. Specifically, the IFFT is useful for OFDM because it generates samples of a waveform with orthogonal frequency components. Then, the parallel to serial block creates the OFDM signal by sequentially outputting the time domain samples. The channel simulation will allow examination of the effects of noise, multipath, and clipping. By adding random data to the transmitted signal, simple noise can be simulated. Multipath simulation involves adding attenuated and delayed copies of the transmitted signal to the original. This simulates the problem in wireless communication when the signal propagates on many paths. For example, a receiver may see a signal via a direct path as well as a path that bounces off a building. Finally, clipping simulates the problem of amplifier saturation. This addresses a practical implementation problem in OFDM where the peak to average power ratio is high. The receiver performs the inverse of the transmitter. First, the OFDM data are split from a serial stream into parallel sets. The Fast Fourier Transform (FFT) converts the time domain samples back into a frequency domain representation. The magnitudes of the frequency components correspond to the original data. Finally, the parallel to serial block converts this parallel data into a serial stream to recover the original input data.

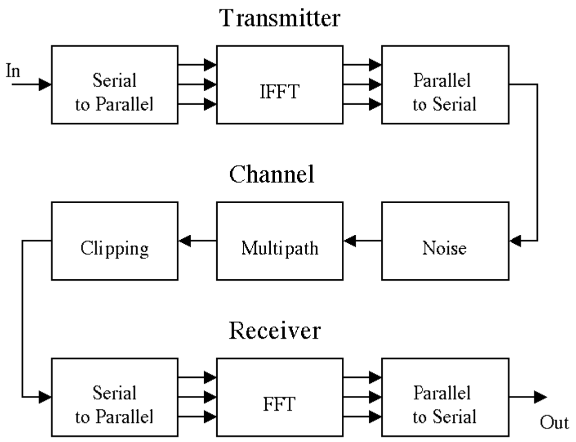

Figure 3: OFDM Simulation Flowchart

2. FADING CHANNELS

Fading refers to the variation of the signal amplitude over time and frequency. In contrast with the additive noise as the most common source of signal degradation, fading is another source of signal degradation that is characterized as a non-additive signal disturbance in the wireless channel. Fading may be either due to multipath propagation, referred to as multi path (induced) fading, or to shadowing from obstacles that affect the propagation of a radio wave, referred to as shadow fading. Fading channel models are often used to model electromagnetic transmission of information over wireless media such as cellular phone and broadcast communication. Broadly, the fading phenomenon can be broadly classified into two different types: large-scale fading and small-scale fading.

Large-scale fading occurs as the mobile moves through a large distance, for example, a distance of the order of cell size. It is caused by path loss of signal as a function of distance and shadowing by large objects such as buildings, intervening terrains, and vegetation. Shadowing is a slow fading process characterized by variation of median path loss between the transmitter and receiver in fixed locations. In other words, large-scale fading is characterized by average path loss and shadowing. On the other hand, small-scale fading refers to rapid variation of signal levels due to the constructive and destructive interference of multiple signal paths (multi paths) when the mobile station moves short distances. Depending on the relative extent of a multi path, frequency selectivity of a channel is characterized (e.g., by frequency-selective or frequency at) for small scaling fading. Meanwhile, depending on the time variation in a channel due to mobile speed (characterized by the Doppler spread), short term fading can be classified as either fast fading or slow fading.

3. GUARD INTERVAL FOR ELIMINATION OF ENTERSYMBOL INTERFERENCE

One key principle of OFDM is that since low symbol rate modulation schemes (i.e., where the symbols are relatively long compared to the channel time characteristics) suffer less from inter symbol interference caused by multipath propagation, it is advantageous to transmit a number of low-rate streams in parallel instead of a single high-rate stream. Since the duration of each symbol is long, it is feasible to insert a guard interval between the OFDM symbols, thus eliminating the inter symbol interference. The guard interval also eliminates the need for a pulse-shaping filter, and it reduces the sensitivity to time synchronization problems. A simple example: If one sends a million symbols per second using conventional single-carrier modulation over a wireless channel, then the duration of each symbol would be one microsecond or less. This imposes severe constraints on synchronization and necessitates the removal of multipath interference. If the same million symbols per second are spread among one thousand sub-channels, the duration of each symbol can be longer by a factor of a thousand (i.e., one millisecond) for orthogonality with approximately the same bandwidth.

4. OFDM TRANSMITTER

An OFDM carrier signal is the sum of a number of orthogonal sub-carriers, with baseband data on each sub-carrier being independently modulated commonly using some type of quadrature amplitude modulation (QAM) or phase-shift keying (PSK). This composite baseband signal is typically used to modulate a main RF carrier. s[n] is a serial stream of binary digits. By inverse multiplexing, these are first de multiplexed into N parallel streams, and each one mapped to a (possibly complex) symbol stream using some modulation constellation (QAM, PSK, etc.). Note that the constellations may be different, so some streams may carry a higher bit-rate than others.

5. OFDM RECEIVER

The receiver picks up the signal r(t), which is then quadrature-mixed down to baseband using cosine and sine waves at the carrier frequency. This also creates signals centered on 2fc, so low-pass filters are used to reject these. The baseband signals are then sampled and digitized using analog-to-digital converters (ADCs), and a forward FFT is used to convert back to the frequency domain.

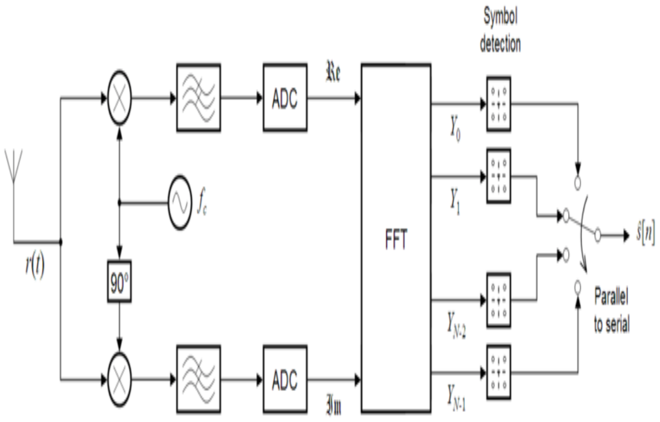

Figure 5: OFDM Receiver

This returns N parallel streams, each of which is converted to a binary stream using an appropriate symbol detector. These streams are then re-combined into a serial stream, s[n], which is an estimate of the original binary stream at the transmitter.

6. CONCLUSIONS

In this paper, three sets of segment combining weights have been optimally derived in different aspects for OFDM systems in high-mobility multipath fading channels. In OFDM systems, efficient channel estimation schemes are essential for coherent detection of a received signal. After multi-carrier demodulation, the received signal is typically correlated in two dimensions, in time and frequency. By periodically inserting pilots in the time-frequency grid to satisfy the 2D sampling theorem, the channel response can be reconstructed by exploiting its correlation in time and frequency. A general reduced-rate orthogonal frequency division multiplexing (OFDM) transmission scheme for inter-sub channel interference (ICI) self-cancellation over high-mobility fading channels. Via transmit and receive processing, we transform the original OFDM system into an equivalent one with fewer subcarriers. By reducing transmission rate, we are able to design a transmitted signal structure with inherent ICI self-cancellation capability without requiring the instantaneous channel state information. On concerning the future scope OFDM based FSO, is a hybrid technique that combines the two developed technology namely OFDM and FSO to enhance the performance of wireless optical communication system. The performance of OFDM based FSO is evaluated Under weak turbulent condition using PSK baseband modulation.

REFERENCES

[1] C.-R. Sheu, M.-C. Tseng, C.-Y. Chen, and H.-P. Lin, "A low-complexity concatenated ICI cancellation scheme for high-mobility OFDM systems," in Proc. IEEE Wireless Commun. Netw. Conf., Mar. 2007, pp.

[2] Peng andW. Ryan, "A low-complexity soft demapper for OFDM fading channels with ICI," in Proc. IEEE Wireless Commun. and Networking Conf., 2006, pp. 15491554.

[3] M.-X. Chang, "A novel algorithm of inter-subchannel interference selfcancellation in OFDM systems," IEEE Trans. Wireless Commun., vol. 6, no. 8, pp. 28812893, Aug. 2007.

[4] M. Faulkner, L. R. Wilhelmsson, and J. Svensson, "Low-complex ICI cancellation for improving Doppler performance in OFDM systems," in Proc. IEEE Veh. Technol. Conf., Sep. 2006, pp. 15.

[5] S. Chen and C. Zhu, "ICI and ISI analysis and mitigation for OFDM systems with insu_cient cyclic pre_x in time-varying channels," IEEE Trans. Consum. Electron., vol. 50, no. 1, pp. 7883, Feb. 2004.

[6] C.-R. Sheu, J.-W. Liu, and C.-C. Huang, "A low-complexity ICI cancellation scheme with multi-step windowing and modi_ed SIC for highmobility OFDM systems," in Proc. IEEE Veh. Technol. Conf., May 2010, pp. 15.

[7] J.-C. Lin, "Least-squares channel estimation for mobile OFDM communication on time- varying frequency-selective fading channels," IEEE Trans. Veh. Technol., vol. 57, no. 6, pp. 35383550, Nov. 2008.

[8] M.-L. Ku, W.-C. Chen, and C.-C. Huang, "EM-based iterative receivers OFDM and BICM/OFDM systems in doubly selective channels," IEEE Trans. Wireless Commun., vol. 10, no. 5, pp. 14051415, May 2011.

[9] K.-Y. Lin, H.-P. Lin, and M.-C. Tseng, "An equivalent channel time variation mitigation scheme for ICI reduction in high-mobility OFDM systems," IEEE Trans. Broadcast., vol. 58, no. 3, pp. 472479, Sep. 2012.

[10] C.-Y. Ma, S.-W. Liu, and C.-C. Huang, "On optimum segment combining weight for ICI self-cancellation in OFDM systems under doubly selective fading channels," in Proc. IEEE Veh. Technol. Conf., May 2012, pp. 15.

Ms. Subhalekshmi K. R., received her B. Tech Degree in Electronics & Communication Engineering from Cochin University in 2013. At present she is pursuing M. Tech in Communication Engineering at Believers Church Caarmel Engg. College, Kerala.

Ms. Sreelekshmi K. R., received her B. Tech Degree in Electronics & Communication Engineering from Cochin University in 2013. At present she is pursuing M. Tech in Communication Engineering at Believers Church Caarmel Engg. College, Kerala.

Mr. Jacob Thomas received his B. Tech Degree in Electronics & Communication Engineering from St. Joseph's College of Engineering and Technology, Affiliated to Mahatma Gandhi University, in 2007. He got M. Tech in Network and Internet Engineering from Karunya University, Coimbatore, in 2011. At present he is working in Believers Church Caarmel Engg. College as Assistant professor in Electronics and Communication Engineering Department. His research areas includes R. F. Communication and Networking.

