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Performance Analysis for Real Time Application Over LTE Network

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Abstract- Packet Scheduling in LTE network is the fundamental task on which the performance of LTE network depends. Scheduling is a process to allocate the resources to users. Radio resource management is used for resource allocation. Many scheduling algorithms have been designed and proposed for scheduling. Scheduling is performed in both direction uplink and downlink. The main aim of this paper is to analyze the performance of downlink scheduling algorithms for real time flow. Three schedulers,i.e, Modified Largest Weight Delay First , Exponential Proportional Fairness, and Proportional Fairness are used for scheduling for real time flow VIDEO and non real time flow VOIP. The performance of schedulers is analyzed in terms of packet loss ratio, throughput and delay parameters. The result shows that performances of PF scheduler are not appropriate for real time application

Keywords: LTE architecture, RRM, PF, M-LWDF, EXP-PF

I. INTRODUCTION

LongTerm Evolution (LTE) is a standard of 3GPP for fourth generation mobile communication, introduced in 2008. The objective behind LTE technology is to develop an environment that provides benefits such as high data rate, minimum delay, and high spectral efficiency for proper communication over growing demand [1-4]. Frequency division scheme is different for uplink and down link Orthogonal frequency division multiple access (OFDMA) is used in the downlink direction. The available bandwidth is divided into subcarrier for satisfying maximum user requirements. Although single carrier frequency division multiple accesses (SC-FDMA) choose in the uplink direction. Because of power conservation at user equipment (UE) side. In this access scheme, a set of a subcarrier is allocated to the single cell users, which is shared between the UEs. LTE allocates resources block in time and frequency domain. A resource block (RB) is small in size and every RB is separated by TTI transmission time interval (TTI). The transmission time interval in Time domain gives as 0.5ms and 0.1ms. OFDMA affords robustness and reliability against multi fading problem, interference and higher efficiency. The range of transmission bandwidth can_be certain between 1.4 MHz and 20 MHz for downlink and uplink [5].

II. LTE SYSTEM MODEL

LTE is IP based flat architecture technology. LTE is extended technology than the previous 3GPP system. In previous 3GPP networks has an extra RAN for radio access network like base station and MSC etc. But LTE system consists mainly two basic components known as core networks called Evolved Packet Core network (EPC) and access network. In the previous cellular network for design a separate radio access network it requires a number of nodes, so node requirement is high. The separate management units like radio link control (RLC), radio resource control (RRC) are maintained in older technology that provides an interface to UEs. Where as in LTE system, the over mentioned protocol function is performed by eNB [2].

The Evolved Universal Telecommunication Radio Access Network (E-UTRAN) is the basic component of the LTE networks that consists only eNodeB. The "evolved packet core" which is made of a core network, it performs the number of functionalities like mobility management unit (MME), the serving gateway (SGW) and the packet data network working as a gateway it is the component of the Evolved Packet Core. Mobility Management Entity is responsible for the management and the establishment of a connection for user mobility, tracking, intra-LTE handover and paging method. The SGW forward user data in between the LTE nodes and also manage handover within the LTE and other previous 3G technology. The PGW provides an interconnection between LTE networks [6]. The EPC works as a gateway between the LTE networks. The LTE network non-radio component as an interface (core network), it permits compatibility with existing standard [3].

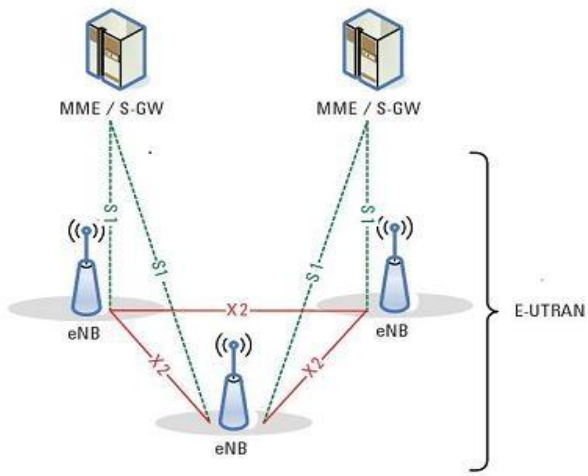

Figure 1. LTE Architecture [5]

MME: Mobility Management Entity

SGW: Service Gateway

E-UTRAN: Evolved Universal Telecommunication Radio Access Network

A. *RADIO RESOURCE MANAGEMENT*

LTE technology focused on how to provide high data rate, low latency, and an improved spectral efficiency. To achieve such goal the radio resource management (RRM) entity that lies on eNB uses advanced MAC and physical functionalities simultaneously. There is a variety of services such as hybrid automatic retransmission request (HARQ), resource sharing functionalities and for secure transmission using channel sensitive scheduling are performed by RRM [6]. The downlink and uplink packet scheduling is performed by RRM at eNodeB and its reasonability to assign portions [2]. RRM is the task of packet scheduler and responsible for the radio resource selection appropriately for users [11]. Radio resource is distributed in LTE system in time and frequency domain. In time domain TTI interval time is less than 1 ms in order to support low latency [12]. Schedulers situated at eNB MAC layer and provide the resource with certain aim like QoS requirement for different application, Fairness among UEs cells, balancing the load among cells and control the impact of interference [13].

III. SCHEDULING

The Radio resources are allocated and shared among user equipment. This task is performed on eNB's enitity RRM. This scheme improves the overall performance of the system by providing a fairness between the UEs. The process of resource allocation moderately between the cell users called scheduling. Scheduling is performed at the base station of LTE system. The LTE has basically three types of scheduling, i.e, Dynamic, persistent, and Non-persistent scheduling. But LTE mostly uses Dynamic scheduling for an effective utilization of the resource. The user equipment calculates channel quality indicator (CQI) report and sends this information to packet scheduler. This information is about physical layer information. The scheduler uses such information and selects best coding and modulation scheme then sent this information to UEs. The UE receives information from scheduler which is sent by using the physical Downlink control channel (PDCCH). (PDCCH) The payload contains information how to use physical Downlink shared channel (PDSCH) [8].

The eNB/base station performs scheduling in both uplink and downlink direction. But here in this paper focused on downlink scheduling. The scheduling performs from eNB to UEs called Downlink scheduling. Such as wired scheduling/channel independent, channel sensitive/QoS-Non-Guaranteed and channel sensitive/QoS-Guaranteed. The channel independent scheduling is based on some assumption like the channel is Error free and time invariant. Channel independent scheduling transmission is error free because it is mostly wired scheme. Wired scheduling is first-in-first-out (FIFO), round robin (RR), weighted fair queuing (WFO), largest weighted delay first (LWDF) etc [2].

The channel Quality indicator (CQI) report is mostly used for periodically updating channel condition in channel sensitive scheduling while channel independent scheduling does not work according to (CQI) report. This CQI value is transfer between UEs and eNB. Channel sensitive scheduling categories in two types of scheduling namely Channel sensitive/QoS-unaware scheduling and channel sensitive/QoS-aware scheduling [6].

Maximum Throughput (MT), Proportional Fair (PF), Throughput to Average (TTA), Modified-Largest Weight delay first (M-LWDF), Exponential Proportional Fairness (EXP/PF), Exponential rule (EXP rule), Logarithmic rule (LOG rule) are Channel Sensitive/ QoS-Guaranteed. Some of them scheduling algorithms are discussed here [2].

B. *CLASSIFICATION OF SCHEDULING ALGORITHMS*

1) *Wired/ Channel Independent strategies*

Channel independent means the scheduler has no pre knowledge about the condition of the channel in term of its quality etc. this strategy used basically, in wired communication. Channel independent scheduling not using COI value. The channel independent scheduling schemes are given in chapter 3 scheduling strategies [7].

2) *Channel Sensitive/Qos-Non-guaranteed strategies*

The channel dependent scheduling as its name indicated the scheduler has knowledge about channel condition, but not consider the fact of the quality of service. Channel sensitive scheme based on Channel quality indicator, which is computed by the user equipment and send to eNB. In periodically manner CQI report is estimated and updated so eNB use such value to estimate the channel condition perceived by each user. So this scheduling scheme is, non-guaranteed QoS. This scheduling is given above chapter 3 [8-7].

3) Channel Sensitive/Qos-Guaranteed strategies

Here the information about channel condition as well as the quality of service guaranteed is considered [8].

Here, in this paper, the main concern will be on channel sensitive/QoS-guaranteed and channel sensitive /QoS Non-guaranteed scheduling algorithms. the scheduling strategies Proportional Fair (PF) is Qos non guaranteed scheduling, exponential-PF, (EXP-PF) and (M-LWDF) Maximum largest weight delay first are Qos guaranteed.

C. *DOWNLINK SCHEDULING ALGORITHM*

1) Exponential Proportional fair

This algorithm Supports both types of service real as well as non-real time. This is a combination of PF and Exponential function. This algorithm stands for Exponential proportional fair algorithm [9]. This is designed to support RT service in an AMC/TDM system [10].

2) Modified-Largest Delay First

This algorithm stands for Modified largest weight delay first. It is modified version of LWDF used in wireless networks. It also works with priority metrics, this algorithm treats real and non-real traffic differently and supports mixed real time data user in the CDMA-HDR system. This algorithm offers a priority to real time services [7]. This scheme supports different real time service with the different quality of service [9].

3) Proportional fairness

This schedule stands for the proportional fair. The PF scheduling algorithm provides a substitution between throughput and fairness. PF schedule is appropriate for non-real time data because it is not delayed sensitive. This schedule is channel sensitive scheduler but Qos unaware schedule. [7-8].

IV. RELATED WORK

Giuseppe Piro et al. [17**]** find out an open source tool known as LTE-SIM (LTE simulator). It provides a complete aspect of designing the LTE network. This tool is used to compare many scheduling algorithms and evaluate the performance of Scheduling algorithms (PF, M-LWDF, EXP-PF). The simulation scenario consists of 19 cells. The numbers of users are homogeneously distributed in the range [10-30] into each cell at speed (3, 120) km/h. The simulation parameter such as packet loss rate (PLR) for video and VOIP traffic show different performance for real time service. The results show PLR is increased in M-LWDF and EXP with an increaseing number of users Whereas PLR decreases in PF. Samia Dardouri et al. [14] presents a study on Downlink Scheduling. Six downlink scheduling algorithm is proposed and their performance is evaluated on different parameters for real and non-real traffic. The simulation result is categorized into two levels: first level concern for real time flow and the second concern for non-real time flow. The result shows that FLS outperforms scheduling. Biswa Paratap singh Sahoo et al. [15][16][17] checking video traffic in the vehicular environment with the three algorithms such as FLS, EXP and LOG rule. The result shows that FLS algorithm is the best approach for video traffic. R. Basukala et al. [18] [19] analyze the performance of EXP/PF and M-LWDF (modified largest wait delay first) on parametes, i.e, system throughput, Packet loss ratio, and fairness for real and non-real time application. The simulation result shows that the minimum load M-LWDF algorithm performs better. When the load is increased EXP/PF performs is better.

V. SIMULATION SCENERIO

In the present scenario, single cell with min 5 UEs to max 30 UEs and interval time of 6 is used. The scenario is implemented with LTE simulator programmed in object oriented programming (OOPS) to provide a higher level of flexibility. The throughput, Packet loss ratio and delay for UEs are captured and measured. The simulator will run every TTI (5 TTI in this experiment). This simulation is carried out for real time application performance in term of packet loss ratio, throughput and delay with different existing schedules namely PF, M-LWDF, and EXP-PF. The simulation started with 5 users in a single cell and up-to 30 users at speed 3km/h. The simulation parameter is depicted in Table 1.

Table 1 Simulation parameter

Simulation Parameters	**Value**
No. of cell	1
Bandwidth	10MHZ
Min-max UEs	5min-30max
Transmission Mode	FDD
Simulation Time	5 TTIs
Scheduler	PF, MLWDF,EXP/PF
Radius of Cell	1.5 km
User Speed	3 km/h
Maximum Delay	0.06
Video Bit Rate	Ps

VI. RESULTS AND DISCUSSION

This section discusses the result and performance of Downlink scheduling algorithms with increasing user in a single cell with speed 3 km/h. The scheduler namely MLWDF, PF, and EXP-PF are proposed for real time flow like Video and VOIP.

A. VIDEO FLOW

Table 2, 3, and 4 presents the packet loss ratio, throughput, and delay of scheduling algorithms for VIDEO. Figure 2, 3, and 4 shows the performance comparison of schedulers over packet loss ratio, throughput, and delay for video flow.

1) Packet Loss ratio for Video

Table 2 Packet Loss Ratio for VIDEO

No of Users	***PF***	***MLWDF***	***EXP-PF***
5	0.03831	0.03267	0.3194
11	0.12709	0.06372	0.06492
17	0.38703	0.11275	0.11956
23	0.55776	0.18105	0.19488
29	0.64430	0.23910	0.26492

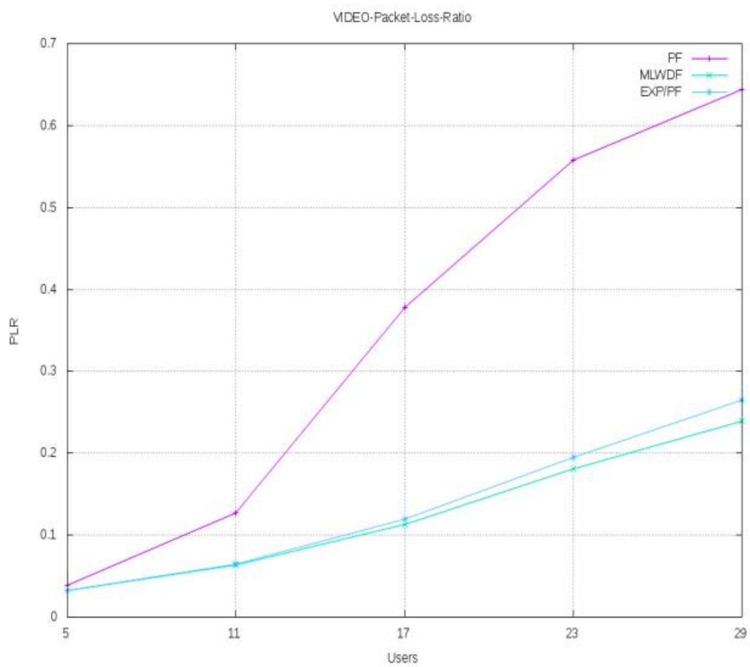

Figure 2. Packet Loss Ratio Performances of schedulers for VIDEO.

2) Throughput for VIDEO

Table 3: Throughput for VIDEO

No of Users	***PF***	***MLWDF***	***EXP-PF***
5	14440.85	14303.21	14962.30
11	32692.21	32532.86	32989.69
17	50336.77	49332.34	50499.08
23	67847.14	70337.49	6969.16
29	83157.25	84634.29	86127.61

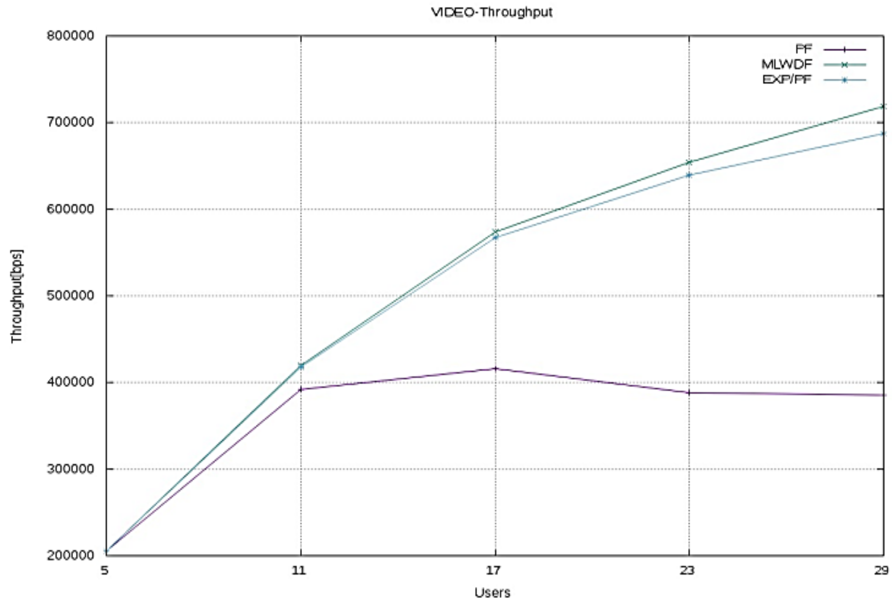

Figure 3. Throughput Performances of schedulers for VIDEO

3) Delay for VIDEO flow

Table 4: Delay for VIDEO

No of Users	***PF***	***MLWDF***	***EXP-PF***
5	0.00748	0.00942	0.0065
11	0.001121	0.01166	0.0089
17	0.02734	0.01458	0.0117
23	0.8892	0.01741	0.0144
29	0.16930	0.01920	0.162

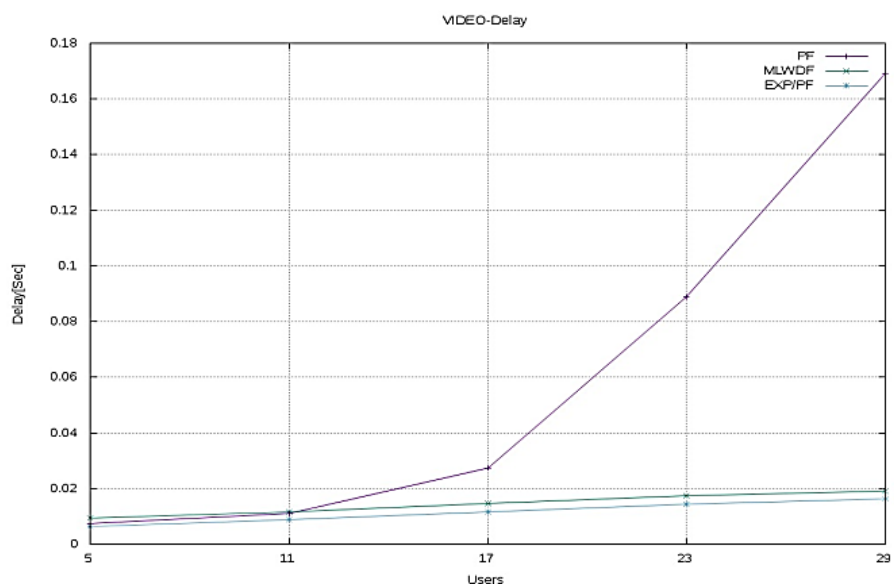

Figure 4: Delay Performances of schedulers for VIDEO

It is shown from the figure 2 that the performance PF schedule is not appropriate for real time flow; its packet loss is higher than rest of the schedulers. M-LWDF packet loss ratio is comparable EXP-PF scheduler' packet loss ratio. Figure 4 shows that Video delay result is constant for MLWDF and EXP-PF for all users in the cell, Whereas PF schedule shows maximum delay.

B. VOIP FLOW

The VOIP stands for voice over IP. It is non real time flow application. The Result for packet loss ratio for different schedulers is presented in Table 5. Table 6 shows the throughput results of scheduling algorithm of VOIP flow and Table 6 shows the delay produced by scheduling algorithms for VOIP. Figure 4, 5, and 6 shows the performance comparison of schedulers over packet loss ratio, throughput, and delay for VOIP flow.

1) Packet Loss Ratio for VOIP

Table 5 Packet Loss Ratio for VOIP

No of Users	*PF*	*MLWDF*	*EXP-PF*
5	0.00184	0.00734	0.00399
11	0.00140	0.00419	0.00466
17	0.00197	0.00272	0.00471
23	0.00232	0.00516	0.00738
29	0.00399	0.00573	0.00598

It has shown that the performance of scheduling algorithms for VOIP is all most different with the different number of users in a single cell. The highest packet loss is in EXP-PF scheduler. M-LWDF scheduler shows average VOIP packet loss to 17 users. With increaseing number of users, VOIP packet loss also increases. MLWDF has less packet loss ratio at 5 to 17 users. VOIP packet loss ratio is higher when scheduled a packet with EXP-PF.

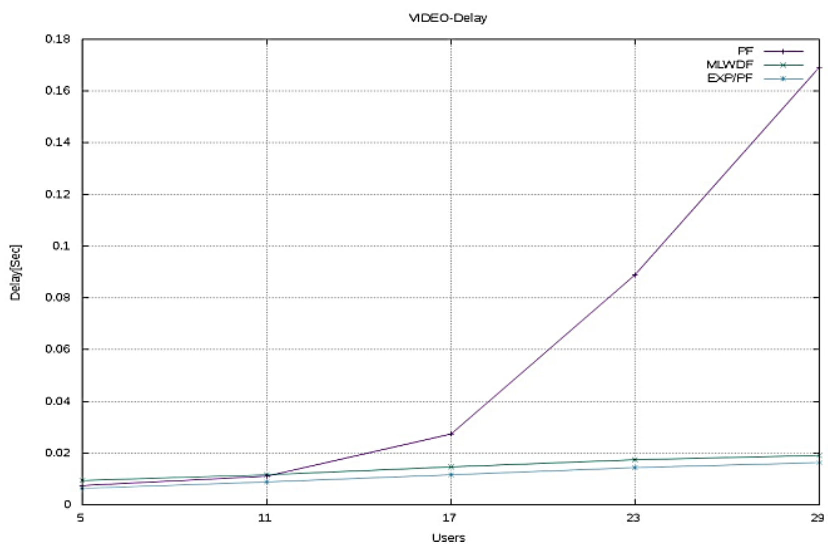

Figure 5. Packet Loss performances of Schedulers for VOIP

2) THROUGHPUT for VOIP

Table 6: Throughput VOIP

No of Users	*PF*	*MLWDF*	*EXP-PF*
5	205437.78	205644.16	205372.49
11	392065.69	419243.69	418263.48
17	415771.01	573970.00	567210.12
23	388313.09	654486.94	639326.77
29	385195.34	718509.76	687668.06

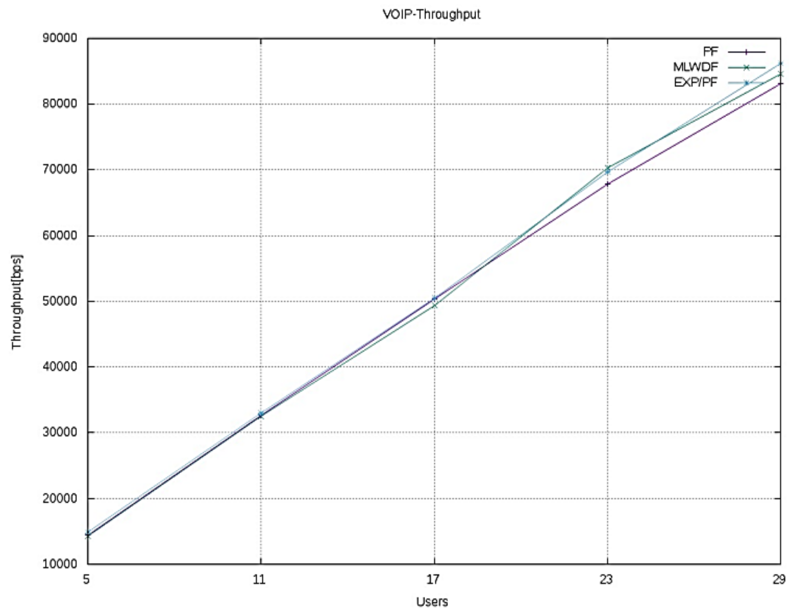

Figure 6. Throughput Performances of Schedulers for VOIP

It has shown from figure 5 that all schedulers provide almost the same throughput for VOIP flow. There exists a little bit difference in their throughput.

3) VOIP DELAY

Table 7: Delay of VOIP

No of Users	***PF***	***MLWDF***	***EXP-PF***
5	0.00289	0.00175	0.00161
11	0.00259	0.00178	0.00163
17	0.00241	0.00204	0.00165
23	0.00257	0.00251	0.00174
29	0.00278	0.00305	0.00182

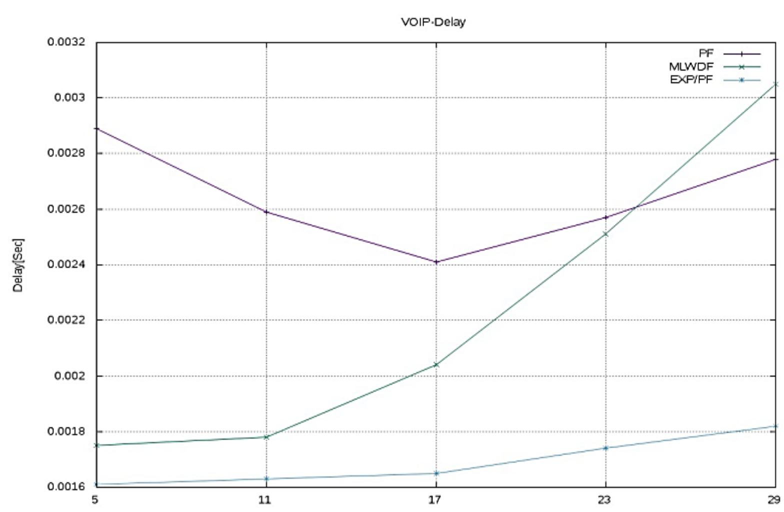

Figure 7. Delay Performances of Schedulers for VOIP

It has shown from figure 6 that the PF scheduler shows an increment in VOIP delay after 17 users.

It has been analyzed that packet loss ratio of PF scheduler is higher than rest of scheduler for VIDEO flow. EXP-PF scheduler provides highest packet loss ratio in VOIP flow. MLWDF scheduler provides less packet loss ratio in VOIP flow.

VI. CONCULSION

In this paper the performance of three Downlink scheduling algorithm EXP-PF, PF and M-LWDF is analyzed and compared using LTE simulator. The performance is analyzed in term of packet loss, delay and throughput for real time flow (VIDEO) and non real time flow (VOIP). It is analyzed that the performance of PF scheduler for Video flow is poor, whereas, in the case of VOIP (non real time flow) PF has less packet loss ratio as compared to other schedulers It can be concluded that PF is appropriate schedulers to apply in non real time flow whereas M-LWDF and EXP-PF is appropriate for real time flows.

REFERNECE

[1] Monika and Deepak Nandal, "*Downlink Packet Scheduling Over LTE Network: A Revie*w," International Journal for Research in Applied Science & Engineering Technology, Vol. 5, Issue VI, pp 2293-2297, June 2017.

[2] A. Dagar, Archana, and D. Nandal, "*High performance Computing Algorithm Applied in Floyd Steinberg Dithering*," International Journal of Computer Applications., vol. 43, pp. 11–13, Apr. 2012.

[3] Ambreen Ahmad M. T. Beg and S.N. Ahmad, "*Resource Allocation Algorithm in LTE: A Comparative Analysis*," IEEE. 2015.

[4] Vallari Sharma, P.K. Sharma, "*A survey On LTE Downlink Packet Scheduling*," International Journal Of Advanced Research in Computer and Communication Engineering. Vol. Issue 9, pp.7896-7899, Sep. 2014.

[5] AymanHajjawi, Mahamod Ismail, and Tito Yuwono, *"Implementation of Three Scheduling Algorithm in Smart Grid Communication Over 4G Networks*," International Conference on Space Science and Communication (Icon space), Langkawi, Malaysia, 10-12 Aug. 2015.

[6] F. Capozzi, G. Piro, L. A. Grieco, G. Boggia, and p. Boggia, "*Downlink Packet Scheduling in LTE Cellular Networks: Key Design Issues and a Survey*," IEEE. Communication Surveys & Tutorials, Vol. 15, no. 2, Second Quarter 2013.

[7] Sindura Sara Palli, *"A Thesis on LTE Downlink Scheduling Algorithm*," published by Proquest.

[8] Pardeep Kumar, Sanjeev Kumar and ChetnaDabas, "*Comparative Analysis of Downlink Scheduling Algorithm for a Cell Affected by Interference in LTE Network,"* Springer, DOI.No. 10 1007/ s4075-016-076-x, 13- April 2013.

[9] Pardeep Kumar and Sanjeev Kumar, "*Performance analysis of Downlink Packet scheduling algorithm in LTE networks*," Springer Science + Business Media Singapore 2016.

[10] P. Charanya, A. Pavithra, "*Content Caching and Multicasting of 5G Hetrogeneous Cellular Wireless Networks*", International Journal of Computer Sciences and Engineering, Vol.5, Issue.7, pp.61-66, 2017.

[11] Le Thanh Tuan, DaesungYoo, Hyungjoo Kim, GwangjuJin, Byungtae Jang, and Soong Hwan Ro, "*The Modified Proportional Fair Packet Scheduling Algorithm for Multimedia Traffic in LTE System,"* Springer-Verlag Berlin Heidelberg 2012.

[12] Davinder Singh and Preeti Singh, "*Radio Resource Scheduling in 3GPP LTE: A Review*," International Journal of Engineering Trends and Technology (IJETT) – Volume 4, Issue 6, pp-2405-2411, June 2013

[13] P. Sengar, N. Bhardwaj, "*A Survey on Security and Various Attacks in Wireless Sensor Network*", International Journal of Computer Sciences and Engineering, Vol.5, Issue.4, pp.78-84, 2017.

[14] SamiaDardouri, RidhaBouallegue, "*Comparative Study of Downlink Packet Scheduling for LTE Networks*," Springer Science + Business Media, New York, 21 Jan. 2015.

[15] BiswasParatapsinghSahoo, "*Performance Comparison of Packet Scheduling Algorithm for Video Traffic in LTE Cellular Networks*," International Journal of Mobile Networks Communication & Telematics," Vol. 3, No. 3, pp.9-17,June 2013

[16] V. Nandal and D. Nandal, "*Maximizing Lifetime of Cluster-based WSN through Energy-Efficient Clustering Method*," International Journal of Computer Science & Management Studies, vol. 12, no. 3,pp 101-105, Sep. 2012.

[17] P. Yadav and D. Nandal, "*Proposing new Equalizer of better performance than previous ones for MIMOOFDM Systems*," IJLTET, vol. 7, no. 3, pp. 524–530,September 2016

[18] V. Nandal and D. Nandal, "*Energy Efficient, Multi-hop Routing scheme, within Network Aggregation for WSN*," International Journal of Computer Science & Management Studies, vol. 12, pp. 201–207, Jun. 2012.

[19] Giuseppe Piro, Luigi Alfredo Grieco, GennaroBoggia, Francesco Capozzi and PietroCamarda, "*Simulating LTE Cellular System: An Open Source Framework,*" IEEE Trns. Vehicular Technology, Oct. 2010.

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