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# Performance Analysis of LTE Downlink

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**ABSTRACT-**This paper analyzes the performance of down link of Long Term Evolution using System Level Simulator from [1]. The results obtained concern the sector throughput and BLER (Block Error Rate), the user throughput and the corresponding CQI (Channel Quality Indicator) during all simulation period. The scenarios considered SISO, different CLSM antenna configurations, five packet scheduling strategies and different number of users in the cell.

**KEYWORDS-** LTE, SISO, CLSM

## I. INTRODUCTION

Long Term Evolution (LTE) is the name given to a 3GPP (3 rd Generation Partnership Project) concerning UTRAN (Universal Terrestrial Radio Access Network) evolution to Meet the needs of future broadband cellular communications. This project can also be considered as a milestone towards 4G (Fourth Generation) standardization. The requirements set for LTE specified in envisage high peak data rates, low latency, increased spectral efficiency, scalable bandwidth, flat all-IP network architecture, optimized performance for mobile speed, etc. In order to fulfill this extensive range of requirements several key technologies have been considered for LTE radio interface of which the most important are: multiple-access through Orthogonal Frequency Division Multiple Access (OFDMA) in downlink and Single Carrier Frequency Division Multiple Access (SC-FDMA) in uplink and multiple-antenna technology.

## II. OVERVIEW OF LTE DOWNLINK

The LTE down link is mainly characterized by OFDMA as multiple access scheme and MIMO (Multiple Input Multiple Output) technology. The benefit of deploying OFDMA technology on down link LTE is the ability of allocating capacity on both time and frequency, allowing multiple users to be scheduled at a time. The minimum resource that can be assigned to a user consists of two Physical Resource Blocks (PRBs) and it is known as chunk or simply Resource Block (RB). In downlink LTE one PRB is mapped on 12 subcarriers (180 kHz) and 7 OFDM symbols (0.5 ms) and this is true for non-MBSFN (Multimedia Broadcast multicast service Single Frequency Network) LTE systems and for normal CP (Cyclic Prefix). Scheduling decisions can be made each TTI (Time Transmission Interval) that in LTE is equal to 1 ms [2]. System performance and individual end user experience depend on the propagation conditions, the mobile device feedback, which is based on measurements, and the scheduling algorithm in the eNodeB (EvolvedNodeB).

The rest of the paper is organized as follows. Overview of LTE downlink is presented in section II. Description of System Level Simulation in the section III and Simulation and result discussion is presented in the section IV. Finally, section V concludes the paper.

## III. LTE SYSTEM LEVEL SIMULATOR

System level simulation focus more on network-related issues, such as resource allocation and scheduling [3], multi-user handling, mobility management, admission control , interference management, and network planning optimization [3]. The simulator consists of two parts: (i) a link measurement model, and (ii) a link performance model. The link measurement model reflects the link quality, given by the UE measurement reports, and is required to carry out link adaptation and resource allocation. The chosen link quality measure is evaluated per subcarrier [3]. Based on the Signal to Interference and Noise Ratio (SINR), the UE computes the feedback (PMI, RI, and CQI), which is employed for link adaptation at the eNodeB. The scheduling algorithm assigns resources to users to optimize the performance of the system. Based on the link measurement model, the link performance model predicts the BLER of the link, based on the

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receiver SINR and the transmission parameters (e.g., modulation and coding)[3]. Fig. 2 shows LTE BLER for CQIs 1 to 15 based on the receiver SINR.

## IV. SIMULATION AND RESULTS

For the first scenario simulated it was selected 1.8 GHz as carrier frequency, 1.4MHz system bandwidth, SISO antenna technology, RR scheduler, 10 UE per eNodeB sector, means70 UEs, UEs speed 3km/h, Typical Urban as channel model, inter eNodeB distance 500 m. The UEs are randomly positioned in the cells.

TABLE I: SIMULATION PARAMETERS

| **Parameters** | **Assumptions** |
|---|---|
| Carrier frequency | 1.8 GHz |
| Transmission bandwidth | 1.4MHZ |
| Thermal noise density | -174dBm/Hz |
| Inter-site distance | 500m |
| Receiver noise figure | 9 dB |
| Simulation length | 500 TTI |
| UE speeds of interest | 3km/hr, 120km/h |
| UEs | 10 UEs/sector |
| BS antenna gain | 15 dBi |
| Minimum coupling loss | 70 dB[12] |
| nTx x nRx antennas | 1x1, 2 x 2, 4x2, 4x4 |
| eNodeB Tx power | 43dBm |
| SINR averaging algorithm | EESM |
| Macroscopic path loss | 128.1 + 37.6log10(R) |

The scenario was built in order to see the user speed influence on the throughput and speed changed from the previous scenario: UE speed (100 km/h). The sector throughput for this scenario is shown in Fig. 3 and Fig. 4. Comparing Fig. 4 with Fig. 3, the sector throughput is smaller in the second scenario because the feedback cannot follow the fast fading. Moreover, the network BLER increases when the user speed is higher. User throughput is

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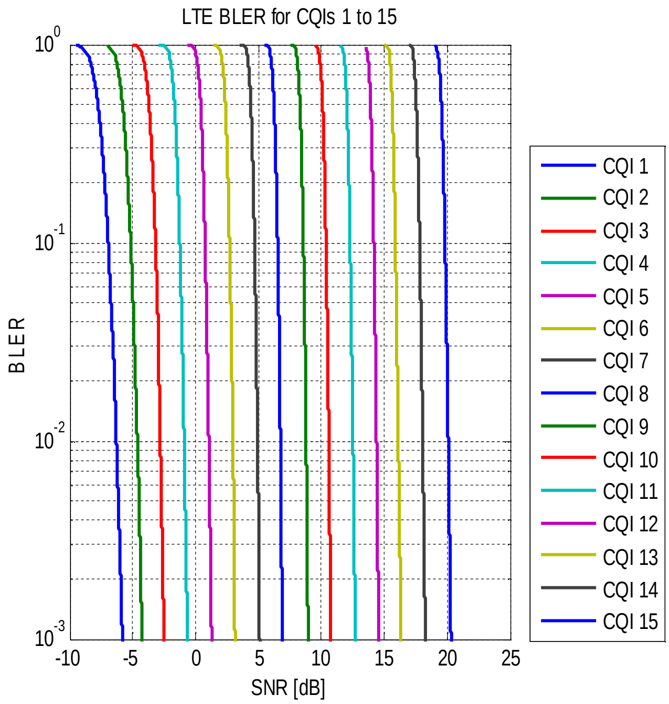


Fig 2 SNR Vs BLER

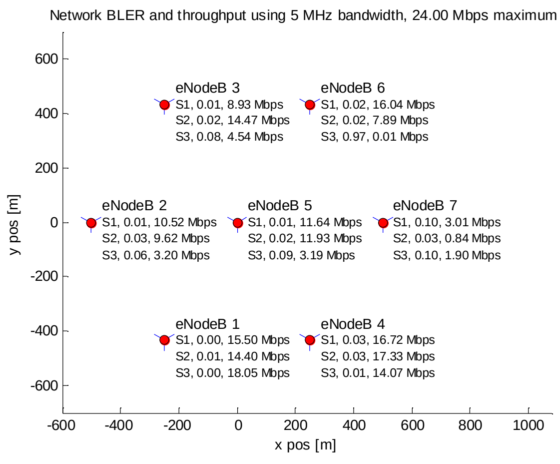


Fig 3 Network BLER and throughput at 1.4MHz and UE speed at 5km/h

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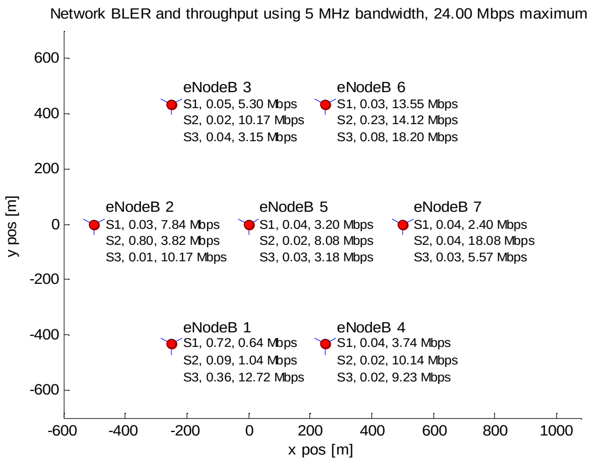


Fig 4 Network BLER and throughput at 1.4MHz and UE speed at 100 km/h

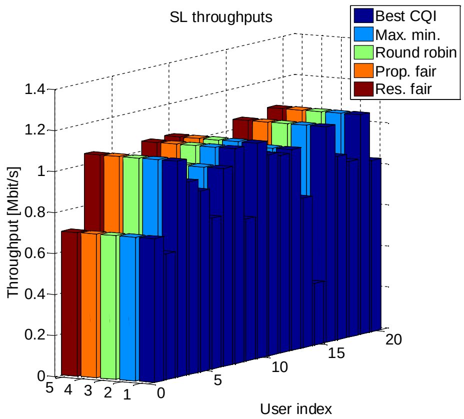


Fig 5 Comparison of algorithms

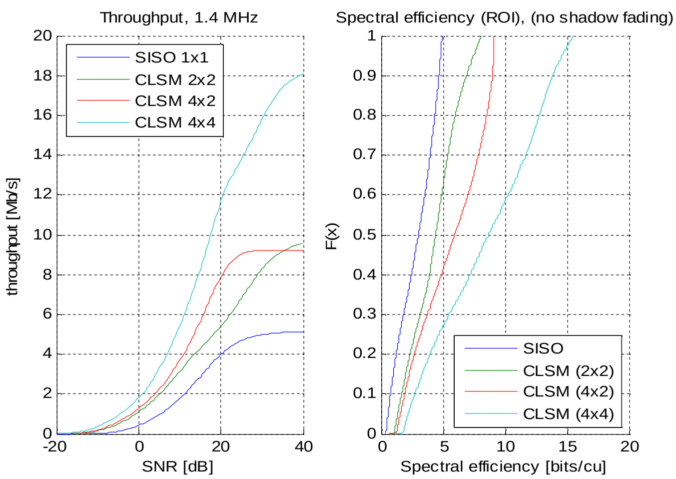


Fig 6 Comparison of different antenna configurations

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Fig 5 shows the comparison of five scheduling algorithms against throughput and users.
Fig 6 shows comparison among the different antenna configurations. As it is expected that CLSM with 4x4 antenna configuration gives you the higher throughput it approximately it is 3 times higher than the SISO and 2 time higher CLSM 2x2. Spectral efficiency almost in reverse situation where CLSM 4x4 configuration is shown poor spectral efficiency than the other configurations.

## V. CONCLUSION

This paper evaluates the mobility and interference of downlink LTE using System Level Simulator. First, it was analyzed the impact of the users speed, for that several simulations has been done with different user speeds and is presented in Fig. 3 and Fig. 4 with 5km/h and 100km/h, on comparing both figures, it is observed there was a strong decrease in user and sector throughput because the feedback cannot follow the fast fading. Second it was analyzed MIMO throughput. As it is expected that CLSM with 4x4 antenna configuration gives you the higher throughput it approximately it is 3 times higher than the SISO and 2 time higher CLSM 2x2. Finally it is observed that
Selection of scheduling algorithm shows considerable impact on the throughput. LTE performance depends on lots of parameters and configuration chosen, but through these simulations, several LTE expectations have been achieved.

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