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High Mobility Evaluation for Voice & Video over LTE

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***Abstract*—** Due to the exponential clients demand for new services with high Quality (QOS). 3GPP has developed a new cellular standard based packet switching allowing high data rate, 100 Mbps in Downlink and 50 Mbps in Uplink, this standard is termed LTE (Long Term Evolution). Beyond the improvement in bit rate, LTE aims to provide a highly efficient, low latency, spectrum flexibility and higher mobile speed performances. The purpose of this paper is to prove the high mobility performances. The performance evaluation is conducted in terms of system throughput, delay, and Packet Loss Ratio, using different scheduling algorithms implemented at the LTE base station (PF, MLWDF and EXP/PF schedulers).
Finally it will be concluded that higher mobile speed performances are proved with all the 3 scheduling algorithms for best effort flows, while for Video flows the M-LWDF and EXP/PF schedulers who are more preferment , and for VoIP flows it's PF and EXP/PF schedulers who gives high performances.

***Keywords*—** LTE ; VOLTE; Video Over LTE; Scheduling; QoS; mobility

I. INTRODUCTION

For all the operators and for many years, voice calls was the sources of benefit, the mobile data demand was initially slow, but in the years leading up to 2010 and due to the discovery of smart phones, the client demand of new and higher quality of data services is increasing as shown in Figure 1.

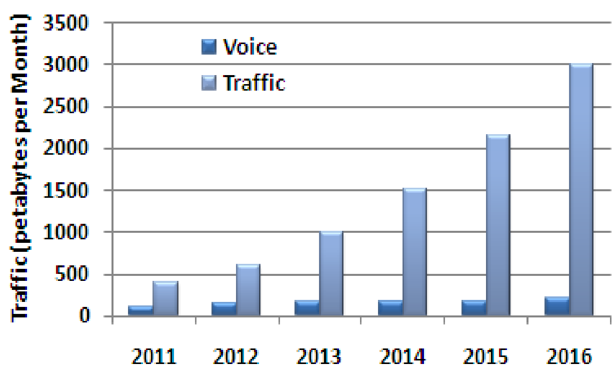

Figure 1. Prevision of voice and data traffic (Petabytes Per Mouth) in worldwide mobile telecommunication networks [1]

The main goal of LTE (Long Term Evolution) Standard is to allow data transfer at very high speed, with greater range, a higher number of calls per cell and lower latency. In theory, it can reach speeds of around 50 Mbps in uplink and 100 Mbps in downlink, sharing between mobile users in a given cell [1]. For operators, LTE involves changing the core network and radio transmitters. They need also to develop appropriate mobile terminals.

In terms of vocabulary, and as explained in Figure 2, the future network is called EPS (Evolved Packet System). It consists of a new access network called LTE (Long Term Evolution) or the E-UTRAN (Evolved Universal Terrestrial Access Network) and a new core network called SAE (System Architecture Evolution) or EPC (Evolved Packet Core) [2].

LTE system conception has focused on data services, that why it supports only the Packet Switched (PS) domain, unlike the UMTS which is capable to support both the Circuit Switched (CS) as well as Packet Switched (PS) core networks, LTE operates in both, Frequency Division Duplexing (FDD) and Time Division Duplexing (TDD) [3].

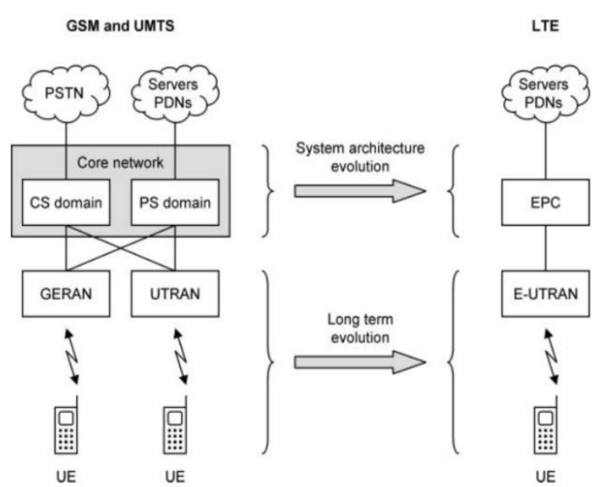

Figure 2. System Architecture Evolution from GSM and UMTS to LTE [1]

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LTE has the flexibility to be used in different bandwidths ranging from 1.4MHz up to 20MHz [4].

The objectives of LTE are to provide a highly efficient, low latency, spectrum flexibility and higher mobile speed performances. The purpose of this paper is to evaluate the performances of the high mobility.

II. LTE NETWORK ARCHITECTURE

The main objective of LTE Network is to increase the capacity and speed of wireless data networks using new strategies and techniques. 3GPP is based on the redesign and simplification of the network architecture to an IP-based system, with significantly reduced transfer latency comparing to the 3G architecture. The LTE Network must be operated on a separate wireless spectrum because its wireless interface is incompatible with 2G and 3G networks [5].

As shown in Figure 3, the overall architecture of LTE Network consists of five consistent elements which are explained as following.

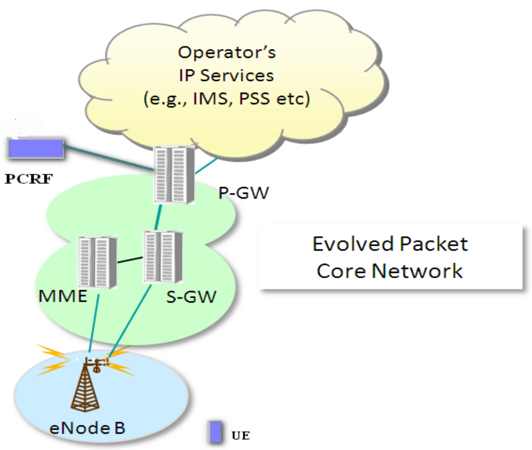

Figure 3. Long Term Evolution System Architecture [6]

- The Evolved UTRAN NODE B (eNodeB)

eNodeB is the evolution of the Node B in UTRA of UMTS. It is the hardware that is connects to mobile phone network that communicates directly with mobile handsets (UEs), like a base transceiver station (BTS) in GSM networks. Traditionally, a Node B has minimum functionality, and is controlled by an RNC (Radio Network Controller). However, with an eNodeB, there is no separate controller element. eNodeB embeds its own control functionality [7], This simplifies the architecture and allows lower response times.

- The Mobility Management Entity (MME)

It' is the control-plane node of the EPC. Its responsibilities include connection/release of bearers to a terminal, handling of IDLE to ACTIVE transitions, and handling of security keys. The functionality operating between the EPC and the terminal is some-times referred as the Non-Access Stratum (NAS), to separate it from the Access Stratum (AS) which handles functionality operating between the terminal and the radio-access network.

- The Serving Gateway (S-GW)

The S-GW is the user-plane node which is connecting the EPC to the LTE Radio Access Network. The S-GW acts as a mobility anchor when terminals move between eNodeBs, as well as a mobility anchor for other 3GPP technologies (GSM/GPRS and HSPA). Collection of information and statistics necessary for charging is also handled by the S-GW.

- The Packet Data Network Gateway (PGW)

The PDN connects the EPC to the internet. Allocation of the IP address for a specific terminal is handled by the P-GW, as well as quality-of-service enforcement according to the policy controlled by the PCRF.

- Policy and Charging Rule Function (PCRF)

PCRF is the policy and charging control element, it is responsible for enforcing various operator policies on the network like guaranteed QoS, maximum bit rate provisioned for a user etc. It communicates with the PDN-gateway in enforcing these policies for various users in the LTE network.

- Home subscriber server (HSS)

It's contains all permanent subscriber data and all relevant temporary subscriber data to support the call control and session management entities of the different Domains and Subsystems.

III. SIMULATION AND PERFORMANCE EVALUATION

LTE-SIM is an Open Source software Simulator, it was designed to make simulations for different scheduling strategies in uplink (UL) and downlink (DL) directions , also it's used for multi-cells/multi-users environments considering the mobility of users, radio resources optimization, frequency reuse, adaptive modulation (AMC) and other significant aspects for industry and scientific community[8].

LTE-SIM allows network simulation according to the scenarios that the user decides, for example in our simulation we consider the case of a Single Cell with Interference, we used an environment with three cells with a radius of 1 Km and in which a set of EU (selected in a range [5-25]) are uniformly in high mobility 120Km/h and are distributed in a cell, the two cells being a source of interference for the first one. EU moves into the cell following MANHATTAN Mobility Model [9]. Each user receives an H.264 Video stream, a VoIP stream, and BE flows modeled by Infinite Buffer.

The purpose of this simulation is to prove the high mobile speed performances in LTE Network, for this we tried to analyze the Performance of PF, M-LWDF and EXP-PF schedulers [10], by the measuring of packet latency (delay), Packet Loss Ratio (PLR), packets throughput and cell spectral efficiency, the simulation parameters are illustrated in the following Table.

Parameters	Value
Simulation duration	120 s
Flows duration	120 s
Frame structure	FDD
Mobile speed	120 Km/h
Radius	1 km
Bandwidth	20 MHz
Slot duration	0.5 s
Scheduling time (TTI duration)	1 ms
Number of Resource Blocks (RBs)	50
Max delay	0.1 s
Video bit-rate	242 kbps
VoIP bit-rate	8.4 kbps
Minimum number of users	5
Maximum number of users	25
Interval between users	5

Table 1. Simulation parameters.

A. *The measurement of packet latency (delay)*

Latency has a most noticeable influence on Network performances. Especially for conversational services, such as VoIP and Video Flows that require low latency [11]. Other services that benefit from low delay are gaming and applications with extensive handshaking, such as e-mail.

It is difficult to substantially improve latency without reducing the transmission time Interval (TTI).

1) *For the Best Effort Flows*

As noticed in Figure 4 the Packet latency is constant and is 1 ms for all the scheduling schemes.

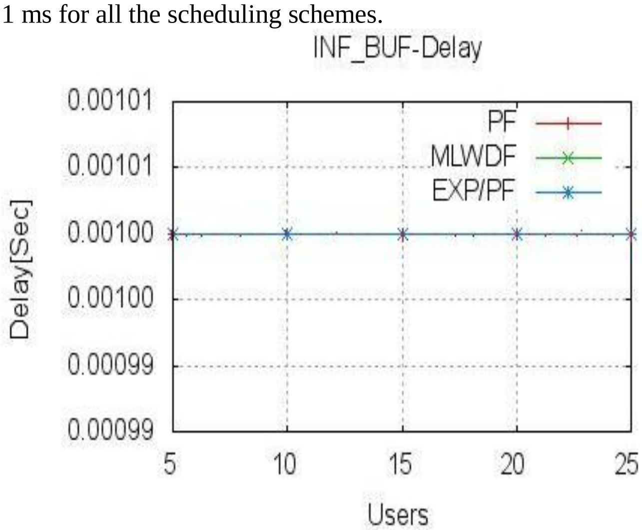

Figure 4. The Delay for Best effort Flows

2) *The VOIP Flows*

The Figure 5 demonstrates that the PF and EXP/PF algorithms give the lowest delay (from 2 ms for 10 UE To 5 ms for 25 UE) ,The Delay at VoIP transmission is higher than at the Best Effort Flows transmission, especially for M_LWDF scheduling algorithm which knows a dramatically evolution by the increase of Users.

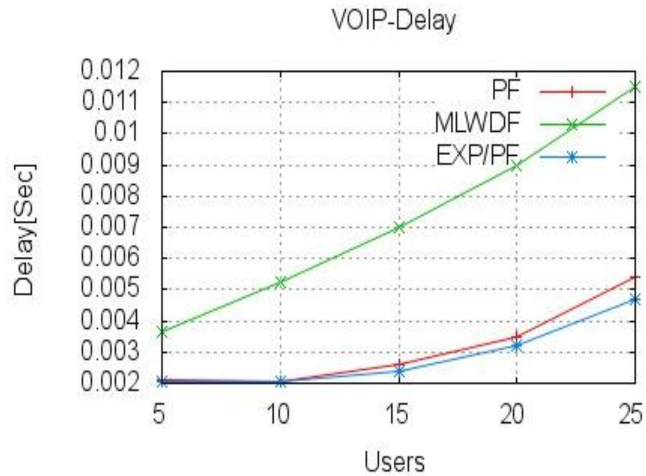

Figure 5. The Delay for VOIP Flows

3) *For Video Flows*

As can be seen in Figure 6, The Video delay for M_LWDF and EXP/PF scheduling algorithms is almost stable and very low even the increase of Users number, which is not true for the PF algorithm who know a dramatically increase starting from a number of 10 users.

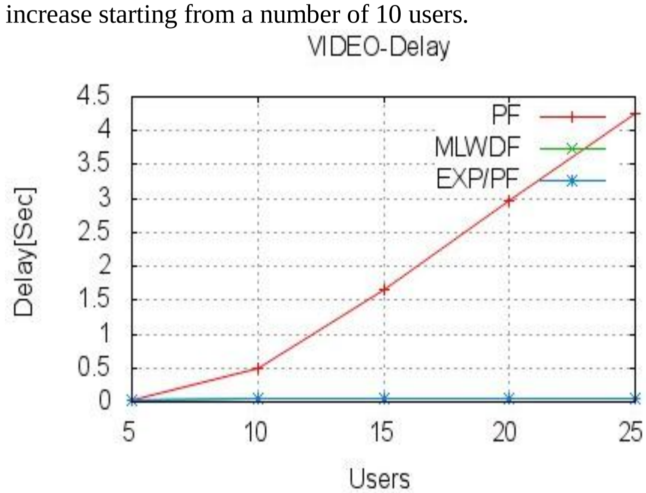

Figure 6. The Delay for Video Flows

B. *The measurement of Packet Loss Ratio(PLR)*

The improvement of PLR estimation is a critical issue, because Packet Loss Ratio has a big effect on the network performances, especially when dealing with real-time traffic such as VOIP and Video Flows [12].

1) *For the Best Effort Flows*

One of the good achievements of LTE Network is that the Packet Los Ration for Best Effort Flows, as shown in Figure 7, is decreasing even the increase of Users.

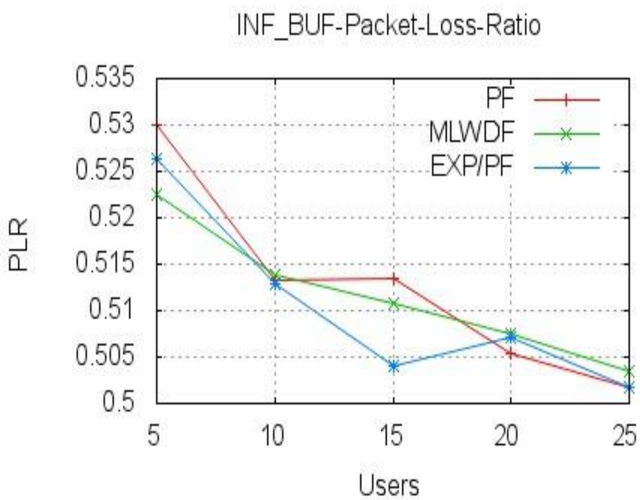

Figure 7. The Packet Loss Ratio (PLR) for BE Flow

2) The VOIP Flows

The Packet Loss Ratio given in Figure 8 show that the PF scheduling algorithm has the lowest Packet Loss Ratio even if it's PLR start to increase from the number of 15 users. In the other hand the EXP/PF scheduler present the same behaviors as PF scheduler except that it has more big value of PLR. For the M-LDWF scheduler it has a very high PLR that start to increase exponentially from a number of 10 users.

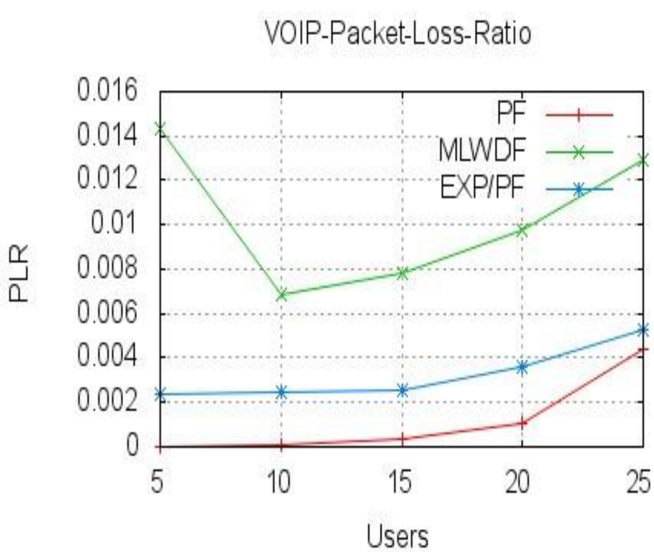

Figure 8. The Packet Loss Ratio (PLR) for VoIP Flow

3) For Video Flows

The packet loss ratio for video flows is given on Figure 9, its noticed that the PLR during video transmission is higher than the PLR during The VoIP transmission, especially for PF scheduling algorithm. The packet Loss Ratio is increased during the video flows by the increase of user's number.

Figure 9. The Packet Loss Ratio (PLR) for Video Flow

C. The measurement of packets throughput

The Packets Throughput measurement is one of the important operation that allow to identify the average rate of successful message delivery over a communication channel [13].

1) For Best Effort Flows

From the Figure 11, we can deduce that as long as the number of users is increasing, the Best Effort throughput decreases, which explain that the network data is reduce with the increase of users.

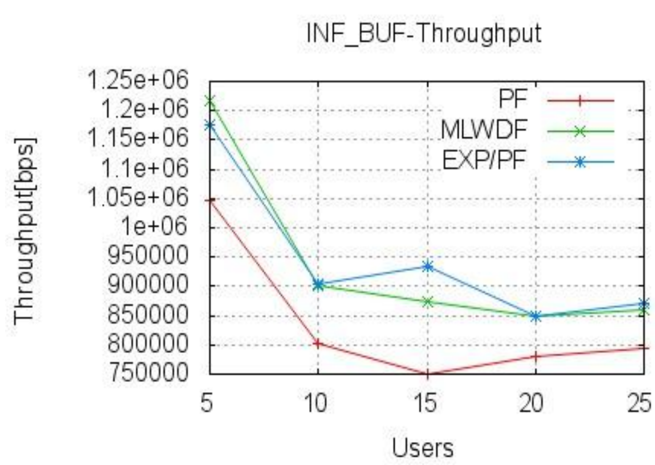

Figure10. The packets throughput for Best Effort Flows

2) For VOIP Flows

The Packet Throughput for VOIP Flows is increasing exponentially as the number of users increase, and it's the same for all the Scheduling algorithms.

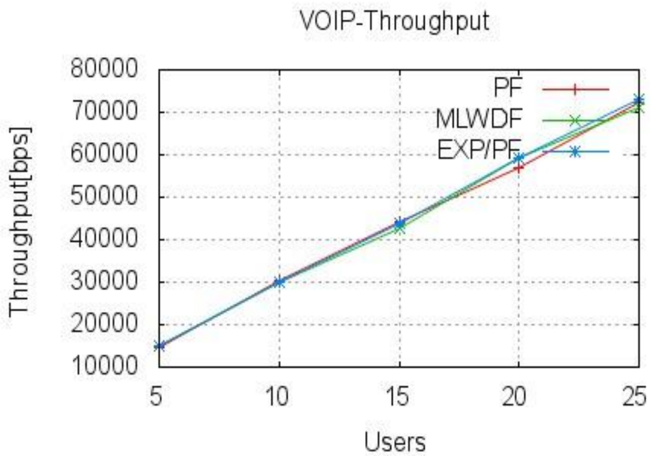

Figure 11. The packets throughput for VOIP Flows.

3) For Video Flows

The Video packet Throughput given in Figure 12 shows that for the M-LDWF and EXP/PF is increasing as Long as the number of users increases. For the PF scheduling algorithm, the Packet Throughput decreased by the increase of users number.

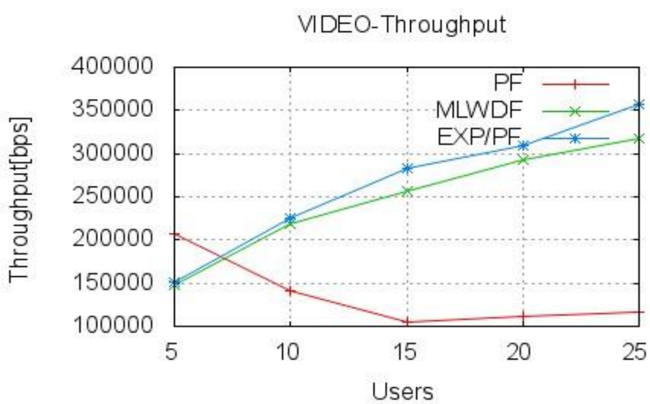

Figure 12. The packets throughput for Video Flows

D. The measurement of cell spectral efficiency

The Spectral efficiency is defined as the maximum user throughput divided by the channel bandwidth. It is the number of correctly received bits normalized by the consumed resource in time and in bandwidth [13]. Thus, spectral efficiency is strongly related to resource consumption and packet error ratio.

As shown in Figure 13, the Cell-spectral-Efficiency for the PF scheduler algorithm is the lowest, however the M-LDWF and EXP/PF Schedulers gets the high Efficiency.

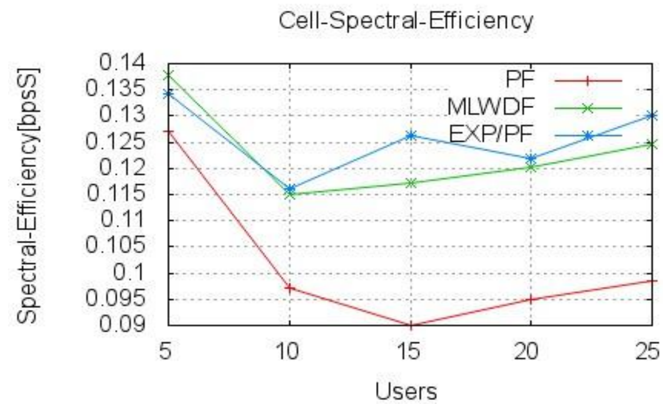

Figure 13. The Cell Spectral-Efficiency

From all the simulated result it can be concluded that the LTE Network is capable to achieve higher mobile speed performances by choosing for each traffic type the suitable scheduling algorithm and by configuring in corresponding Base Station an exact parameters.

III. CONCLUSION

This paper approved the higher mobile speed performances, this result considered different scheduling algorithms that are evaluated by using LTE-SIM network simulator, and finally we find that:

- For best effort flows, all the three algorithms approve the higher mobile speed performances.
- For VoIP flows, The PF and EXP / PF Scheduling algorithms are the most suitable, while M-LWDF is not convenient due to its very high delay and high packet loss ratio.
- For video flows, The M - LWDF and EXP / PF scheduling algorithms show a good performances , but for PF scheduling algorithm and due to it high delay, big packet loss ratio and low throughput, it's didn't give a good result.

LTE aims to provide a higher mobile speed, low latency, highly efficient and spectrum flexibility. It is expected to satisfy the market needs for new services with high QOS, The research demonstrate that to get what LTE aims to offer, a right selection of scheduling strategy at a network base station is required. In future work we will focus on the effects of handover to voice and video quality in Long Term Evolution.

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