Performance Evaluation of Inband Emission for Lte System

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Abstract: These years’ there is a rapid development in the field of wireless communication. Increased demands for the broadband mobile wireless connections and the materialization of new wireless multimedia implementation have constituted the enthusiasm for the development of broadband wireless accessible technologies. Long Term Evolution (LTE) system that has been standardized by the Third Generation Partnership Project (3GPP) to the approach towards fourth-generation (4G) mobile for the assurance of the 3GPP keeping the dominance of the mobile communication technologies. The Long term evolution (LTE) is a 3GPP (Third Generation Partnership Project), 4G technology, which improves the development in the area of telecommunication and also improves the performance of the system for the different types of traffic stream. In this paper an evaluation of the LTE uplink channel has been done for three modulation schemes namely 16-QAM, 64-QAM and QPSK for in-band emission. The system discussed here has the transmitter part designed which is the UE to transmit the signal. Then for transmission and implementation of channel the noise has been added to the transmitted data. At the receiver end the received signal is tested for its intactness and EVM.

1. Introduction

LTE system is a global standardization for the fourth generation of the mobile broadband (4G) which is supported by all major operators in the industry which was introduced by 3rd Generation Partnership Project in the year 2008. It has been anticipated that LTE system will provide an expansion in capacity and a there will be improvement in the performance as compared to the existing HSPA (High Speed Packet Access) based networks [1]. Here the basic idea of LTE is to build up an environment which presents benefits like high data rates required for proper communication, minimum delay which is termed as latency and higher range of spectral efficiency for a wide range of bandwidth. The objective in the evolution of LTE networks is to raise the data-rates to fulfill the needs of the user.

In LTE the Radio resource is divided and is shared efficiently amongst different active users with maintaining a satisfied level in terms of QoS to all the active users. So as to fulfill the needs, the LTE system depends on orthogonal frequency division multiple access (OFDMA) technique in the downlink. The OFDMA technique separates the available bandwidth into many narrow band sub-carriers thereby allocates a group of sub-carriers to any user based on the current system load, requirement and system configuration [1]. The SC-FDMA (Single Carrier Frequency Division Multiple Access) is used in the uplink and multi-antenna technology [3]. Transmission bandwidth can be chosen between 1.4MHz to 20MHz [1]. The bandwidth of 20MHz can provide downlink user data rate up to 150Mbps in 2X2 MIMO system and 300 Mbps data rate with 4x4 MIMO systems. So as to support downlink services with higher transmission rates, the BS transmits the data or information using shared channels to which the information or data that comes from many sources or users is multiplexed in frequency and time domains. Hence different scheduling approaches are proposed considering different requirements and necessities of the users along with the performance. The LTE-Advanced (Long Term Evolution-Advanced) is a standard for cellular networking system that offers high...
throughput as compared to its predecessor which is known as LTE (Long Term Evolution). The Long Term Evolution-Advanced system can transmit data at a rate of 1 GB per second that is reasonably higher as compared to LTE networks which have a maximum data transmission rate of 300 MB per second. Consequently, the higher need of the cellular bandwidth illustrate that carriers may need to use the standard LTE-Advanced which results as the increase in system capacity and it isn’t necessary to deliver extensively higher speeds. The system of LTE-Advanced network uses multiple-input and multiple-output (MIMO) technology to deliver or produce the data transmission faster using greater than one signal. MIMO needs multiple antennas to get input or to receive those signals, that can limit its utilization in compact devices like smart phones, tablets and mobiles [2].

2. SCHEDULERS

2.1 Maximum Throughput Scheduler
The approach that is known as Maximum Throughput (MT) intended at maximizing the overall throughput that assigns each RB (Resource Block) to the user that can gain the maximum throughput in existing TTI.

2.2 Modified Largest Weighted Delay First
The Modified LWDF (M-LWDF) is a channel-aware extension of LWDF and surrounded packet delivering delay is provided. In the course of shaping the behavior of MLWDF, PF it utilizes information about the accumulated delay, assuring a good balance amongst airness, spectral efficiency and the QoS prerequisite. It has been developed to support multiple real time data users.

2.3 Proportional Fair Scheduler
A classic way of finding a trade-off between the requirements of fairness and the spectral efficiency is nothing but the Proportional Fair (PF) scheme and the idea behind this is that the past average throughput may act as a weighting factor for the expected data rate, such that users in bad situation will be served inside a certain amount of time.

3. LTE System Architecture
LTE supports time and frequency division duplex schemes (TDD/FDD) in the same frequency bands as those allocated to UMTS: 15 frequency bands are FDD and 8 bands (33 to 40) are TDD. LTE also supports three modulation schemes, which are QPSK, 16- QAM and 64-QAM. Error Vector Magnitude (EVM) is a parameter used to measure the quality of modulation. The minimum requirements for the EVM are 17.5% for QPSK, 12.5% for 16-QAM and 8% for 64-QAM. LTE downlink transmission scheme is based on Orthogonal Frequency Division Multiple Access (OFDMA), while the uplink transmission is based on Single Carrier Frequency Division Multiple Access (SC-FDMA). The main drawback of OFDMA over SC-FDMA is its high Peak to Average Power Ratio (PAPR). OFDMA allocates individual users in the time and the frequency domain and its signal generation in the transmitter is based on the Inverse Fast Fourier Transform (IFFT). OFDMA converts the wide-band frequency selective channel into a set of many fading sub-channels, which enables optimum receivers to be implemented with reasonable complexity during MIMO transmission. In the uplink, SC-FDMA is more power efficient than OFDMA due to its low PAPR, which leads to decrease in linearity requirements and enhances the efficiency of the power amplifiers of the User Equipment (UE). SC-FDMA is based on discrete Fourier transform (DFT)-precoded OFDMA. Concerning uplink, LTE output power limits vary depending on the frequency band. The maximum TX power is 23 dBm.

3.1. LTE UPLINK ARCHITECTURE
LTE uplink (from device to tower) transmission is based on SC-FDMA. Uplink transmission is organized in a frame structure with the frame duration of 10 ms. SC-FDMA increases the capacity of the users by means of using several frequencies for carrying the data of a single user and augments the BER. The transmitter and receiver structure of the LTE Uplink is shown in Fig. 2. PUSCH channel can be divided into bit level, symbol level and sample level. The physical uplink shared channel is used to transmit the uplink shared channel (UL-SCH) and control information (L1 and L2). UL-SCH is the transport channel used for transmitting uplink data (a transport block) which undergoes transport block coding. The encoding process includes type-24A CRC calculation, code block segmentation and type-24B CRC attachment, rate matching with and code block concatenation.

![Figure 2. Signal Interface.](image-url)
The system used here for the evaluation contains the transmitter, transmission channel and the receiver. The configuration of the system used for the evaluation is shown in the table below.

### Table 1. Table example.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>RC</td>
<td>A3-1</td>
</tr>
<tr>
<td>2.</td>
<td>Total Sub-frames</td>
<td>15</td>
</tr>
<tr>
<td>3.</td>
<td>Modulation Type</td>
<td>16-QAM / 64QAM / QPSK</td>
</tr>
<tr>
<td>4.</td>
<td>Sampling Rate</td>
<td>1920000</td>
</tr>
<tr>
<td>5.</td>
<td>Nfft</td>
<td>128</td>
</tr>
<tr>
<td>6.</td>
<td>DeltaRB</td>
<td>[1;2;3;4;5]</td>
</tr>
<tr>
<td>7.</td>
<td>CyclicPrefixUL</td>
<td>Normal</td>
</tr>
<tr>
<td>8.</td>
<td>DuplexMode</td>
<td>FDD</td>
</tr>
<tr>
<td>9.</td>
<td>TrBlkSizes</td>
<td>104</td>
</tr>
<tr>
<td>10.</td>
<td>CodedTrBlkSizes</td>
<td>288</td>
</tr>
</tbody>
</table>

The system used for the evaluation has been designed as per the configuration given in table above. The Fixed Resource Channel used for the evaluation is A3-1. This channel provides the basic frame design for carrying the information over the channel. The sampling rate of the SCFDMA system used is 1920000 and the FFT for the signal spectrum selected to be 128. FDD has been used for duplex transmission mode. Transmit block size defined is 104 and so the coded turbo block size developed is 288. Based on this configuration the system is evaluated for different modulation schemes namely 16-QAM, 64-QAM and QPSK.

### 4. Results

Error Vector Magnitude (EVM) is a measurement of modulator or demodulator performance in the presence of impairments. Essentially, EVM is the vector difference at a given time between the ideal (transmitted) signal and the measured (received) signal. The in-band emission graph obtained is shown below.
The obtained Error Vector Magnitude for the allocated and unallocated RB for emission shows that for 16-QAM the error obtained is least.

### Table 2. Obtained EVM for Different Modulation Scheme.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Modulation Type</th>
<th>Averaged overall PUSCH EVM</th>
<th>Averaged overall DRS EVM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>16-QAM</td>
<td>1.325%</td>
<td>0.923%</td>
</tr>
<tr>
<td>2.</td>
<td>Total Sub-frames</td>
<td>1.325%</td>
<td>0.923%</td>
</tr>
<tr>
<td>3.</td>
<td>Modulation Type</td>
<td>1.325%</td>
<td>0.923%</td>
</tr>
</tbody>
</table>

5. Conclusion

LTE system has been developed for providing higher data rates to the user. And that need the bandwidth to be used efficiently. With the development it has been implemented and is being used to fulfill the need to a great instant. Further modification and improvement in the system may increase the provided data rate. For this reason the error introducing and error occurrence part should be handled and maintained properly. Here in the paper one of such evaluation has been done to check the performance of the system for various modulation type and it has been obtained that the percentage Error Vector Magnitude for 16-QAM is least while the EVM for QPSK is the most.

6. References


[15] Maria A. Lema and Mario Garcia-Lozano, Improved Scheduling Techniques for Efficient Uplink Communications with Carrier Aggregation.
