Study and Analysis of LTE-Advanced Systems at 2.6 GHz for Indoor Large Hall

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Abstract - *In this work, Long Term Evaluation (LTE)-Advanced Systems for indoor large hall has been studied. The frequency selected is at 2.6 GHz. Different Quadrature modulation techniques has been applied as input to evaluate the performance of the system. The techniques used are, Quadrature Phase Shift Keying (QPSK), 16 bit Quadrature Amplitude modulation (QAM) and 64 bit QAM. The results were simulated to evaluate the performance of the network by performing the Signal to Noise Ratio (SNR) versus Bit Error Rate (BER) test. The analysis showed that the 16-bit QAM hac better performance than the QPSK and 64-bit QAM modulation techniques.*

Key Words: Long term evolution, modulation, bit error rate, OFDM, advanced system.

1. INTRODUCTION

Recently, the explosion of handheld devices has caused an exponential increase in mobile data traffic usage. Cisco forecasts [1] have shown that mobile data traffic will grow by 61 % from 2013 to 2018. This growth is based on current mobile data services and applications, such as mobile games, mobile videos, and location-based check-in services. This trend is expected to keep growing due to the appearance of new mobile services and applications. The significant growth in mobile traffic, new network services, and applications are pushing carrier network operators to upgrade their systems in order to meet new requirements and increasing customer demands. This imposes challenges for the current cellular network architecture, such as high upgrade costs, complex operation, and slow deployment of new innovations and services [2]. In addition, the simultaneous appearance of multiple wireless technologies has also brought challenges, including the interworking between these diverse technologies, inter-cell interference, and radio resource management in the dense network environment.

It has been widely understood that radio propagation has a significant impact on the performance of wireless communication systems. The impact on future broadband systems is even more important due to increased data rate, bandwidth, mobility, adaptivity, QoS, etc. Because of the major influence on the system performance and complexity, radio channel models and simulations have to be more versatile and accurate than in earlier systems [3-5]. The radio interface supports the challenging requirements of systems beyond 3G. It is scalable in terms of carrier bandwidth and carrier frequency range. The system concept supports a wide range of radio environments providing a significant improvement in performance and Quality of Service (QoS). The radio interface optimizes the use of spectral resources, e.g. through the exploitation of actual channel conditions and multiple antenna technology. New networking topologies (e.g. relaying) supports cost effective deployments. Long Term Evolution (LTE)-Advanced system, which is generally recognized as the evolved LTE system, offers significant improvements over previous technologies such as Universal Mobile Telecommunications System (UMTS) and High-Speed Packet Access (HSPA) by introducing a novel physical layer and reforming the core network [6-8]. The main reasons for these changes in the Radio Access Network (RAN) system design are the need to provide higher spectral efficiency, lower delay, and more multi-user flexibility than the currently deployed networks [9]. Operating frequency in-between 2.5 GHz to 2.7 GHz for LTE system has been widely used due to several wireless communication characteristics on this band. In the development and standardization of LTE, as well as the implementation process of equipment manufacturers, simulations are necessary to test and optimize algorithms and procedures.

In this work, LTE-Advanced Systems at 2.6 GHz has been studied and analyzed for different modulation techniques. QPSK, 16 bit QAM and 64 bit QAM has been studied to evaluate the performance of LTE-Advanced Systems. The rest of this paper is organized as follows: Section II describes the simulation methodology and assumptions; Section III shows the simulation results for different modulation factors; while Section IV concludes and summarizes the paper.

2. METHODOLOGY

Wireless World Initiative New Radio (WINNER) model for LTE advanced system has been studied for indoor large hall. The block diagrams of transmitter and receiver is shown in Fig. 1 and Fig. 2 respectively. The transmitter and receiver give the idea for selecting modulator and demodulator. Three different modulation techniques were used for this experiment.

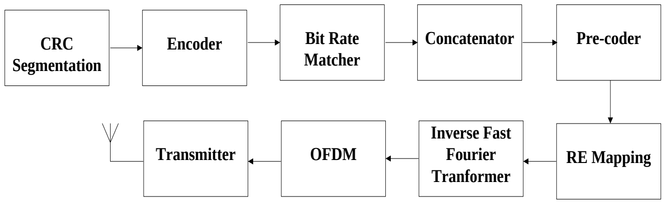

Fig-1: Block diagram of transmitter

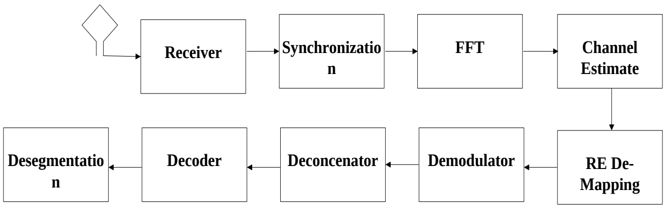

Fig-2: Block diagram of Receiver

Quadrature Phase Shift Keying (QPSK), 16-bit Quadrature Amplitude Modulation (QAM) and 64-bit QAM were used. The model is used for generation of multidimensional channel matrix H, containing time-variant Channel-Impulse-Responses (CIR) between all transmitter and receiver antenna combinations of MIMO system. Large scale parameters were optimized as shown in Table 1.

Table -1: Parameters selected for channel type B3-large indoor hall

S. No.	Parameters	Value
1.	Frequency	2.62 GHz
2.	Type	ULA
3.	Antenna Elements	2
4.	Spacing between Elements	0.5
5.	Slant	12

Although WINNER channel model is constructed as antenna independent model, antenna array model is necessary to obtain signals at the output of the radio-channel. This model is deterministic and permanent from the viewpoint of the simulation, and can be created independently from channel model simulations. Therefore certain type of array requires only single construction, which should be performed independently from WIM simulations - in pre-processing phase. Antenna geometry is selected in accordance to their array types. Uniform Linear Array (ULA) elements are placed along x-axis is such a way that the center of the array is at [0 0 0].

B3 represents the propagation conditions pertinent to operation in a typical indoor hotspot, with wide, but non-ubiquitous coverage and low mobility (0-5 km/h). Traffic of high density would be expected in such scenarios, as for example, in conference halls, factories, train stations and airports, where the indoor environment is characterized by larger open spaces, where ranges between a base station (BS) and a mobile station (MS) or between two MS can be significant.

Typical dimensions of such areas could range from 20 m × 20 m up to more than 100m in length and width and up to 20 m in height. Both line-of-sight (LOS) and non line-of-sight (NLOS) propagation conditions could exist. In this study, only LOS has been considered. As a multiplexing technique, Orthogonal Frequency Division multiplexing (OFDM) is used. Since the system sampling rate is set to 5 mega-samples per second, the channel delay was quantized to the nearest multiples of 200 nsec (= 5 × 10−6). Also, the length of the cyclic prefix (CP) is chosen as 4μs (20 samples) considering the maximum channel delay of the Vehicular A channel, which is 2.51μs. Table 2 summarizes the simulation assumptions and parameters that were used throughout this simulation for evaluating BER.

Table -2: Simulation parameters for evaluating BER

Parameters	Value
System Bandwidth	5 MHz
Sampling rate	5 x 106 samples/sec
Data modulation format	QPSK, 16-QAM, 64-QAM
Pulse shaping	none
Cyclic prefix	120 samples (4 us)
Transmitter IFFT size	512
Sub carrier (tone) spacing	5 MHz/512
No of Iterations	1

The resultant data was transmitted through the relay channel with channel filtering. Then Additive white Gaussian noise (AWGN) was added. Now the receiver end of this data will be the receiving end of the relay. After receiving the data at the receiver of the relay, the Cyclic Prefix is removed, IFFT is applied and MMSE equalization is done. Then the IFFT is applied on the equalized data and the Cyclic Prefix (CP) is added. Then the data is transmitted through the access channel with channel filtering and adding Additive white Gaussian noise. At this point the received end is the receiver of the UE. Cyclic Prefix is removed from the received data, IFFT is applied and MMSE equalization is done. After that the hard detection is performed for evaluating the Bit Error Rate.

3. RESULTS AND DISCUSSIONS

The proposed work is studied using three different modulation techniques at fixed frequency. While studying QPSK modulation technique, the SNR vs Bit Error Rate curve for this scenario is shown in Figure 3. From Figure 3, it is evident that environment exhibits that bit Error Rate are lower for 212 value than 211. Hence for QPSK values, BER decreases with the increase in SNR. For 16-bit QAM, BER values are inverse than the case for QPSK technique.

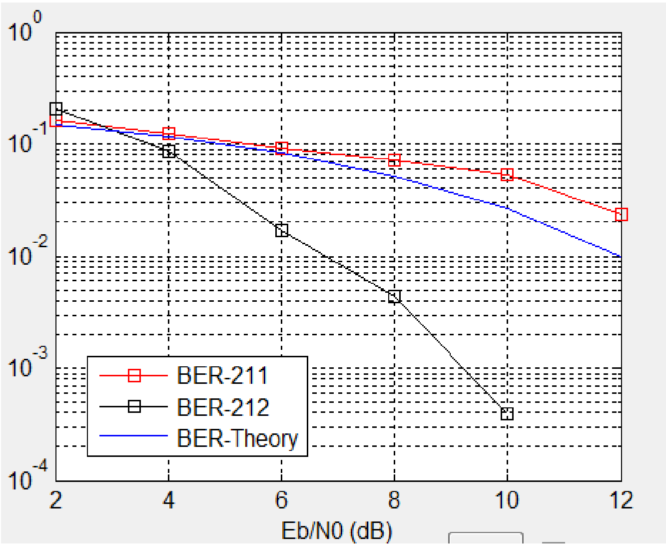

Fig-3: SNR vs. BER for large indoor hall scenario with QPSK technique

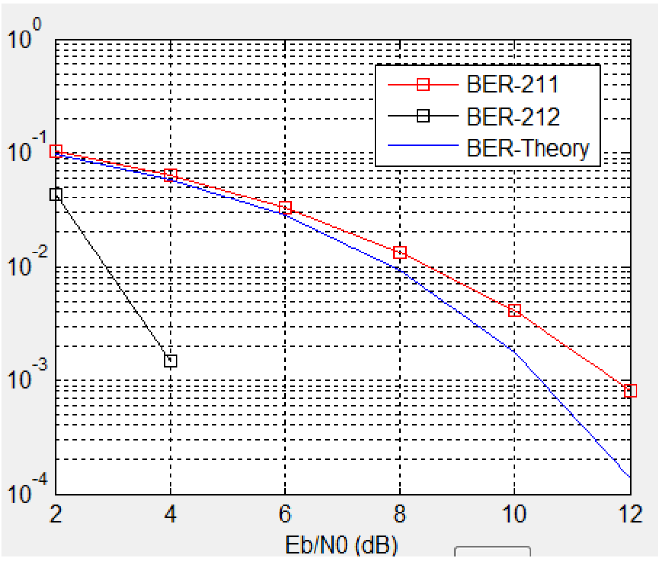

Fig -4: SNR vs. BER for large indoor hall scenario with 16-bit QAM

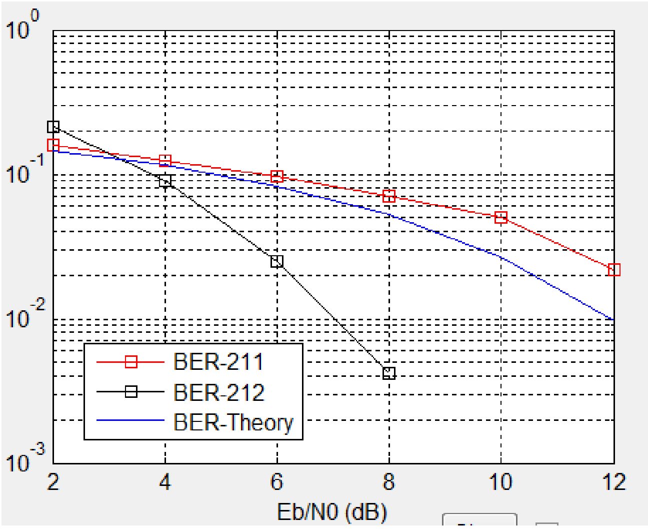

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Fig -5: SNR vs. BER for large indoor hall scenario with 64-bit QAM

The SNR vs bit Error Rate curve for this scenario with 64-bit QAM is shown in Figure 5. In this scenario it is clear that in the lower signal to noise ratio, 212 perform much better than the rest of the two. Upto a 8 dB SNR, 212 performs better than 211. If we compare all the three cases, it is clear that 16-bit QAM has better performance than the other modulation techniques.

4. CONCLUSIONS

The main idea of this study was to explore the feasibility of LTE-Advanced for different modulation techniques. We have considered WINNER II channel model as the LTE channel model for our research interest. This channel model is used to create B3 (large indoor hall) scenario. We considered the scenario with one base station (BS) and one user equipment (UE). Thus, the results were simulated to evaluate the performance of the network by performing the SNR vs BER test. We considered the simulations for different modulation techniques. The simulation results showed that the 16-bit QAM posses better performance than the QPSK and 64-bit QAM modulation techniques.

REFERENCES

[1] Ye Wang, Wen-Jun Lu, Hong-Bo Zhu, “Propagation Characteristics of the LTE Indoor Radio Channel With Persons at 2.6 GHz,” IEEE Antennas and Wireless Propagation Letters, Vol. 12, 2013, pp. 991-994.

[2] Z. Wang, A. C. Bovik, H. R. Sheikh, E. P. Simoncelli, “Image Quality Assessment: From Error Visibility to Structural Similarity,” IEEE Transactions on Image Processing, Vol. 13, , 2004, pp. 600-612.

[3] S. Lee, K. Cho, K. Kim, D. Yoon, T. Kim, "Performance analysis of LTE-Advanced system in the down link spatial channel model," IEEE International Conference on Network Infrastructure and Digital Content, 2009, IC-NIDC 2009.

[4] M. Sawahashi, Y. Kishiyama, H. Taoka, M. Tanno, T. Nakamura, "Broadband Radio Access: LTE and LTEAdvanced," International Symposium on Intelligent Signal Processing and Communication Systems (ISPACS 2009), December 7-9, 2009,

[5] Y. Yang, H. Hu, Jing Xu, Guoqiang Mao, "Relay Technologies for WiMAX and LTE-Advanced Mobile Systems," IEEE Communications Magazine, October 2009.

[6] G.X. Yuan, X. Zhang, W.B. Wang, Y. Yang, "Carrier Aggregation for LTE-Advanced Mobile Communication Systems," IEEE Commun. Mag., 2010, pp. 88–93.

[7] Y. Yu, E. Dutkiewicz, X. Huang, M. Mueck, G. Fang, "Performance analysis of soft frequency reuse for inter-cell interference coordination in LTE networks," in Proc. International Symposium on Communications and Information Technologies (ISCIT), 2010.

[8] M. Qian, et al. "Inter-cell interference coordination through adaptive soft frequency reuse in LTE networks," In Proc. IEEE Wireless Communications and Networking Conference (WCNC), 2012.

[9] P. Mogensen, N.Wei, I. Koväcs, F. Frederiksen, A. Pokhariyal, K. Pedersen, T. Kolding, K. Hugl, and M. Kuusela, "LTE Capacity compared to the Shannon Bound," In Proceedings of the 65th IEEE Vehicular Technology Conference, VTC2007-Spring, 2007, pp. 1234–1238.