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Performance Analysis of A Novel Scheduling Algorithm for Different Traffics in LTE Networks

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***Abstract*-As the demand for Packet based mobile broadband system is increasing day by day .So, to meet the needs of future mobile communication requirements, 3GPP (3rd Generation Partnership Project) has standardized a new technology which is the next step of current 3G mobile network i.e. LTE(Long Term Evolution) The main objective of LTE is to achieve high data rate, low latency radio access technology and to serve the challenges arising from the growing demand of network services like VoIP, video streaming, web browsing with constraints on delays and bandwidth requirements. LTE is an emerging and promising technology for the improvement in the performance which is achieved through streamlining the system for packet services as long term evolution is an all Internet protocol based network. Traffic scheduling plays an important role in LTE technology by assigning the shared resources among users in the most efficient manner. This paper presents there is a scheduling mechanism which is studied and its performance is analyzed for the different traffic flows like video, voice and text traffic with fixed user equipments and number of packets in queue in terms of the different parameter metrics such as the Average Goodput, Average Delay time, Invalid Packet rate, Packet loss ratio and Spectral efficiency.**

Keywords:Long term evolution (LTE), Channel Quality Indicator (CQI), User Equipment UE), Quality of Service (QoS).

I. INTRODUCTION

As LTE is all IP network technology, the requirements like high speed data rate, low latency, increased spectral efficiency, scalable bandwidth etc. can be fulfilled by selecting several key technologies for LTE radio interface. Of which, the most important technologies are multiple access through SCFDMA (Single Carrier Frequency Division Multiple Access) in uplink, OFDMA (Orthogonal Frequency Division Multiple Access) in downlink and multiple antenna technology. For high flexibility of LTE, variable bandwidth feature is included which gives freedom to network operator to use bandwidth between 1.4MHz and 20MHz. The 20MHz bandwidth can provide up to

150Mbps downlink user data rate with 2X2 MIMO and 300 Mbps with 4x4 MIMO. The most important feature introduced by LTE specifications is enhanced Quality of Service (QoS) support by means of new RRM technique [1]. An extension in the system capacity and improvement in the performance as compared to the high speed packet access is expected from LTE. The objective of LTE was to develop a framework for the evolution of the 3GPP radio-access technology towards a high-data-rate, spectral efficiency, low value of latency and packet optimized radio-access technology. The need for this system is to have data rates of high speed, low latency, increased spectral efficiency, scalable bandwidths, flat all-IP network architecture etc [4]. The main objective of the LTE network is to increase the data-rate to fulfill the demand of services. The Radio resources are divided and shared efficiently among different active users while maintaining a satisfied level of QoS to all active users. To fulfill the requirements, the LTE system uses orthogonal frequency division multiple access (OFDMA) technology in the downlink. In this, a single multiplexer is used and the data is divided into its different sub-carriers. The Filter banks are replaced by Inverse Fast Fourier Transform in case of higher number of sub carriers. In LTE, for both FDD and TDD modes, the downlink modulation technique used is OFDM [1] SC-FDMA (Single Carrier Frequency Division Multiple Access) in uplink in which different users are provided with different non overlapping sub-carriers and multi-antenna technology [3]. The Key characteristics of LTE are Resource allocation in the frequency domain takes place with the resolution of 180MHz resource blocks both in uplink and in downlink [2]. The scheduling mechanism, implemented in the evolved base station (eNodeB) and distributing radio resources among users according to the channel quality indication it get from the user equipment according to the channel condition

II. LTE ARCHITECTURE

The LTE architecture is given in Fig 1 in which there are two layers Evolved Packet Core and Evolved UTRAN. The EPC consists of MME (Mobility Management Entity) and different gateways for the communication with the outside world and E-UTRAN consists of evolved base stations (eNBs).The main feature of LTE systems is Multi user scheduling because it is responsible for allocating different resources to different active users in order to satisfy the QoS needs. The Packet Scheduler are deployed at the eNodeB (for both uplink and downlink).A Physical Resource Block (PRBs) consists of 7symbols x 12 subcarriers. With QoS, different applications meet different requirements. Different scheduling strategies are used for the services like Proportional Fair, Round Robin, Modified Largest Weighted Delay First, Exponential-Proportional Fair, Logarithmic Rule etc. and all these algorithms comes under different categories of LTE scheduling strategies.

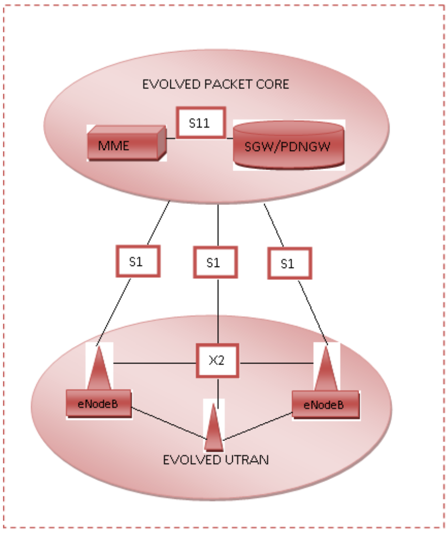

Fig 1.LTE Architecture

They are classified as- Channel unaware, Channel aware/ QoS unaware, Channel aware/QoS aware and Semi Persistent scheduling for VoIP support. The most important objective of LTE scheduling is to fulfill the requirements of Quality of Service. A key feature of LTE is the inclusion of advanced Radio Resource Management (RRM) procedures in order to increase the performance of the system up to the Shannon limit. Packet scheduling mechanisms plays an important role, because they are responsible for selecting, with fine time and frequency resolutions, distribution of radio resources among different stations, considering the channel condition and QoS requirements. This goal should be accomplished by providing an optimal trade-off between spectral efficiency and fairness. The downlink channel under frequency division duplex configuration is considered as an object of our study, but they are valid for other configurations also. A survey was also provided for complementing the above concepts on recent technique. Thus, this survey would be useful for the readers interested in learning the basic concepts. Performance comparison of the already available scheduling schemes with focus on QoS is done.

III. Packet Scheduling

Multi-user scheduling is one of the main features in LTE systems because it is in charge of distribution of available resources among active users to satisfy their QoS needs. Packet schedulers (for both the downlink and the uplink) are deployed at the eNodeB, and OFDMA provides no inter-channel interference. They work with one TTI and one Resource Block in the time and frequency domain respectively. The LTE may operate as a pure packet switching system and all the traffic including delay sensitive services need to be scheduled. Therefore, the scheduling mechanism implemented in the network base station (BS) and distribution of radio resources among users should be considered as a significant part of the system design. The purpose of Packet Scheduling is to distribute the resources among users in a fair and efficient way to maximize the system throughput along with. The scheduler is basically very important part of the LTE system as it is very beneficial for determining the performance of the system.

Fig 2 represents that the main Radio Resource Management modules that interact with the downlink packet scheduler. The process of packet scheduling is divided into number of sequences per TTI:

(a) Each UE decodes the reference signals, computes the Channel quality indicator, and sends it back to the eNodeB.
(b) The eNodeB uses the CQI information for the allocation decisions and fills up a RB “allocation mask”.
(c) The AMC module selects the best MCS that should be used for the data transmission by scheduled users.

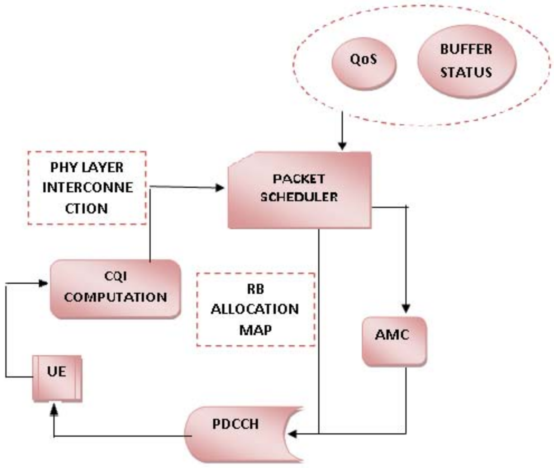

Fig 2.Packet Scheduler

(d) The information about these users, the allocated RBs, and the selected MCS are sent to the UEs on the PDCCH.
(e) Each UE reads the PDCCH payload and, in case it has been scheduled, accesses to the proper PDSCH payload

IV. Scheduling Mechanism

In this scheduling mechanism, the results are analyzed for the video traffic only and for fixed number of packets in queue of user equipments i.e. 120. For achieving QoS requirements of LTE netwoks, the most important parameters are many QoS parameters i.e. time delays, error rates and goodputs. There are basically three phases for designing PPM and in this the first phase works in frequency domain and rest of the two phases work in time domain.

1. Initial Scheduling for Physical Resource Blocks (PRBs).

2. Managing queues and predication of packets for delays.
3. Cut in process.

a. Initial Scheduling for PRBs

First consider the frequency domain. In this phase, focus is on the system performance. PRBs are allocated to users with best CQI's. In each TTI, the CQI values of different users are compared. The design goal of the first phase is to have good throughputs.

b. Managing Queues and predication of packets for delays

In the second phase the performance of those users are considered whose CQI values are not good. Those users may be located at the cell edges relative to base station. Their packets are not transmitted to the destination on time. There will be out of date packets present which are discarded at the destinations if we only consider the throughputs

c. Cut in process

For attaining maximum throughput, the resource block y is allocated to user x but in case, when there is no cut in process. From all the available users, a cut in user z is chosen such that,

$$C_{z,y} = \min\,(ET_{x,y} - ET_{z,y})$$

Of all the available users let that cut in user z will generate minimum decrease in the value of throughput for the utilization of resource block y. This process is repeated until all the resource blocks are allocated to the users properly or all the cut in users are properly handled. If, initially all the cut in users are handled then the users with highest throughput are allocated with the remaining of the resource blocks. If, in the second case all resource blocks are allocated then this indicates that there is need for more resource blocks for the cut in users

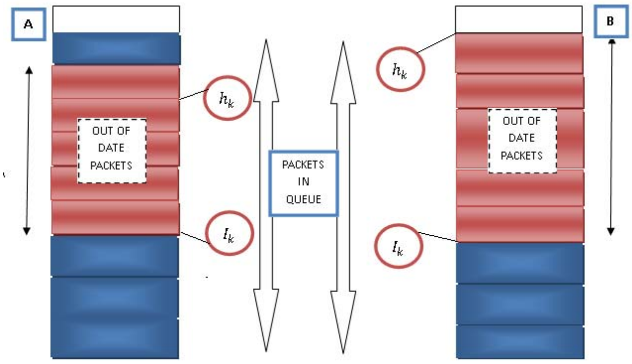

Fig 3 Scenario of Continuous out of date packets

V. Results And Discussion

Fig 4(a) shows the average cell goodput for video, voice and text flows with fixed user equipments and the average cell goodput for the video flow is maximum while for the text flow is minimum.

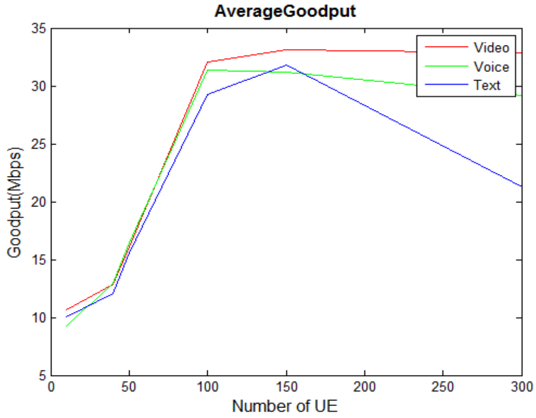

Fig 4(a) Average Cell Goodput

Fig 4(b) shows the Average Delay time for the three different flows and it shows that the delay time in text traffic is very high as compared to other two traffic flows.

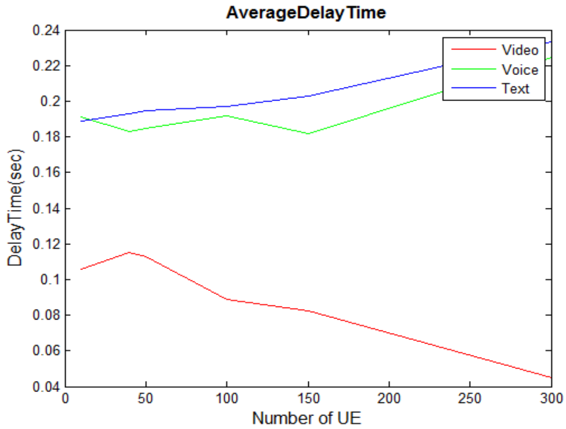

Fig 4(b) Average Delay Time

Fig 4(c) shows the invalid packet rate for the different traffics and the video traffic is having minimum invalid packet rate while it is maximum for text traffic.

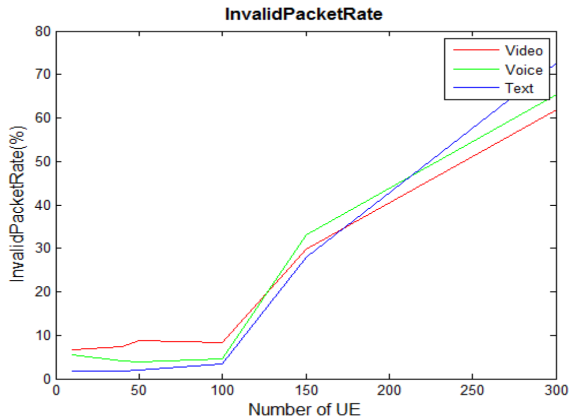

Fig 4(c) Invalid Packet Rate

Fig 4(d) shows the packet loss ratio and its very is high in case of text traffic and minimum value in case of video traffic as more number of packets are transmitted in this case. Fig 4(e) shows the spectral efficiency, video traffic is having highest spectral efficiency among all the three traffic flows.

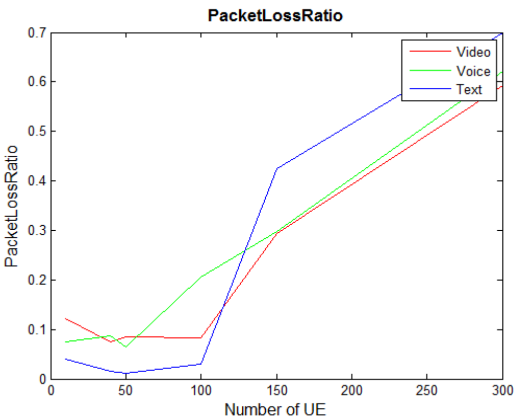

Fig 4(d) Packet Loss Ratio

VI. Conclusion

In this paper, a scheduling mechanism is studied for downlink video traffic for different flows like video, voice and text traffics with fixed user equipments in terms of Average goodput, Average Delay time, Invalid Packet rate, Spectral Efficiency and Packet loss ratio. Future research will focus on more challenging problems of scheduling, considering both the uplink and downlink directions.

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