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COMPARISON OF BIT ERROR RATE OF OFDM-SYSTEM WITH BPSK MODULATION AND CO-OFDM

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ABSTRACT: In the current circumstance, the assumption about the nature of signs in remote correspondence is as high as could reasonably be expected. This quality issue is reliant upon the distinctive correspondence parameters. A standout amongst the most critical issues is to decrease the bit blunder rate (B.E.R) to improve the execution of the framework. The staggering development of remote specialized apparatuses has raised the quantity of portable supporters from just about 700 million in 2000 to more than 4 billion in 2009. The gigantic number of endorsers has prompted a few issues with how administration is given. The high client request has constrained engineers to defeat the issues of the old simple frameworks and to present OFDM as a promising method that can satisfy clients' levels of popularity. This strategy coordinates well with high information rate association and gives a higher ability to the subscriber's' use. The OFDM, as a multi-carrier, is more intricate than the single bearer transmission plan. Be that as it may, the OFDM procedure keeps up better execution for high information rate as far as bit blunder rate (BER). In this proposal an examination has been introduced between the multi-carrier OFDM and the single transporter to demonstrate, in a recreation frame, the hypothetical perspective. In spite of the upsides of utilizing the OFDM plan, there are a few downsides. One of these negatives is the high top to normal force proportion (PAPR). In this paper we talk about various calculations of OFDM furthermore examine about pervious exploration elements and disadvantages.

In this paper we give a relative investigation on the premise of parameter bit mistake rate (B.E.R). We have analyzed the bit blunder rates (B.E.R) for various number of subcarriers in OFDM framework for BPSK adjustment plan. We have taken 8 variations of information subcarriers with a specific end goal to investigate this correlation. For this four variations of BPSK and four variations of AM are taken. We have tentatively concentrated on and looked at the bit blunder rate at various ghostly productivity of different PSK adjusted got OFDM flag and bit mistake rate for shifting otherworldly proficiency if there should be an occurrence of AM based gotten OFDM flag and think about piece mistake rate (BER) estimation strategies for cognizant optical orthogonal recurrence division multiplexing transmission.

Keywords: OFDM, BER, Carrier, BPSK, PSK, AM

I. INTRODUCTION

For exchanging of information's, regulation is the most widely recognized and every now and again utilized strategy utilized as a part of advanced correspondence, in this technique the data is mapped on to changes in recurrence, stage, abundancy or blend of bearer sign. Multiplexing manages allotment/convenience of clients or assets in a given bandwidth.[2]

Orthogonal Frequency Division Multiplexing (OFDM) is mix of adjustment and additionally multiplexing, The principle highlight of this method is that the asset is shared among individual tweaked information sources, ordinary regulation procedures like AM, PM, FM, BPSK, QPSK, and so forth are single bearer balance strategies in which the approaching data is adjusted over a solitary transporter [1].

OFDM uses a few bearers henceforth is alluded as multi- transporter adjustment strategy inside the designated transfer speed, along these lines, passes on data from source to destination. A few accessible computerized balance strategies, for example, BPSK, QPSK, QAM are utilized independently for given transporter.

Lately, an overall merging has been seen for the utilization of Orthogonal Frequency Division Multiplexing (OFDM) as developing innovation for data exchanging at high information rates. Specifically, the majority of the remote norms, for example, Wi-Max, IEEE802.11a, LTE, DVB makes utilization of OFDM innovation for expanding drastically future remote correspondences. OFDM is a standout amongst the most suited type of Multi-carrier transmission and is suited for recurrence particular channels and high information rates[3]. OFDM changes a frequency- selective wide- band channel into a gathering of non- selective narrow band channels, accordingly making it powerful against expansive deferral spreads by saving orthogonality in the recurrence domain[5]. Besides, the quick presentation of cyclic repetition at the transmitter diminishes the many-sided quality to just FFT handling and one tap scalar leveling at the beneficiary

1.1 Principle of OFDM

"Conceptually, OFDM is a specialized FDM, the additional constraint being that all carrier signals are orthogonal to one another. 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 [6]. This greatly simplifies the design of both the transmitter and the receiver unlike conventional FDM." Separate filter for each sub- channel is not required. The orthogonality requires that the subcarrier spacing is

$$f = k/\mathbf{T}_U \text{ Hertz},$$

Where TU seconds is the useful symbol duration (the receiver side window size), and k is a positive integer, typically equal to 1. Therefore, with N sub-carriers, the total pass band bandwidth will be

The orthogonality also allows high spectral efficiency.With a total symbol rate near the Nyquist rate for the equivalent baseband signal (i.e. near half the Nyquist rate for the double-sideband physical passband signal)[7]. Almost the whole available frequency band can be utilized. OFDM generally has a nearly 'white' spectrum, giving it benign electromagnetic interference properties with respect to other co-channel users.

"OFDM requires very accurate frequency synchronization between the receiver and the transmitter with frequency deviation the sub-carriers will no longer be orthogonal, causing inter-carrier interference (ICI) (i.e., cross-talk between the sub-carriers). Frequency offsets are typically caused by mismatched transmitter and receiver oscillators, or by Doppler shift due to movement. While Doppler shift alone may be compensated for by the receiver, the situation is worsened when combined with multipath, as reflections will appear at various frequency offsets, which is much harder to correct. This effect typically worsens as speed increases, and is an important factor limiting the use of OFDM in high-speed vehicles". In order to mitigate ICI in such scenarios, one can shape each sub-carrier in order to minimize the interference resulting in a non-orthogonal subcarriers overlapping. For example, a low-complexity scheme referred to as WCP-OFDM (**Weighted Cyclic Prefix Orthogonal Frequency Division Multiplexing**) consists in using short filters at the transmitter output in order to perform a potentially non-rectangular pulse shaping an a near perfect reconstruction using a single tap per subcarrier equalization[8]. Other ICI suppression techniques usually increase drastically the receiver complexity.

1.2 Idealized System Model

This area depicts a straightforward glorified OFDM framework model reasonable for a period invariant AWGN channel. An OFDM transporter sign is the aggregate of various orthogonal sub-carriers, with baseband information on each sub-carrier being autonomously adjusted normally utilizing some sort of quadrature sufficiency tweak (QAM) or stage shift scratching (PSK). This composite baseband sign is commonly used to tweak a fundamental RF transporter.

s[n] is a serial stream of paired digits. By backwards multiplexing, these are initially demultiplexed into N parallel streams, and every one mapped to a (perhaps mind boggling) image stream utilizing some adjustment heavenly body (QAM, PSK, and so on.). Note that the groups of stars might be distinctive, so a few streams may convey a higher bit-rate than others.

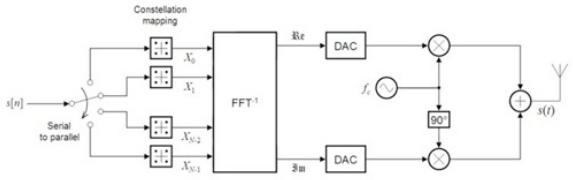

Fig 1.1: Transmitter schematic for Ideal OFDM Transmission

A reverse FFT is figured on every arrangement of images, giving an arrangement of complex time-domain tests. These specimens are then quadrature-mixed to passband in the standard way[9]. The genuine and fanciful segments are initially changed over to the simple space utilizing digital-to-analogue converters (DACs) the simple signs are then used to regulate cosine and sine waves at the bearer recurrence, fc, individually. These signs are then summed to give the transmission signal.

The collector gets the sign r(t)}, which is then quadrature-mixed down to baseband utilizing cosine and sine waves at the bearer recurrence. This likewise makes signals fixated on 2fc, so low- pass channels are utilized to dismiss these[10]. The baseband signs are then tested and digitized utilizing analog-to-digital converters (ADCs), and a forward FFT is utilized to change over back to the recurrence space.

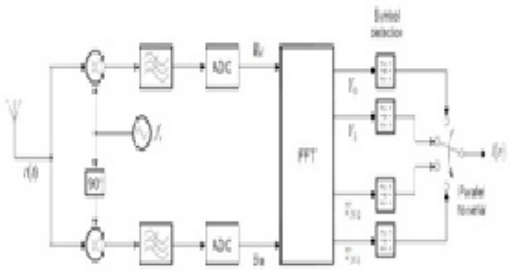

Fig 1.2: Receiver schematic for Ideal OFDM Reception

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[11].

1.4 Advantages and Limitations of OFDM

Advantages of using OFDM

- High spectral efficiency as compared to other double sideband modulation schemes, spread spectrum, etc.
- Can easily adapt to severe channel conditions without complex time-domain equalization.
- Robust against narrow-band co-channel interference

- Robust against intersymbol interference (ISI) and fading caused by multipath propagation
- Efficient implementation using fast Fourier transform (FFT)
- Low sensitivity to time synchronization errors
- Tuned sub-channel receiver filters are not required (unlike conventional FDM)
- Facilitates single frequency networks (SFNs) (i.e. transmitter macrodiversity)

Limitations of using OFDM

- Sensitive to Doppler shift
- Sensitive to frequency synchronization problems
- High peak-to-average-power ratio (PAPR), requiring linear transmitter circuitry, which suffers from poor power efficiency
- Loss of efficiency caused by cyclic prefix/guard interval

II. REVIEW OF LITERATURES

The interest for broadband remote interchanges is developing with a to a great degree quick pace. These frameworks are required to work in a situation which is portrayed by high transporter recurrence, information transmission rate and portability out and out such a domain can be displayed by a recurrence particular quick time shifting blurring channel. It has been examined and set up, that the multicarrier information transmission strategies, for example, MC-CDMA and OFDM are most appropriate for such channels [11, 39]

The OFDM is an uncommon instance of multicarrier balance in which serial stream of information is partitioned in parallel and afterward adjusted by orthogonal sub-carriers with fractional covering recurrence groups. The OFDM images have moderately long time length when contrasted with single transporter regulation with a slender data transmission. This builds the heartiness against multipath disintegrations and results in less mind boggling equalizers which helps in playing out the divert evening out effectively in the recurrence area through a bank of one-tap multipliers [45, 52 and 102]. The primary favorable position of utilizing OFDM framework is to build the strength against recurrence specific blurring or narrowband interference[13]. Because of its beneficial elements (like high information transmission rate, high transfer speed proficiency, strength against multipath blurring and less intricate equalizer), the OFDM has additionally been embraced as a noteworthy information transmission system by numerous remote correspondence gauges [28, 32, 33, 34, 46-51]. OFDM was produced amid 1980s and 90s. Regardless of a few invaluable components, the OFDM frameworks have two noteworthy concerns i.e. high PAPR of transmitted sign and synchronization (timing and recurrence) at the recipient. The impacts of every one of these issues are showing up as inter-carrier and intersymbol obstruction. Subsequently, for general change in the execution of OFDM framework, it is required to handle every one of these issues independently. Part of work has been accounted for in writing with respect to these issues. The greater part of the work distributed in the late 1990s and 2000s was identified with these issues, the center of work was on the examination and arrangement of these issues [15]. This writing overview gives a brief audit of all the distributed material with respect to the examination and arrangement of these issues of OFDM framework. The following segment expounds these issues. This part portrays audit of written works that has been discovered valuable in comprehension the different ideas and executing them.

Harivikram (et.al 2013) composed calculation to minimize the mistake likelihood of a LTE framework and to bring the range effectiveness through a procedure known as versatile regulation and coding rate. LTE typically utilizes OFDM as its innovation to execute the versatile tweak in OFDM frameworks [4].

Zhao (et.al 1996) recommended that the piece of ICI can be drop if the same image with various polarities is tweaked on two contiguous sub-carriers and afterward transmitted. By utilizing this technique, the ICI relies on upon the distinction between the adjoining weighting coefficients as opposed to on the coefficients themselves. As the distinction between contiguous coefficients is little, the ICI will be less. In the event that adjoining coefficients were equivalent, then the ICI would be totally cancelled[25].

Zhao (et.al 2001) by adjusting the same information in a few adjoining sub-channels with ideal weights. The weighting coefficients are planned so that the ICI can be minimized. At the beneficiary side, by straightly joining the got signals on these subcarriers with proposed coefficients, the remaining ICI contained in the got signs can then be further diminished. The SIR can be further enhanced if the gathering size is taken as two, three or more[25]

Lien (et.al 2006) thought of outline and usage of MIMO (numerous information different out) based OFDM baseband handset for subjective radio frameworks with enhanced resistance of clamor on the system[12].

Li (et.al 2007) proposed a calculation that was proficient, productive and exceptionally powerful towards recognition of impedance and unraveling OFDM based psychological radio frameworks having obscure interference[14].

Rajbanshi (et.al 2006) accompanied a usage alluded as NC-OFDM transcievers if there should be an occurrence of intellectual radios that has very enhanced efficiency[18].

Moose (et.al 2004) examined the impacts of recurrence counterbalance on the execution of orthogonal recurrence division multiplexing (OFDM) computerized interchanges. The principle issue with recurrence counterbalance is that it presents impedance among the assortment of transporters in the OFDM signal. It is appeared, and affirmed by reproduction, that to keep up signal-to-interference proportions of 20 dB or more noteworthy for the OFDM transporters, counterbalance is constrained to 4% or less of the intercarrier spacing[21].

Moose (et.al 2004) depicted a system to gauge recurrence balance utilizing a rehashed information image. A most extreme probability estimation (MLE) calculation is inferred and its execution figured and contrasted and reproduction results. Since the intercarrier impedance vitality and sign vitality both contribute reasonably to the assessment, the calculation creates to a great degree precise gauges notwithstanding when the counterbalance is dreadfully incredible to demodulate the information values[22].

Shieh (et.al 2006) proposed a sound optical orthogonal recurrence division multiplexing is proposed to battle scattering in optical media and demonstrated that optical-signal-to-noise proportion punishment at 10 Gbps is kept up beneath 2 dB for 3000 km transmission of standard-single mode fiber without scattering compensation[24].

Naval force (et.al 2002) examined the execution of OFDM frameworks under stage clamor and its reliance on the quantity of sub-carriers both in the nearness and nonappearance of a stage adjustment system. Other than some handy results are given in order to give some knowledge into the stage commotion ghastly determinations that ought to be required of the neighborhood oscillator[3].

Tsonev (et.al 2012) proposed a novel regulation method U-OFDM that utilizations distinctive time test states and an inventive revision of the Orthogonal Frequency Division Multiplexing (OFDM) outline which take into account the making of unipolar OFDM signals required for Optical Wireless Communication (OWC) with Light Emitting Diodes (LEDs). In contrast with comparable procedures like DC-biased Optical OFDM (DCO-OFDM) and Asymmetrically Clipped Optical OFDM (ACO-OFDM),

U-OFDM is both optically and electrically more power productive in an Additive White Gaussian Noise (AWGN) channel, which is common in an optical remote system[26].
Mohamed (et.al 2013) gave two methodologies for changing the execution of asymmetrically- cut optical orthogonal frequency-division multiplexing (ACO-OFDM) strategy are proposed. These two methodologies include the utilization of unipolar encoding which encourages transmission through optical channels. Monte Carlo recreations have been done for the proposed framework to assess its bit blunder rate (BER) execution. Our reproduction results are then contrasted with that of both ordinary ACO-OFDM and bipolar OFDM frameworks. It worked out that the proposed changes enhance the BER execution when contrasted with that of customary systems[9].

Amiri (et.al 2014) utilized a covering subcarriers without bringing about inter-carrier impedance. It gives both a high information rate and image term utilizing recurrence division multiplexing over different subcarriers inside one channel. The outcomes demonstrate that MRRs support both single-carrier and multi-carrier optical soliton beats, which can be utilized as a part of an OFDM in light of whether quick Fourier change or discrete wavelet change transmission/recipient system[16].
Ribeiro (et.al 2014) exhibited an extensive examination to highlight focal points and inconveniences, regarding channel limit and computational many-sided quality (CC), of a so-called clustered-orthogonal recurrence division multiplexing (OFDM) plan for electrical cable correspondence (PLC) advances for access networks[15].
Bhatia (et.al 2014) gave a versatile channel based scattering pay for optical-OFDM framework. Nonlinear bending and top to normal force proportion (PAPR) were broke down with utilization of Different turbo code rates (DTCRs). High recipient affectability and enhanced Bit mistake rate by more than 2 dB is observed[26].
Basar (et.al 2013) displayed an orthogonal recurrence division multiplexing (OFDM) plan, called OFDM with list tweak (OFDM-IM), for operation over frequency-selective and quickly time-varying blurring channels. In this plan, the data is passed on not just by M- ary signal groups of stars as in established OFDM, additionally by the records of the subcarriers, which are enacted by approaching piece stream[20].
Barros (et.al 2015) assessed the execution of three direct-detection orthogonal frequency- division multiplexing (OFDM) plans in battling multipath bending in indoor optical remote connections, contrasting them with unipolar M-ary pulse-amplitude balance (M-PAM) with least mean-square blunder decision-feedback balance (MMSE-DFE). The three OFDM strategies are DC-clipped OFDM and unevenly cut optical OFDM (ACO-OFDM) and PAM-modulated discrete multitone (PAM-DMT). We depict an iterative method to accomplish ideal force distribution for DC-OFDM. For every balance technique, we evaluate the got electrical SNR required at a given piece rate on a given channel, considering a gathering of 170 indoor remote channel[29].
Srikanth (et.al 2012) gave a nitty gritty correlation of the execution of OFDMA in LTE and WiMAX. The multiuser differing qualities preferred standpoint of OFDMA is very much utilized as a part of LTE, though the recurrence differences favorable position is pleasantly abused in WiMAX. The physical layer overhead in LTE is essentially superior to in WiMAX. The system passage procedure of a LTE versatile is more straightforward than in a WiMAX portable. What's more, LTE frameworks are relied upon to respond quicker to changes in the movement and channel conditions because of the littler edge times. In any case, the OFDMA outline in WiMAX will provide food for more great channel conditions, which is maybe more than what is normal by and by as our examination reveals[11].

Stadelmeir (et.al 2010) allocated every heavenly body gathering to another regulation plan. A majority of sub-carriers is doled out to none or one of the heavenly body bunches and every tweak utilizes another of the star grouping bunches. The specialized gadget incorporates no less than one adaptable interleaver unit, wherein each interleaver unit is doled out to one of the heavenly body bunches and interleaves the task of information bits mapped to every star grouping bunch and the sub-carriers that convey an image data got from the information bits[19].

Fan (et.al 2015) gave orthogonal recurrence division multiplexing (OFDM) with list tweak (OFDM-IM). By selecting an altered number of subcarriers as dynamic subcarriers to convey heavenly body images, the files of these dynamic subcarriers may convey extra bits of data. In this paper, we propose two speculation plans of OFDM-IM, named OFDM with summed up list regulation 1 (OFDM-GIM1) and OFDM-GIM2, individually. In OFDM- GIM1, the quantity of dynamic subcarriers in an OFDM subblock is no more settled. Reliant on the info double string, distinctive quantities of dynamic subcarriers are doled out to convey heavenly body images. In OFDM-GIM2, autonomous file tweak is performed on the in-phase and quadrature part per subcarrier. Through such ways, a higher otherworldly productivity than that of OFDM-IM might be accomplished [7].

Sharma (et.al 2014) exhibited a displaying and reenactment of OFDM in view of WLAN standard (IEEE 802.11a). Execution of OFDM is assessed for various tweak plans, for example, PSK, QAM, DQPSK, and OQPSK. The execution of OFDM is looked at regarding BER versus SNR for various tweak groups

III. CONCLUSION

The telecommunications industry faces the problem of providing telephone services to rural areas, where the customer base is small, but the cost of installing a wired phone network is very high. One method of reducing the high infrastructure cost of a wired system is to use a fixed wireless radio network. The problem with this is that for rural and urban areas, large cell sizes are required to obtain sufficient coverage. Currently Global System for Mobile telecommunications (GSM) technology is being applied to fixed wireless phone systems in rural areas. However, GSM uses Time Division Multiple Access (TDMA), which has a high symbol rate leading to problems with multipath causing inter-symbol interference. Several techniques are under consideration for the next generation of digital phone systems, with the aim of improving cell capacity, multipath immunity, and flexibility. These include Code Division Multiple Access (CDMA) and Coded Orthogonal Frequency Division Multiplexing (COFDM). Both these techniques could be applied to providing a fixed wireless system for rural areas. However, each technique has different properties, making it more suited for specific applications. OFDM is currently being used in several new radio broadcast systems including the proposal for high definition digital television, Digital Video Broadcasting (DVB) and Digital Audio Broadcasting (DAB). However, little research has been done into the use of OFDM as a transmission method for mobile telecommunications systems.

REFERENCES

[1]. J. Chuang and N. Sollenberger, “Beyond 3G: Wideband wireless data access based on OFDM and dynamic packet assignment,” IEEE Communications Mag., vol. 38, pp. 78–87, July 2000.

[2]. Saltzberg, B. R., “Performance of an Efficient Parallel Data Transmission System,” IEEE Trans. On Communications, Vol. COM-15, No. 6, December 1967, pp. 805–811.

[3]. A.G.Armada, “Understanding the Effects of Phase Noise in OFDM,” IEEE Transaction on Broadcasting, vol. 47, No.2, June 2001.

[4]. STOTT, J.H., "The DVB terrestrial (DVB-T) specification and its implementation in a practical modem". In proceedings of the 1996 International Broadcasting Convention,IEEE Conference Publication No. 428, pp. 255-260, September 1996.
[5]. Sari, Karam, Jeanclaude," Transmission techniques for digital terrestrial TV broadcasting", IEEE communications magazine Vol.33,No.2,Feb.1995.
[6]. Ahmad R.S. Bahai and Burton R. Saltzberg. "Multicarrier digital communications, theory and applications of OFDM", Kluwer Academic Publishers, pp. 192 (2002)
[7]. [7]ETSI,"Hiperlan/2-Technical-Overview",Online:http://www.etsi.org/technicalactiv/Hiperlan/hiperlan2tech.htm
[8]. T. Pollet, M. van Bladen, and M. Moeneclaey, "BER sensitivity of OFDM systems to carrier frequency offset and Wiener phase noise," IEEE Trans. Commun., vol. 43, pp.191–193, Feb./Mar./Apr. 1995.
[9]. S. Glisic. "Advanced Wireless Communications, 4G Technology". John Wiley & Sons Ltd: Chichester, 2004.
[10]. L. Hanzo, W. Webb, and T. Keller, "Single and Multi-carrier Quadrature Amplitude Modulation", New York, USA: IEEE Press-John Wiley, April 2000.
[11]. [11]S. B. Weinstein and P. M. Ebert, "Data transmission by frequency division multiplexing using the discrete fourier transform," IEEE Transactions on Communication Technology, vol. COM–19, pp. 628–634, October 1971.
[12]. [12] K. Fazel and G. Fettweis, eds., "Multi-Carrier Spread-Spectrum". Dordrecht: Kluwer, 1997. ISBN 0-7923-9973-0. International Journal of Engineering (IJE), Volume: 4, Issue: 4 266
[13]. X. Cai and G. B. Giannakis, "Low-complexity ICI suppression for OFDM over time- and frequency-selective Rayleigh fading channels," in Proc. Asilomar Conf. Signals, Systems and Computers, Nov. 2002.
[14]. Shaoping Chen and Cuitao Zhu, "ICI and ISI Analysis and Mitigation for OFDM Systems with Insufficient Cyclic Prefix in Time-Varying Channels" IEEE Transactions on Consumer Electronics, Vol. 50, No. 1, February 2004.
[15]. J.A.C. Bingham, "Multicarrier Modulation for Data Transmission: an idea who's time has come", IEEE Communications Magazine, Vo1.28, No.5, pp.5-14, May 1990.
[16]. Albdran, S., Alshammari, A., & Matin, M. (2012). "The Sensitivity of Bit Error Rate (BER) Performance in Multi-Carrier (OFDM) and Single-Carrier", SPIE optics and photonics.
[17]. Donald, N. (2004). "Air Interface for Fixed Broadband Wireless Access Systems", IEEE Standard 802.
[18]. Tubbax, J. et. al, (2004). "OFDM versus Single Carrier: A Realistic Multi- Antenna Comparison", EURASIP Journal on Applied Signal Processing 2004:9, 1275– 1287_c.
[19]. Alshammari, A., Alabdran, S., & Matin, M. (September 2012). "Effects of Fading Channels on OFDM". IOSR Journal of Engineering, 2(9), 116-121.
[20]. Bahai, A., Saltzberg, B., & Ergen, M. (2004). "Multi carrier digital communications: Theory and applications of OFDM", Springer Science, New York.
[21]. Saleh, A.M. and Valenzuela, R.A. (1987). "A statistical model for indoor multipath propagation". IEEE J. Select. Areas Commun., 5(2), 128–137.
[22]. Ochiai, H., & Imai, H. (Feb. 2001). "On the Distribution of the Peak to Average Power Ratio in OFDM Signals", IEEE Trans. Commun., vol. 49, no. 2, pp. 280- 289.
[23]. Han, S., & Lee, J. "An overview of peak-to-average power ratio reduction techniques for multicarrier transmission," IEEE Wireless Communications, vol. 12,
[24]. Alhasson, B., & Matin M. (2011). "Reduction of PAPR for OFDM Downlink and IFDMA Uplink Wireless Transmissions", International Journal of Computer Science and Information Security, Vol. 9, No. 3, pp 6-13, ISSN: 1947-1955
[25]. Zhou, C., & Wunder, G., Bakker, H., & Kaminski, S. (2005). "OFDM-HSDPA: conceptual approach, simulation methodology and throughput performance," in Proceedings of the 10th International OFDM Workshop, Hamburg, Germany.
[26]. Alhasson, B., & Matin, M. (2010). "The challenge of scheduling user transmissions on the downlink of a long-term evolution (LTE) cellular communication system". Optics and Photonics for Information Processing IV, Proc. of SPIE Vol. 7797, 779719.
[27]. Capoglu, I.R., Li,Y., & Swami, A. (2005). "Effect of Doppler spreadin OFDM based UWB systems. IEEE Trans". Wireless Commun., 4(5), 2559–2567.
[28]. Akki, A.S. & Haber, F. (1986). "A statistical model of mobile-to-mobile land communication channel". IEEE Trans. Veh. Technol., 35(1), 2–7.
[29]. Smith, J.I. (1975). "A computer generated multipath fading simulation for mobile radio". IEEE Trans. Tech., 24(3), 39–40.
[30]. Seidel, S.Y. et al. (1991). "Path loss, scattering and multipath delay statistics in four european cities for digital celluarl and microcellular radiotelephone". IEEE Trans. Veh. Technol., 40(4), 721–730.
[31]. Alard, M., & Lassalle, R. (1987). "Principles of modulation and channel coding for digital broadcasting for mobile receivers". EBU Tech. Review (224), 47–69.

[32]. Sari, H., Karam, G., and Jeanclaude, I. (1995) "Transmission techniques for digital terrestrial TV broadcasting". IEEE Commun. Mag., 33(2), 100–109.
[33]. Willink, T.J. and Witteke, P.H. (1997) "Optimization and performance evaluation of multicarrier transmission". IEEE Trans. Commun., 43(2), 426–440.
[34]. Vande, J., Sandell ,M., & Beorjesson , O.(1997). "ML estimation of time and frequency of OFDM systems". IEEE Trans. Commun., 45(7), 1800–1805.
[35]. Pollet, T., Spruyt, P., & Moeneclaey, M. (Nov. 1994). "The BER performance of OFDM systems using non-synchronized sampling". IEEE GLOBECOM'94, pp. 253–257

{36}http://www.bing.com/knows/Orthogonal%20frequency-division%20multiplexing

{37} https://www.coursehero.com/file/p7479s/The-equalizer-only-has-to-multiply-each-sub-carrier-by-a-constant-value-or-a/
{38} http://www.academia.edu/7312292/OFDM_Modulation_Using_Verilog