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Dr C Kalaiarasan[1], K.C.Geetha maligaa[2]

[1] Dean,[2] PG Scholar

[1&2]Department of CSE

[1&2]SNS College of Engineering, Coimbatore, Tamilnadu, India.

Corresponding author E-Mail-ID: geethachellappan94@gmail.com

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ABSTRACT

Multiple access techniques are used to allow a large number of users to share the allocated spectrum in the most efficient manner. The multiplexing techniques are Space Division multiple access (SDMA) and Frequency division multiple-access (FDMA).In FDMA the important scheme is Orthogonal Frequency Division Multiple Access (OFDMA) for advanced Channels. Long Term Evolution (LTE) has become a powerful technology for 4th Generation networks. New generation always demand a better quality of service mainly in terms of higher data rate, better signal quality, large coverage area and services at low cost etc. LTE comes to support the 4G environment by adopting the above multiplexing techniques. In this paper, Evaluated OFDMA with different assigned parameters and also derived parameters for the better performance of FDMA in LTE.

Keywords: *LTE, Cognitive Radio, Wi-Fi/IoT in5GHz Band, SDMA ,FDMA, OFDMA, BPSK.*

1. INTRODUCTION

The demand for a radio system with higher data rate and throughput has been increasing tremendously in recent years. Long Term Evolution (LTE) has become a powerful technology for 4th Generation networks. LTE can provide a data rate of 100Mbps in downlink and 50Mbps in uplink when operating in a bandwidth of 20MHz. The main goal of LTE is to provide a high data rate, low latency and packet optimized radio-access technology, supporting flexible bandwidth deployments. LTE networks carries large amount of data. on spite of efficient cell management, large spectrum is required to handle such huge data. To address these issues, Long Term Evolution in unlicensed (LTE – U) is considered as the best innovations to meet the high performance and seamless user experience. Multiple access techniques are used to allow a large number of users to share the allocated spectrum in the most efficient manner. As the spectrum is limited, so the sharing is required to increase the capacity of cell or over a geographical area by allowing the available bandwidth to be used at the same time by different users. This must be done in a way such that the quality of service doesn't degrade within the existing users. A cellular system divides any given area into cells where a mobile unit in each cell communicates with a base station. The main aim in the cellular system design is to be able to increase the capacity of the channel i.e. to handle as many calls as possible in a given bandwidth with a sufficient level of quality of service. There are several different ways to allow access to the channel.

This includes mainly the following:

1) Frequency division multiple-access (FDMA)

2) Time division multiple-access (TDMA)

3) Code division multiple-access (CDMA)

4) Space Division multiple access (SDMA)

FDMA, TDMA and CDMA are the three major multiple access techniques that are used to share the available bandwidth in a wireless communication system. Depending on how the available bandwidth is allocated to the users, these techniques can be classified as narrowband and wideband systems.

2. RELATED WORK

The License Assisted Access with Long Term Evolution allows co-existence with Wi-Fi through carrier aggregation. The Cognitive radio which supports the efficient spectrum utilization to detect the white spaces in 5GHz band to accomplish Listen-Before-Talk regulatory requirement of radio communication in LTE-U. SDMA uses physical separation methods that permit the sharing of wireless channels. For instance, a single channel may be used simultaneously if the users are spaced far enough from one another to avoid interference., The method Known as frequency reuse is widely used in cellular radio systems. Cell sites are spaced from one another to minimize interference.

The CR system at the LTE eNB node, on getting a transmission request from LTE source, identifies the white space in U-NII band and estimates the Clear Channel Assessment (CCA) threshold. CCA threshold is estimated by measuring the energy level of the free channel for a listening period of 20 μs. . If the energy level in the channel is below -80 dBm for the listening period of 20 μs, considering it as low interference level in the channel and assumed to be free. The Channel is then allocated for the U-LTE signal transmissions for the duration equal to Channel Occupancy Time of 10ms. To reduce the interference on channel occupancy we implement space division multiple access schemes in cognitive radio system (CR) with multiple primary users (PUs) and secondary users (SUs) shares the same spectrum and they are analyzed. Consider downlink transmission of a single cell system covered by one primary base station (PBS) and one cognitive (secondary) base station (CBS) cooperatively. PBS transmits to multiple primary users (PU) through different authorized frequency channels in Figure1.

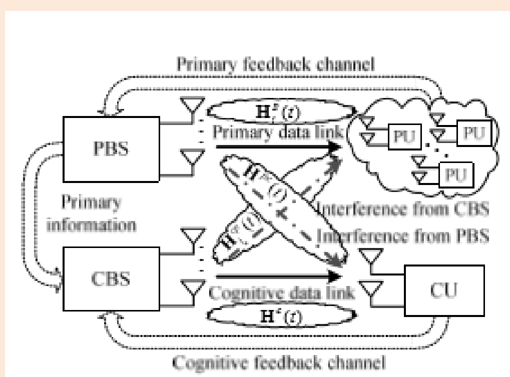

Figure 1: System model

In slot t, Channel State Information (CSI) between PBS and the PU is occupying channel *i* PU is denoted as $\mathbf{H}_i^p(t)$ Similarly, CSI between CBS and CU is $\mathbf{H}^c(t)$. Note that our scheme is based on collaboration between the primary and secondary (cognitive) system. Wi-Fi back off rate increases and the increase in back off rate is due to the dominance usage of medium by LTE-U users due to time slot aggregation with increased data traffic. The data traffic for different IEEE standards of 5GHz band with Space division multiplexing that creates reduces interference to Wi-Fi/Internet of Things users and the chances of fair and friendly coexistence of U-LTE with

Wi-Fi/IoT users. The proposed work includes comparison of SDMA and FDMA. OFDMA has an higher frequency and constant delay time than the FDMA. The system model is simulated in compliance to LTE standards using MATLAB showing the Parameters of Frequency Division Multiple Access and orthogonal frequency division multiplexing are listed in Table I.

PARAMETERS	FDMA	OFDMA
Throughput access scheme	Low frequency	High frequency
Delay	Short	Constant and shorter
Allotted bandwidth	12.5 MHz	15 MHz
Required channel Bandwidth	0.03 MHz	1.25 MHz to -20 MHz
Bandwidth	4 MHz to 1 GHz	10 MHz to 18 MHz

Table I: General Simulated Parameters

3. PROPOSED SYSTEM

In proposed work, we have implemented one of the multiplexing technologies to reduce the interference during channel occupancy, for that we are going for Frequency Division Multiple Access (FDMA). The initial multiple access technique for cellular systems in which each individual user is assigned a pair of frequencies while making or receiving a call. One frequency is used for downlink and one pair for uplink. This is called frequency division duplexing (FDD). The allocated frequency pair is not used in the same cell or adjacent cells during the call so as to reduce the co channel interference. Even though the user may not be talking, the spectrum cannot be reassigned as long as a call is in place. Different users can use the same frequency in the same cell except that they must transmit at different times.

The features of FDMA are as follows: The FDMA channel carries only one phone circuit at a time. If an FDMA channel is not in use, then it sits idle and it cannot be used by other users to increase share capacity. After the assignment of the voice channel the BS and the MS transmit simultaneously and continuously. The bandwidths of FDMA systems are generally narrow i.e. FDMA is usually implemented in a narrow band system The symbol time is large compared to the average delay spread. The complexity of the FDMA mobile systems is lower than that of TDMA mobile systems. FDMA requires tight filtering to minimize the adjacent channel interference.

FDMA Scheme has an important method that is termed as Orthogonal Frequency Division Multiple Access (OFDMA) is the access technique used in Long-Term Evolution (LTE) cellular systems to accommodate multiple users in a given bandwidth. Orthogonal frequency division multiplexing (OFDM) is a modulation method that divides a channel into multiple narrow orthogonal bands that are spaced so they don’t interfere with one another. Each band is divided into hundreds or even thousands of 15-kHz wide subcarriers. The data to be transmitted is divided into many lower-speed bit streams and modulated onto the subcarriers. Time slots within each sub channel data stream are used to package the data to be transmitted. This technique is very spectrally efficient, so it provides very higher data rates. It is less affected by multipath propagation effects. OFDMA is an important multiple access technique used at downlink channel in the LTE system. Orthogonal Frequency Division Multiplexing (OFDM) supports high Quality of service (QOS) to the accessing points. OFDMA has different features as high flexibility, robustness to channel fading, easy equalization and high spectral efficiency.

The channel in this case is modeled as a simple AWGN channel. Since the channel is considered to be an AWGN channel, there is no need for the frequency domain equalizer in the OFDM receiver Frequency domain equalizer will be helpful only if the channel introduces multipath fading. Since our channel is an AWGN channel, the frequency domain equalizer block in the above diagram can be removed.

4. SIMULATION:

To simulate an OFDM system, let's consider the OFDM system parameters as defined in IEEE 802.11 specifications. The Given parameters in the specification Table II is to determine the given values of unlicensed subcarriers.

PARAMETERS	VALUES
Total No of subcarriers	*N=64*
No of data subcarriers	*Nsd=48*
No of pilot subcarriers	*Nsp=4*
OFDM Bandwidth	*OFDMbw=20*16^6*

Table II: Given Parameters

The given simulated parameters are to estimate the optimizing function of BPSK in the given values of unlicensed subcarriers. Here, the given Table II, we have derived some of the parameters that they are listed below:

- Bandwidth for each subcarrier – ΔF = ofdmBW/N .
- IFFT or FFT period - 1/ΔF = 3.2us .
- Guard interval duration (Tgi) = Tfft/4.
- Total duration of BPSK-OFDM symbol = Guard time + FFT period.
- Number of symbols allocated to cyclic prefix (Ncp) = N*Tgi/Tfft.
- Number of total used subcarriers (Nst) = Nsd + Nsp.
- The number of Bits per Symbol =Nst

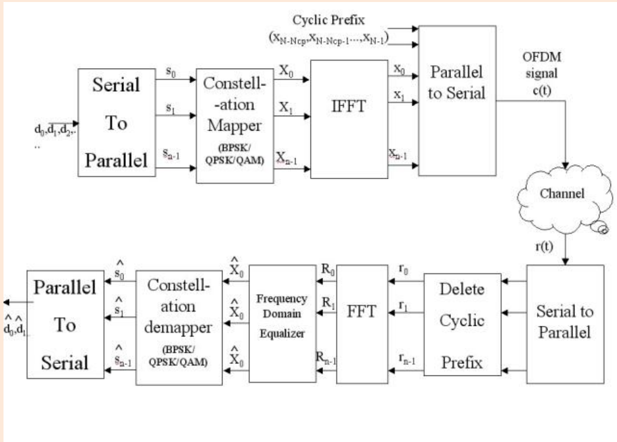

Figure 2: OFDM communication Architecture with Cyclic Prefix

A. Calculating Es/N0 or Eb/N0 for OFDM system:

In order to do a Monte Carlo simulation of an OFDM system, required amount of channel noise has to be generated that is representative of required Eb/N0. In Matlab it is easier to generate a Gaussian noise with zero mean and unit variance. The generated zero-mean-unit-variance noise has to be scaled accordingly to represent the required Eb/N0 or Es/N0. If we have Es/N0, the required noise can be generated from zero-mean-unit-variance-noise by,

$$required\;noise = 10^{-\frac{E_s}{N_0} \frac{1}{20}} \times noise$$

Since the OFDM system transmits and received the data in symbols, it is appropriate/easier to generate required noise based on Es/N0 instead of Eb/N0 . we are interested in plotting BER against Eb/N0.

Normally for a simple BPSK system, bit energy and symbol energy are same. So Eb/N0 and Es/N0 are same for a BPSK system. But for a OFDM BPSK system, they are not the same. This is because, each OFDM symbol contains additional overhead in both time domain and frequency domain. In the time domain, the cyclic prefix is an additional overhead added to each OFDM symbol that is being transmitted. In the frequency domain, not all the subcarriers are utilized for transmitted the actual data bits, rather a few subcarriers are unused and are reserved as guard bands.

B. Effect of Cyclic Prefix on Es/N0 :

The following diagram illustrates the concept of cyclic prefix. Each OFDM symbol contains both useful data and overhead (in the form of cyclic prefix). The bit energy represents the energy contained in the useful bits. In this case, the bit energy is spread over N bits (where N is the FFT size). On top of the useful data, additional Ncp bits are added as cyclic prefix, which forms the overhead. So if the entire OFDM symbol is considered, the symbol energy is spread across N+Ncp bits.

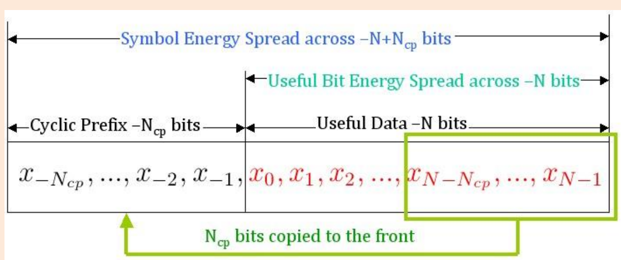

Figure3: concept of cyclic prefix

This relationship is given as

$$Es(N+N_{cp})=NE_{b}$$

Which translates to,

$$E_{s}=\frac{N}{N+N_{cp}}E_{b} \;\;\;\;\;\;\;\; (1)$$

C. Effect of unlicensed subcarriers:

As mentioned earlier, not all the subcarriers are used for transmission. Out of the total N subcarriers, only Nst carriers are used for OFDM symbols transmission this includes both data and pilot subcarriers. Again, in the frequency domain, the useful bit energy is spread across Nst subcarriers, whereas the symbol energy is spread across N subcarriers. This gives us another relationship between Es and Eb as given below

$$E_{s}\times {N}=N_{st}\times E_{b}$$

which translates to,

$$ E_{s}=\frac{N_{st}}{N}\times E_{b} \;\;\;\;\;\;\;(2)$$

Since Ncp cyclic prefix are added to the OFDM symbol, the output signal from the parallel to serial converter has to be boosted to compensate for the wastage of energy associated with the addition of cyclic prefix. To properly generate the required SNR in Matlab, the signal term at the output of the parallel to serial converter has to be scaled as follows

$$ Boosted\; OFDM\;signal = \sqrt{\frac{N_{cp}+N}{N}}\times OFDM\;signal $$

The received signal is represented as (for the given Eb/N0)

$$ y = boosted \; OFDM \; signal + required \; noise $$

D. Arrangement of subcarriers:

The IEEE 802.11 specification specifies how to arrange the given subcarriers. The 52 used subcarriers (data + pilot) are assigned numbers from -26,-25,…-2,,-1 and 1,2,…,25,26. The following figure illustrates the scheme of assigning these subcarriers to the IFFT inputs.

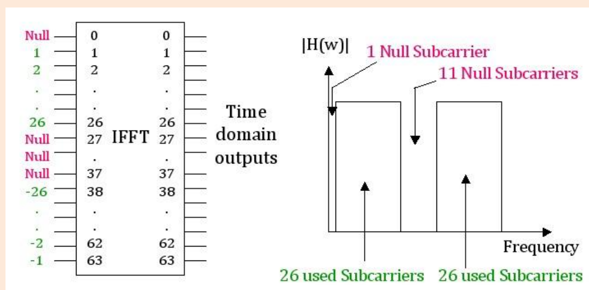

Figure 4: Assignment of OFDM Subcarriers

From the simulated graph, it can be ascertained that the OFDM- BPSK modulation has no advantage over a normal BPSK system in AWGN. OFDM proves to be effective in multipath environments.

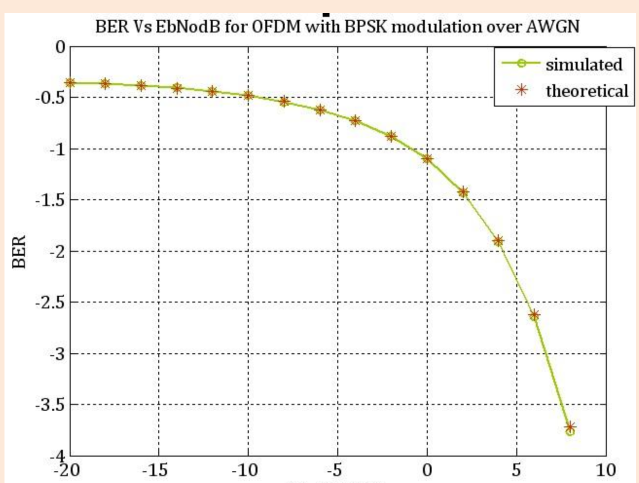

Figure 5 : Eb/N0 Vs BER for BPSK-OFDM over AWGN

5. CONCLUSION

This work is done on the basis of predefined multiple techniques in order to analyze the performance using SDMA and FDMA as important parameters. The multiple techniques are applied and tested using simulated environment. The simulated result is derived with the help of different assigned parameters using Nsd, Nsp and OFDMA Bandwidth. The Final result is projected with the derived values applied on the Standard IEEE 802.11 that specifies the subcarriers of OFDMA. The analysis work is effective, but the work can be extended in future by using other modulation techniques and also analyze the performance of these techniques on the basis of other parameters.

REFERENCES

[1] Alcatel-Lucent, Alcatel-Lucent Shanghai Bell, Ericcson, Huawei, HiSilicon, 3GPP RP-140808, "Review of Regulatory Requirements for Unlicensed Spectrum", IASEI, LG, Nokia, NSN, Qualcomm, NTT Docomo, June 2014.

[2] Qualcomm, Qualcomm Research LTE in Unlicensed Spectrum: Harmonious Coexistence with Wi-Fi, June 2014.

[3] 3GPP TS 36.201 version 13.0.0 LTE Evolved Universal Terrestrial Radio Access (E-UTRA) LTE physical layer, General description Release 13, 2016.

[4] S. Haykin, Cognitive radio: brain-empowered wireless communications, IEEE J. Select. Areas Commun, 2005 23 (2): 201– 220.

[5] Deepa Das, Susmita Das,Primary User Emulation Attack in Cognitive Radio Networks: A Survey, IRACST – International Journal of Computer Networks and Wireless Communications, 2013, 3 (3): 312-318.

[6] Carl R. Stevenson, Gerald Chouinard, IEEE 802.22: The First Cognitive Radio Wireless Regional Area Network Standard, IEEE Communications Magazine, 2009 130-138.

[7] T. C. Clancy, Dynamic Spectrum Access in Cognitive Radio Networks. Ph. D. thesis, University of Maryland, College Park, MD, 2006.

[8] Zamblé, Raoul, et al.,Peaceful Coexistence of IEEE 802.11 and IEEE 802.16 Standards in 5GHz Unlicensed Bands, World Academy of Science, Engineering and Technology, International Journal of Electrical, Computer, Energetic, Electronic and Communication Engineering 4.7, 2010, 1054-1059.

[9] A C Sumathi , M Priya , R Vidhyapriya. "Realization of LBT for Co-existence of U-LTE with Wi-Fi using Cognitive Radio". International Conference on Innovative Trends in Electronics Communication and Applications (2015): 153-158. Print.

[10] A. Osman and A. Mohammad,, "Performance Evaluation of a LowComplexity OFDM-UMTS-LTE System, " IEEE, vol. 4, no. 3, pp. 16, 2008.

[11] R. Chauhan, "Performance Enhancement of MIMO-OFDM Technology in LTE System," International Journal of Computer Science (IJCSI), vol.1, no. 8, October 2013.

[12] Y.Wu and W. Y. Zou, "Orthogonal Frequency Division Multiplexing: A Multi-Carrier Modulation Scheme," IEEE Trans. Consumer Electronics, vol. 4, no. 3, pp. 392–399, August 2003.

[13] Wu Y., Zou W. Y., "Orthogonal Frequency Division Multiplexing: A Multi-Carrier Modulation Scheme," IEEE Trans. Consumer Electronics, vol. 4, no. 3, pp. 392–399, August 1995.

[14] A.S Rao and S. Srinivas, "A New BER and SNR Calculations for MIMO System," International Journal of Inventive Engineering and Sciences (IJIES), vol. 2, no. 8, July 2014.

[15] R. Dinis, D. Falconer and C. Lam, "A Multiple Access Scheme for the Uplink of Broadband Wireless Systems," IEEE Communication Society Globecom, pp. 3808-3812, 2004.