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Analysis on Energy Efficient Traffic Load Balancing in Downlink LTE-Advanced Heterogeneous Network

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ABSTRACT: This paper presents a framework to activate and deactivate micro nodes in a heterogeneous multi cell LTE network, based on load and energy efficiency consideration. The framework exploits historical data (i.e., per-macro-cell load curves) to select a set of candidate switch-on/switch-off instants of microcells, assuming a *limited* number of state changes is allowed in a day. The switching instants are instead determined *online*, by taking into account the actual traffic as well as the load curves. Moreover, inter cell interference is fully accounted for. Our simulations show that this framework allows a multi cell network to sustain peak-hour load when necessary and to reconfigure to a minimum coverage baseline whenever feasible, thus saving power (up to 25% in our scenarios). Moreover, the framework is *robust*, meaning that deviations of the actual traffic with respect to the prediction offered by the load curves can easily be handled.

I. INTRODUCTION

The base stations power consumption in Long Term Evolution (LTE) has therefore, become a major challenge for vendors to stay green and profitable in competitive cellular industry. It necessitates novel methods to devise energy efficient communication in LTE. Importance of the topic has attracted huge research interests worldwide. Energy saving (ES) approaches proposed in the literature can be broadly classified in categories of energy efficient resource allocation, load balancing, carrier aggregation and bandwidth expansion. Each of these methods has its own pros and cons leading to a trade-off between ES and other performance metrics resulting into open research questions. This paper discusses various ES techniques for the LTE systems and critically analyses their usability through a comprehensive comparative study. We have seen usage of 1G, 2G, 3G and now4G as the communication standard with each resulting into enhanced performance of cellular systems . Aiming towards the key achievements such as short transmission time, high throughput, low latency and security, these systems generally consist of Base Stations (BS) connected to core network. Each BS has designated cover-age area, called cell and communicates directly with User Equipment (UE) within its coverage . Whenever UE moves from serving cell to neighbor cell, its transfer of control is initiated through handover process.LTE is a 4G technology,

Objectives of LTE and LTE-Advanced
The overall objective for LTE is to offer an extremely high performance radio access technology which offers complete vehicular speed mobility and that can readily coexist with HSPA and earlier networks. LTE is referred as Universal Terrestrial Radio Access Network (E-UTRAN). LTE supports Downlink peak data rates up to 326 Mbps with 20 MHz bandwidth and Uplink peak data rates up to 86.4 Mbps with 20 MHz bandwidth. LTE also supports scalable bandwidth such as 1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, and 20 MHz .Besides, LTE supports reduced latency up to 10 milliseconds (ms) round-trip times between user equipment and the base station, and to less than 100 ms transition time from inactive to active.

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Table 1: Technical specifications published by the 3GPP group

Release	Specification	Date	Downlink Data Rate	Uplink Data Rate	Round Trip Time
Release 99	WCDMA	March, 2000	384 kbps	128 kbps	150 ms
Release 4	TDSCDMA	March, 2001	384 kbps	128 kbps	150 ms
Release 5	HSDPA	March to June, 2002	14 Mbps	5.7 Mbps	<100ms
Release 6	HSUPA	December, 2004 to March, 2005	14 Mbps	5.7 Mbps	<100ms
Release 7	HSPA	December, 2007	28 Mbps	11 Mbps	<50ms
Release 8	LTE	December, 2008	100 Mbps	50 Mbps	10 ms
Release 10	LTE-Advanced	Published 2012	1 Gbps in a low mobility	375 Mbps	5ms

Architecture of LTE

Long Term Evolution (LTE) has been considered to maintain only packet switched service for providing seamless Internet Protocol (IP) connectivity between the packet data network (PDN) and the user equipment (UE), without any interruption to the end users" applications during the period of mobility. The term “LTE” covers the advancement of the Universal Mobile Telecommunications System (UMTS) radio access through the Evolved UTRAN (EUTRAN). LTE is accompanied through the non-radio aspects under the term “System Architecture Evolution” (SAE), which includes the Evolved Packet Core (EPC) network. SAE and LTE consist of the Evolved Packet System (EPS). The LTE and SAE architecture decreases operating expenses (OPEX) and capital expenditures (CAPEX).

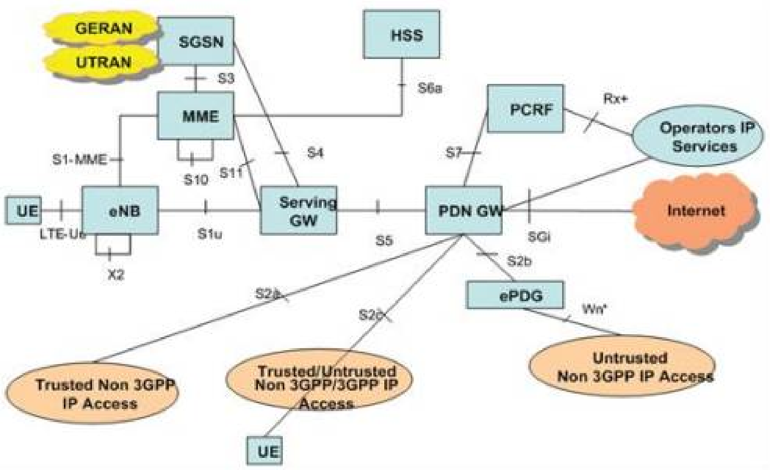

Figure 1 : High level architecture for 3GPP LTE

EPS is the combination of CN and E-UTRAN radio access network. Core Network (CN) delivers access to external packet IP networks assures privacy, security, QoS, and terminal context management.

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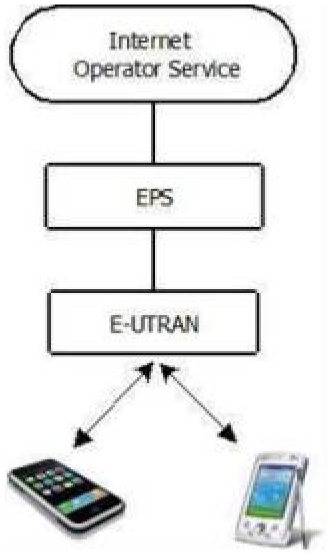

Figure 2 : Architecture of EPS (LTE/SAE)

II. PROPOSED METHODOLOGY

LTE PDSCH CHANNEL

LTE PDSCH is a physical downlink shared channel. It is used to transmit downlink channel (DL-SCH). The DL-SCH is the transport channel for transmitting downlink data. One of the two coded transport blocks (codeword's) can be transmitted simultaneously on PDSCH depending on pre-coding scheme. The coded DL-SCH codeword's undergoes scrambling, modulation, layer mapping, resource elements. Scrambled codeword's undergoes QPSK, 16 QAM or 64 QAM modulations. Choices created flexibility to allow the scheme to maximize the data throughput depending on channel condition.

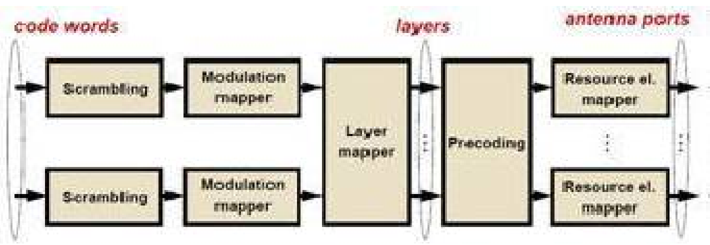

Figure 3: LTE PDSCH downlink channel

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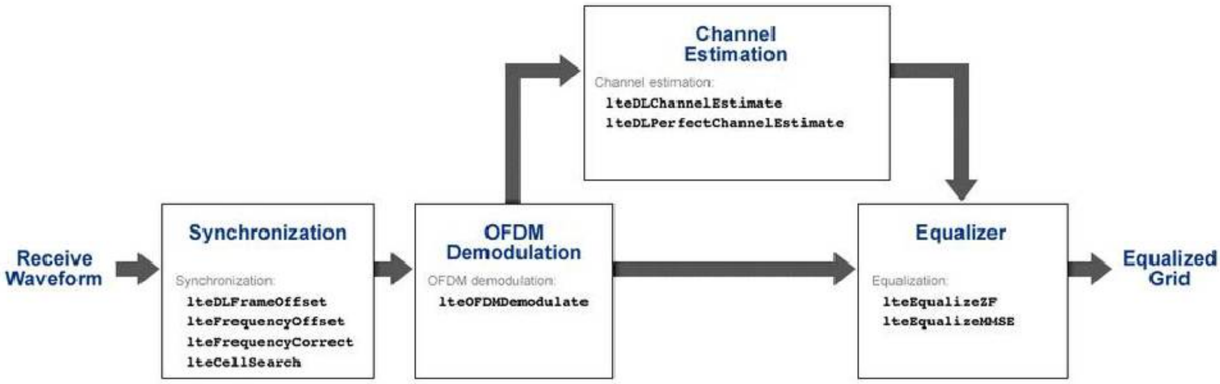

Figure 4 PDSCH downlink receiver function

III. SIMULATION RESULTS

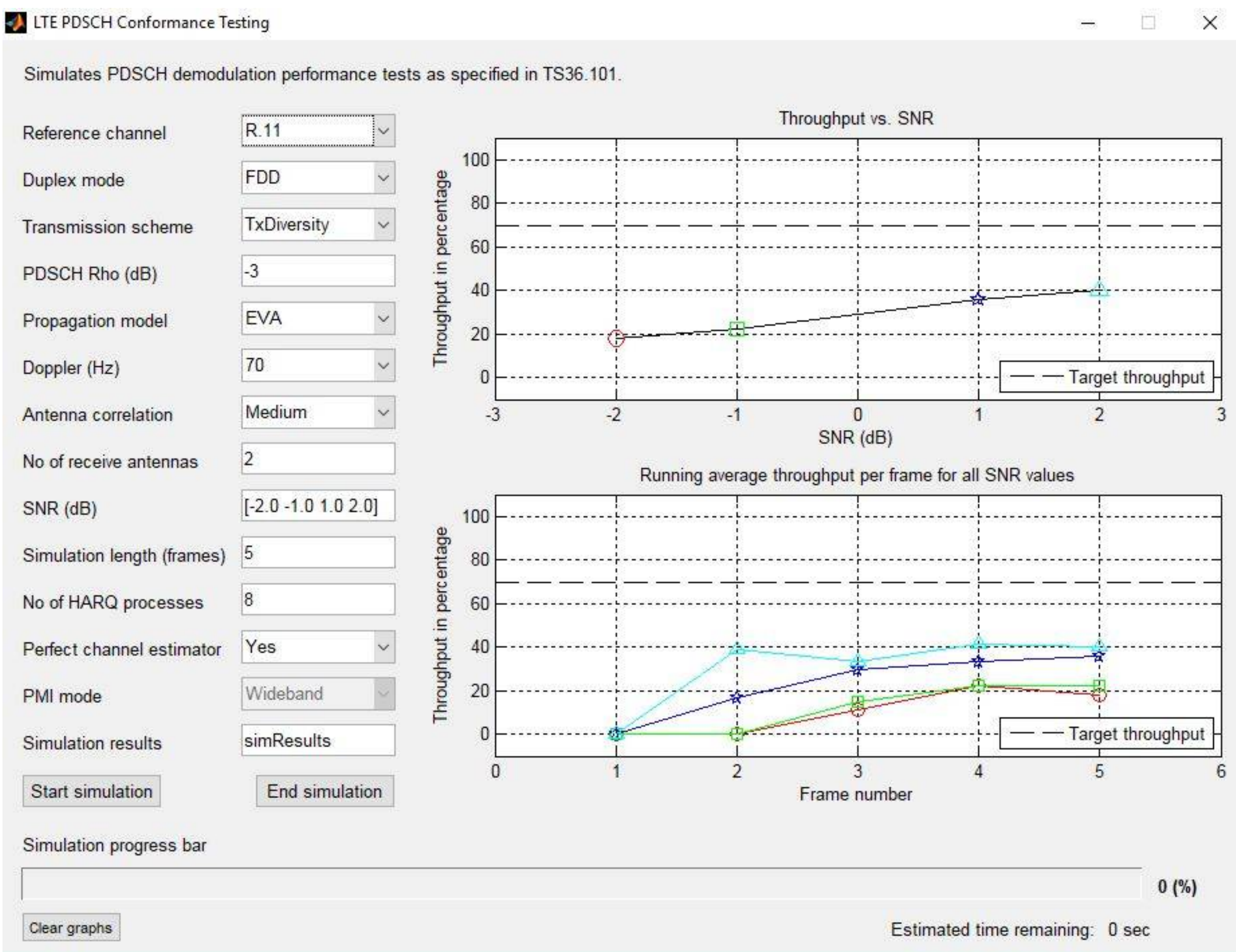

Figure 4 : % throughput for SNR & no. of frames (70 Hz doppler)in EVA model

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In Fig. 4, throughput vs SNR for EVA with 70 Hz Doppler Effect has been plotted. Here, it has been observed that when the value of SNR is -2dB then the throughput is 17.78%, for -1dB it is 22.22%, for 1dB it crosses the target throughput which is 35.56%. The throughput is 40% for 2dB SNR. In 70Hz doppler values, % of throughput for various SNR values are changing as per the no.of frames transmitted.

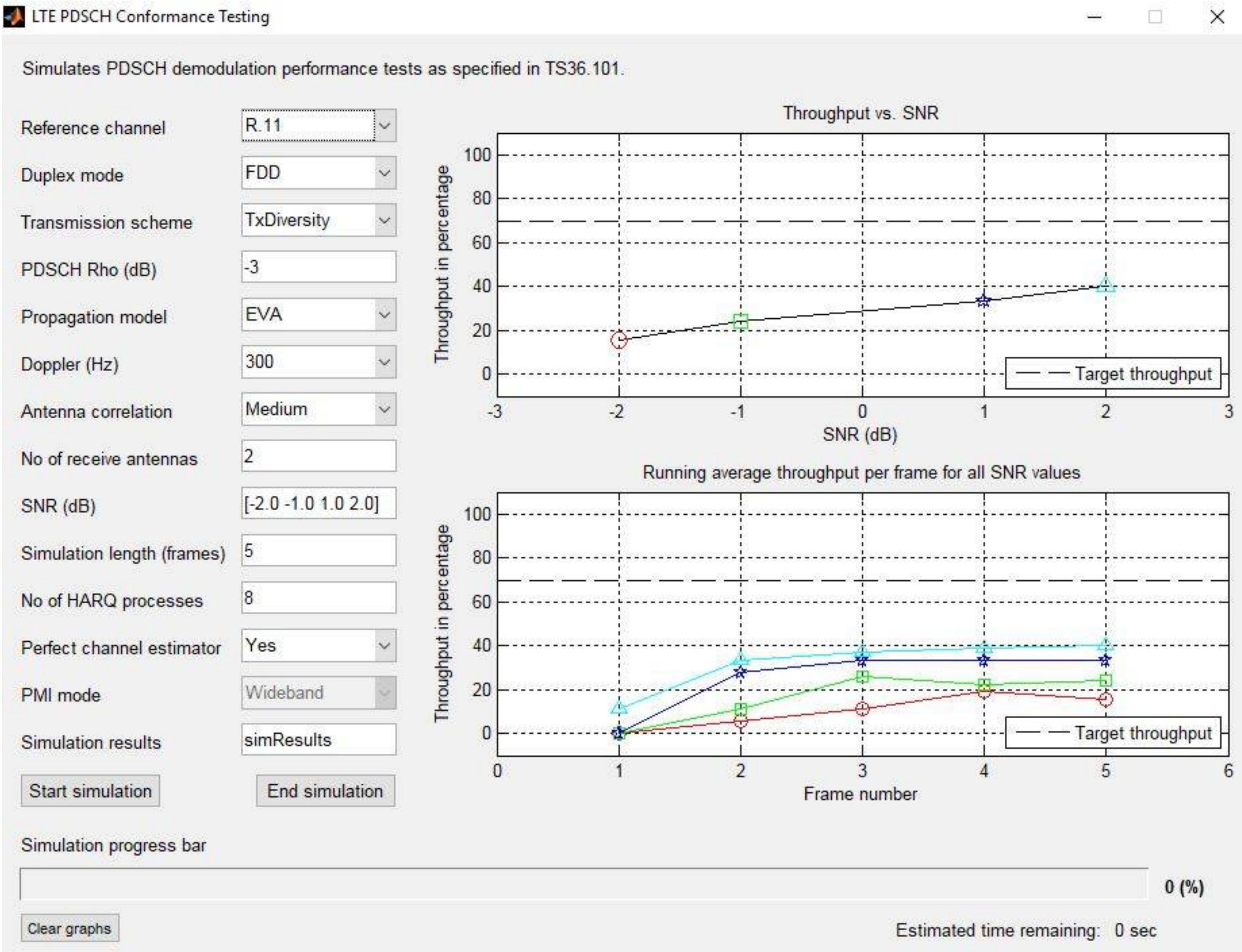

Figure : 5 % throughput for SNR & no. of frames (300 Hz doppler)in EVA model

In Fig. 5, throughput vs SNR for EVA with 300 Hz Doppler Effect has been plotted. Here, it has been observed that when the value of SNR is -2dB then the throughput is 15.56%, for -1dB it is 24.44%, for 1dB it crosses the target throughput which is 33.33%. The throughput is 40% for 2dB SNR. In 300Hz doppler values, % of throughput for various SNR values are changing as per the no.of frames transmitted.

So from all the figures, it can be summarized that the higher SNR value gives the higher throughput and higher Doppler Effect will result the higher throughput. For 5Hz, ETU gives the best result, for 70 Hz, ETU gives the best and for 300 Hz all the models are same.

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IV. CONCLUSION

Simulation results show the impact of % throughput depending on SNR & no. of frames transmission for EPA, EVA and ETU model in LTE PDSCH channel. For the different doppler values, % of throughput for various SNR values are changing as per the no.of frames transmitted. Best throughput performance is estimated above the targeted throughput for both cases i.e. SNR & Frame number.In this proposed work, the performances of three propagation models of LTE (EPA, EVA & ETU) have been analyzed. In the analysis, throughputs for various SNR's value in several Doppler effects have been considered. It has been found that for 5 Hz Doppler Effect, ETU shows the best performance and EVA shows the worst. In case of 70 Hz, ETU is the best and EPA is the worst. But in case of 300 Hz, all the models are identical. It has been also found that increasing the value of SNR increases the value of throughput.

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