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Performance Analysis of Different Scheduling Algorithms in LTE System for Jitter Constraint

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Abstract— LTE (Long Term Evolution) is an emerging technology which promises to provide higher user throughput, reduced latency and reduced cost compared to previous technologies. One of the critical factor of latency in LTE is jitter. During the handover process a UE (User Equipment) context is to be handed over form Source eNB (evolved Node Base station) to the Target eNB. If the variation in jitter is very high then it reduces the performance of the system. Thus in this paper an attempt has been made to analyze the performance of scheduling algorithms for jitter constraint during the handover process in LTE system. Handover scenario is created using QualNet 7.1 simulator, and performance evaluation is done for RR (Round Robin) and PF (Proportional Fading) scheduling algorithms considering jitter as performance metric.

Key words: Jitter Constraint, LTE System

I. Introduction

Higher data rate, reduced latency, improved capacity and lower cost are the main driving factors of communication technology. Earlier technologies like GSM, EDGE, and UMTS were lagging to provide services in one or the other above mentioned factors [4]. The evolutionary technology Long Term Evolution (LTE) will fulfill these requirements by providing higher data rate, reduced latency and improved system capacity at lower cost. Because of these attributes of LTE, mobile operators are drifting towards the LTE technology.

To achieve high throughput, lower latency and improved system capacity LTE adopts [6] some of the features like OFDMA (Orthogonal Frequency Division Multiple Access) in downlink, SC-FDMA (Single Carrier Frequency Division Multiple Access) in uplink, and MIMO (Multi Input Multi Output) antenna technique in both uplink and downlink. OFDMA and SC-FDMA techniques enhances the bandwidth utilization by reducing inter-channel interference, which allows more number of user connections compared to TDMA and FDMA techniques. With the use of OFDMA technique LTE provides more user connections which is 18 times more better compared to GSM (Global System for Mobile Communication) technology. MIMO multi-antenna technique implements the beam-forming which enhances the user throughput by transmitting multiple data streams simultaneously in the direction of users with reduced error rate compared to SISO and SIMO antenna techniques.

In downlink LTE connection OFDMA technique provides 100Mbps date rate and in uplink LTE connection SC-FDMA technique provides data rate of 50Mbps. Due to these higher data rates LTE can support handover at higher UE speed. LTE supports handover at a speed of 350Kmph to 500Kmph. The process of handover is initialized when UE (User Equipment) is moving from one eNB (evolved Node Base station) to other eNB. Handover is a process where a UE's context is transferred from Source eNB to the Target eNB. In LTE a provision is given such that both UE and eNB can initialize the handover process.

There are two types of handover mechanisms one is soft handover and other is hard handover. Soft handover is also referred as "make before break", where a UE will establish a connection with the Target eNB before breaking with the Source eNB. Hard handover [1] is referred as "break before make", where a UE will be disconnected from Source eNB before connecting to the Target eNB. In LTE hard handover procedure is considered, since it does not require *Ack* message to the Source eNB. Thus LTE network utilizes these channel resource for other users to enhance the spectral efficiency.

The rest of the paper is organized as follows. Section II provides an overview of LTE. Section III describes steps involved in handover process. Section IV provides the Performance analysis results of the LTE system during handover. Finally, Section V concludes the paper.

II. LTE Overview

Long Term Evolution is an acronym that refers to a series of cellular standards developed by 3GPP (3rd Generation Partnership Project) to meet the requirements of IMT (International Mobile Telecommunication) specifications. LTE provides the provision of high data rate in order to support multimedia applications such as voice call, video streaming etc. The systems designed using LTE technologies are completely packet-based which consists of reduced number of network elements, improved coverage and system capacity, better performance in terms of flexible bandwidth, small end to end delay or latency, higher data rates and it can also provide services to the back end wireless communication systems such as 2G, EDGE etc. IP based LTE network architecture is shown in Fig. 1 comprises of following modules.

A. *User Equipment:*

User Equipment is a device used to establish a communication link with base station. It consists of multiple installed applications for different types of services like video call, voice call, internet, WiFi etc. There are different types of UE models, based on the handset different services are provided by the base station. Practically UE is used for communication applications, which communicates with the base station for establishing a communication link, maintaining it and removing the link according to the user needs. Some of the other functions performed by UE according to the instructions provided by network are mobility management, which includes handovers, sending the Received Signal Strength (RSS) information, and reporting the terminal equipment location.

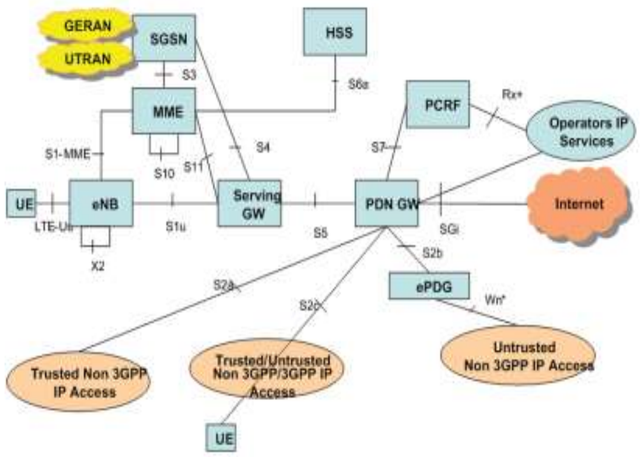

Fig. 1: LTE network architecture.

B. Evolved UMTS Terrestrial Radio Access Network (E-UTRAN):

E-UTRAN or RAN [3,5] does not contain any centralized unit as in the case of EPC. Hence the architecture of RAN (Radio Access Network) is very flat where all the functionalities are handled by eNBs. The eNB is not a physical implementation but rather it is a logical node. The three sector site is an often implementation that can be observed in most of the cases. The absence of centralized architecture in RAN results in improved spectral efficiency and reduced latency. The communication related activities between the UE and the EPC (Evolved Packet Core) are assisted by the eNB. The RAN contains multiple cells where in each cell there are UEs which are controlled and managed by one single eNB. The eNBs are connected to the EPC by means of S1 interface and the neighboring eNBs can communicate using X2 interface. The X2 interface is used for the purpose of context release of mobile data during the handover process between the eNBs. The S1-C interface is used for the communication between the eNB and MME (Mobility Management Entity) whereas the S1-U interface is used to connect the eNB to the S-GW.

C. Evolved Packet Core (EPC) / System Architecture Evolution (SAE):

EPC is a core network shown in Fig. 1 that monitors and controls all the modules in the system. EPC is evolved from its previous technologies like GSM, GPRS, HSPA. Hence it is backward compatible network. As the previous technologies were not sufficient to provide the required services, some of the enhancements were included in this system resulting into Evolved Packet Core, and EPC shows significant improvements. The new technique like evolved LTE architecture, OFDM techniques are used in EPC to provide better service.

III. HANDOVER PROCEDURE

In wireless communication system the most significant attribute is the mobility [7]. As long as the UEs are in the same cell there is no need of using handover techniques to provide continuous service. Whenever there is movement of UE from one cell to another cell care has to be taken to provide continuity in the service. This type of continuity of service from cell to cell is referred as handover. Handover is initiated by both UE and eNB.

Steps involved in handover procedure [2] are as follows which is shown in Fig. 2.

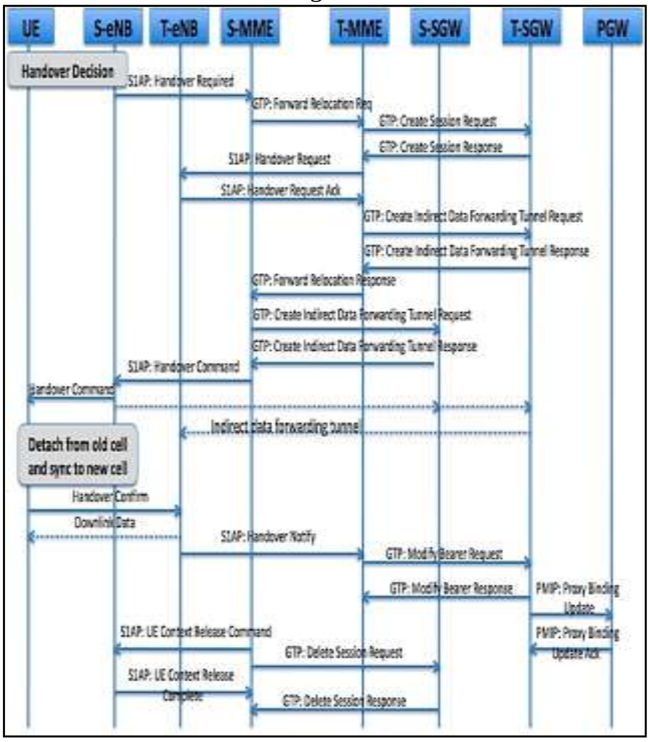

Fig. 2: Handover steps in LTE.

1) Handover is initiated by UE which sends Measurement Report to the Source eNB. Source eNB will make handover decision based on Measurement Report and Radio Resource Management (RRM) information.
2) Next HO preparation will be initiated by sending HO Request from Source eNB to the Target eNB, which consists of all the information about the HO.
3) Target eNB saves the context, prepares for the HO and responds to the Source eNB with a HO Request ACK that provides information required for the establishment of new radio link.
4) Source eNB will send all the necessary information to UE. Source eNB transfers the context of UE to the Target eNB. UE performs radio link establishment to Target eNB after the starting time indicated in HO Command elapses. This procedure involves detaching from the old cell, synchronizing to the new one, obtaining timing advance and uplink allocation.
5) UE informs the Target eNB about the success of radio handover by sending Handover Confirm message. Up to this time the Target eNB buffers DL data received from the Source eNB. After receiving this message it starts transmitting the buffered data to the UE.
6) Target eNB initiates data path switching by sending Handover Complete to MME/SAE Gateway. UE location information is updated at MME/SAE Gateway after receiving the Handover Complete message and it performs the path switching after which packets are directly sent to the Target eNB.
7) The MME/SAE Gateway confirms the path switching with a Handover Complete Ack message. After receiving this message the Target eNB sends a Release Resource indication to the Source eNB that can flush its forwarded DL data buffer that was stored in case of

fallback. The Source eNB still continues forwarding in-transit packets.

IV. PERFORMANCE EVALUATION AND RESULTS

The scenario has been designed by considering two cells of radios 2Km consisting of one eNB and 10UEs each in a 5Km X 5Km terrain area. To study the effect of handover on jitter, initially simulation study is carried out by moving one UE from cell_1 to cell_2 by selecting RR (Round Robin) scheduling algorithm for Rayleigh fading channel. The above simulation study is repeated by increasing the number of UEs moving from cell_1 to cell_2 one at each step. Similarly the same simulation study is repeated for PF (Proportional Fair) scheduling algorithm. The snapshot of the scenario for performance analysis is shown in Fig. 3.

The result in Fig. 4 shows the average jitter for RR and PF scheduling algorithm with increase in number of handovers. From the Fig. 4 it is observed that the jitter variation in RR scheduling algorithm is better than the jitter variation of PF scheduling algorithm. RR scheduling algorithm gives equal fairness to all incoming UEs by allocating the channel without any preference whereas in PF scheduling algorithm channel is allocated based on preference.

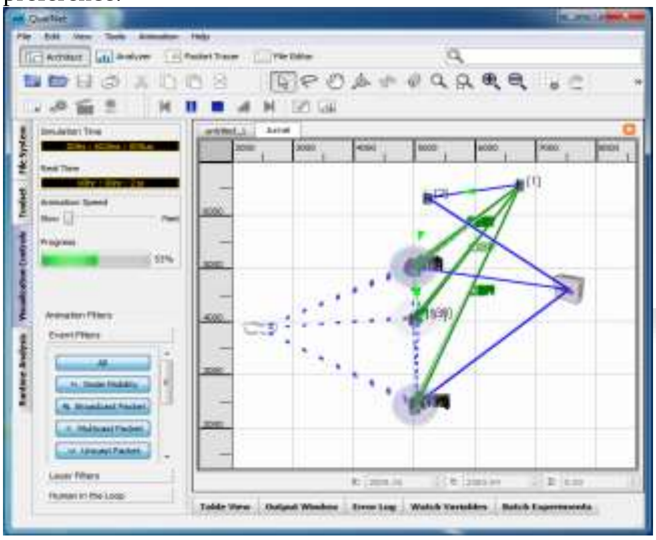

Fig. 3: Snapshot of the scenario for performance analysis of scheduling algorithms.

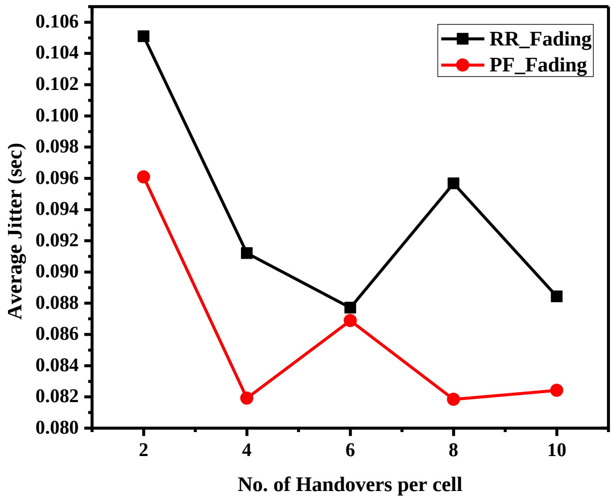

Fig. 4: Performance of Average Jitter for RR and PF scheduling algorithms.

V. CONCLUSION

From the performance analysis it is observed that RR scheduling algorithm performs better than the PF scheduling algorithm for jitter constraint during the handover process. The performance analysis emphasizes that during handover process in LTE system RR scheduling algorithm prevents the degradation of system performance compared to PF scheduling algorithm.

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