An Innovative Approach of through put-Oriented Scheduling Algorithm in LTE Cellular Systems
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ABSTRACT
The LTE standard is the most important standard in the wireless broadband market. The Broadcasting Resource Management at the base station plays a chief role in sustaining users demand for high data rates and quality of service. A vital feature of Long Term Evolution (LTE) system is the acceptance of advanced Radio Resource Management techniques in order to raise the system performance. In this method, Packet scheduling algorithm plays an essential role. Since, they have the complete authority of choosing how to allocate radio resources between different stations. In this paper, an improved Proportional Fair (PF) scheduling algorithm is suggested for capability improvement for LTE system and compared with the PF downlink scheduler, which is categorized by high quality performance but with low spectral efficiency. Simulation results show that the proposed system improves the overall system capacity and also offers highly definite in the distribution of the resources. The proposed system also enhances the throughput, overall efficiency and decreases the delay as compared with the previous algorithms.

Keywords: Long Term Evolution (LTE), Packet scheduling algorithm, radio resource management, Proportional Fair (PF).

1. INTRODUCTION
In recent times, the growth of mobile data usage and presence of new application like mobile TV and other courser substances forced the 3rd Generation Partnerships Project (3GPP) to progress the Long-Term Evolution (LTE). Long term evolution is a modern radio access technology intended by the 3GPP in order to afford a smooth journey towards fourth generation (4G) wireless systems. In the 3GPP LTE radio network architecture, there is only one node between the user and the core network known as Node B which is used to operate all radio resource management (RRM) functions. Due to the all-IP based architecture, the air interface needs to provide somewhere to stay a combination of real and non-real time services. This means that all traffic containing delay sensitive services needs to be scheduled. The main determination of the scheduling system in the Base Station (BS) is to select and assign the available frequency time wealth to specific single user equipment (UE). The scheduling which is accomplished at the MAC (Medium Access Control) layer is not consistent and it is an application specific mechanism. The complete system performance and reusability of possessions are generally inclined by the scheduling algorithm. The strategy of a downlink scheduling algorithm is a difficult procedure and offerings a number of design challenges, such as intensification of system capacity and spectral efficiency, bit error performances, fairness method, etc. Packet scheduling is function of the RRM. For the reason that of its smart selections of users and communication of their packets, the radio resources are utilized efficiently and quality of service is also sustained. Packet scheduling for wireless communications has been an active exploration area in recent years, because there has been promptly growing difficulties on data services with the probable to detonate progress of traffic such as Internet, E-mail, multimedia. To sustain these packet data services, the fright and limited wireless resource must be used in finest way to raise capacity and security QoS. On condition that priority or fairness is also an open concern in wireless system. Nevertheless, it is not simple to encounter all of these requirements.

Packet scheduling is a problem of optimization technique where the scheduling function can be created such as to describe the way the objects of optimization are stretched. In agreement with the method the optimization is
attained, a simple classification of this purpose can be made: rate-adaptive, delay-adaptive and value based schemes. The rate-adaptive process can be instantaneous, proportional-fair and rate-adaptive with a boundary. The instantaneous algorithm exploits multiuser diversity by allocating the subcarriers to those users that practice the best channel circumstances. This algorithm inclines to make best use of the overall system capability but miscarries to confirm fairness or any QoS guarantee. Moreover, this algorithm does not recover cell edge presentation and it can lead to starvation for users that have bad channel conditions. The proportional fair algorithm delivers fairness among users such that the lowest data rate prescribed on each user is exploited. These algorithms have a habit of accomplishing determined capacity with a limitation of data rate fairness to all users. The rate adaptive with a border line more over deliberates QoS requirements such that it is likely to assure a minimum data rate to each user. The delay based algorithms have a tendency to enhance the whole system delay below definite constraints. The delay based function can be immediate function where users that would practice a minimum delay are highlighted. It can also be proportional where the extreme delay prescribed on each user is minimized. The rate adaptive and delay adaptive algorithms can be deliberated in arrangement. Furthermore, the independent function can include a definite grade for cell edge performance, and/or cell load balancing. The algorithms are associated under changed standards, such as the exploitation of multi-user diversity property, fairness and delay necessities for real-time traffic. In the proportional fair algorithm is improved such that a prioritization factor is considered based on the delay requests for each service.

2. LITERATURE SURVEY

Chadchan&Akki (2013) proposed a method for multi-user scheduling that operates on the boundary of the achievable multiuser rate region while guaranteeing a desired long term average fairness. Another scheduling algorithm based on the utility function has been implemented in order to improve the performance of the LTE system, particularly, improving the throughput and fairness performance. The throughput fairness between users can be effectively controlled by dividing the packet scheduler into a time domain and a frequency domain and utilizing different algorithms in both domains.

Li et al. (2010) proposed a Generalized Proportional Fair (GPF) scheduling approach and its application to OFDMA with frequency scheduling has been presented and compared to a system without frequency scheduling, this increases the system throughput and yields an improved fairness with respect to the allocated resources and the achieved data-rate per user. Xie&Hui (2011) proposed an adaptive proportional fair scheduling algorithm for LTE system has been proposed in which provides a good trade-off between capacity and fairness, by adjusting the scheduling priority according to individual user’s channel condition.

Kawser et al. (2012), Parruca et al. (2013), Girici et al. (2010), Sun et al. (2006) were proposed the scheme of a typical way to find a trade-off between requirements on fairness and spectral efficiency is the use of PF scheme. In this paper, we try to improve the performance of the LTE system by improving the throughput and fairness performance of the well-known PF scheduling algorithm; then the performance of the proposed algorithm is compared to other algorithms in the literature; followed by evaluation on the performance of the proposed algorithm via simulations and the conclusion is made that the proposed algorithm is very efficient in terms of both throughput and fairness.

Losif&Bănică (2011) proposed a Downlink control signalling is carried by three physical channels and the most important from a scheduling perspective is the Physical Downlink Control Channel (PDCCH), which carries assignments for downlink resources and uplink grants, including the used MCS as shown in Fig. 1. Considering that each modulation scheme corresponds to a fixed physical data rate, the link adaptation module establishes the maximum available physical data rate for each UE (based on the received channel quality information) to provide an optimal resource allocation among all users.

3. OVERVIEW OF LTE SYSTEM

In order to support wide range of applications, LTE network is intended with
challenging requirements that surpass the features of 3G networks chiefly planned for voice services. LTE network affords spectrum flexibility where the transmission bandwidth can be designated between 1.4 MHz and 20 MHz dependent on the available spectrum. The peak data rate, which is the significant parameter by which different technologies are typically associated, commonly depends on the amount of spectrum used. The endorsed peak data rate for the DL and UL is equal to 100 Mbps and 50 Mbps correspondingly. LTE objectives to provide spectral efficiency two to four times better than 3G systems (15 bps/Hz in DL and 3.75 bps/Hz in UL). LTE is flat; Internet Protocol (IP) based architecture with respect to the previous 3G systems. In earlier system, separate Radio Access Network (RAN) that consists of Radio Resource Control (RRC), Radio Link Control (RLC) and Medium Access Control (MAC) protocols is used to interface with User Equipment (UE). But in LTE, takes care of the above mentioned protocol functions. So it requires lesser number of nodes that reduces the system latency and improves overall performance [4]. The network architecture of LTE consists of core network called Evolved Packet Core (EPC) and access network called Evolved Universal Terrestrial Radio Access Network (E-UTRAN).

Fig.1: LTE network architecture

4. SCHEDULING IN LTE SYSTEM

The process of scheduling in LTE system is a comprehensive technique and it needs several attributes. At the eNB, the packet scheduler dispenses radio resources among active users with the purpose of fulfill their Quality of Service (QoS) requirements. Scheduling decisions are rigorously connected to the channel quality practiced by UEs. In specific, the UE occasionally processes this channel quality using reference symbols; then it leads the CQI feedback to the eNB, with an uplink control message. The material about the quality of the time and frequency variant channel is exploited by the link adaptation module to choose, for each UE, the most suitable Modulation and Coding Scheme (MCS) at the physical level with the independent of the spectral efficiency maximization. This method is known as Adaptive Modulation and Coding (AMC) and it has been accepted by numerous wireless technologies, such as Enhanced Data for GSM Evolution (EDGE). Downlink control signalling is agreed by three physical channels and the most significant from a scheduling perspective is the Physical Downlink Control Channel (PDCCH), which carries responsibilities for downlink resources and uplink allowances, containing the used MCS. Taking into account that each modulation scheme resembles to a fixed physical data rate, the link adaptation module launches the maximum accessible physical data rate for each UE to afford an optimal resource allocation among all users.
A practical scheduler must be accomplished of exploiting the overall system capacity while still sustaining some degree of fairness among the users. The proposed scheduling algorithm inclines to allocate the resources fairly among different users, consequently allowing fairness while at the same time frustrating to maximize system capacity performances within the cell.

5. PROPOSED SYSTEM

5.1 Different Scheduling Methods in LTE

There are different scheduling methods proposed by different researchers in order to improve the efficiency and throughput of the LTE downlink system. They are explained as follows:

1. Round Robin (RR): The scheduler is responsible of providing the resources intermittently to the users without bearing in mind channel conditions into account. It’s a humble process providing the best fairness. But it would suggest depriving the users in terms of cell throughput. It encouters the fairness by providing an equal share of packet transmission time to each user. In Round Robin (RR) scheduling the terminals are allotted the resource blocks in chance without considering CQI. Thus the terminals are equally scheduled. Nevertheless, throughput performance damages considerably as the algorithm does not rely on the described instantaneous downlink SNR values when responsible the number of bits to be communicated.

2. Proportional fair (PF): The Chief purpose of Proportional Fair algorithm is to balance between throughput and fairness between all the UEs. It attempts to exhaust the possibilities total [wired/wireless network] throughput while at the same time it affords all users at least a minimal level of service. It was initially established to sustain NRT service in code division multiple access high data rate (CDMA-HDR) system. The scheduler can disturb Proportional Fair (PF) scheduling by distributing more resources to a user, relatively with enhanced channel quality. This is completed by providing each data flow a scheduling priority that is inversely proportional to its estimated resource consumption. This offers high cell throughput as well as fairness adequately. Thus, Proportional Fair (PF) scheduling may be the best option.

3. Best Channel Quality Indication: This type of scheduling algorithm is used for approach to allocate resource blocks to the user with the best radio link circumstances. The resource blocks allocated by the Best CQI to the user will have the maximum CQI on that RB. The MS should respond the Channel Quality Indication (CQI) to the BS to accomplish the Best CQI. With the purpose of accomplishing scheduling, terminals send Channel Quality Indicator (CQI) to the base station (BS). Ultimately in the downlink, the BS transmits reference signal (downlink pilot) to terminals. These reference signals are used by UEs for the intention of the CQI. An advanced CQI value means better channel condition.

5.2 Enhanced PF Scheduling Method

The anticipated enhanced scheduling algorithm objectives to accomplish an important increase in the total throughput with a minor decrease in the fairness performance associated to the conventional PF scheduling algorithm. The novel metric of the proposed enhanced scheduling algorithm can be written as:

\[
m_{nk}^{Enh} = \log_2 \left( \frac{r_k(t)}{\alpha} \right) - \log_2 \left( (1 - \alpha) \tilde{R}^\text{th}(t) + r_k(t) \right)
\]

The new parameter \(\alpha\) presented in the proposed metric equation is responsible for governing the interchange between throughput and fairness accomplished by the proposed enhanced scheduling algorithm. The operating range of \(\alpha\) is between 0
and \(0<\alpha<1\), when \(\alpha=1\) the proposed enhanced scheduling algorithm contributes the same performance of the conventional PF scheduling algorithm which is categorised by high fairness but with low spectral efficiency. On the other hand, when \(\alpha=0\), the proposed enhanced scheduling algorithm gives the same performance of the best-CQI scheduling algorithm which is regarded as by high throughput but with poor fairness performance.

6. PERFORMANCE EVALUATION AND SIMULATION RESULTS

The main simulation parameters utilized are determined by the 3GPP simulation cases and Performance with round robin, proportional fair and best CQI scheduling. It has been observed for UEs at different distances from the eNodeB and mapping of UEs and eNodeB is illustrated in Table 1.

Table 1: Simulation parameters

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>ASSUMPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission bandwidth</td>
<td>2.14GHz</td>
</tr>
<tr>
<td>No. of User Equipments (UE) per eNB</td>
<td>20 UEs</td>
</tr>
<tr>
<td>No. of eNB</td>
<td>8eNBs</td>
</tr>
<tr>
<td>Simulation length</td>
<td>100 TTI</td>
</tr>
<tr>
<td>UE speeds of interest</td>
<td>5km/hr</td>
</tr>
<tr>
<td>Uplink delay</td>
<td>3 TTIs</td>
</tr>
<tr>
<td>eNB's Transmit Power</td>
<td>40 watts</td>
</tr>
<tr>
<td>eNodeB TX power</td>
<td>43dBm</td>
</tr>
<tr>
<td>Receiver Noise Figure</td>
<td>9 dB</td>
</tr>
</tbody>
</table>

Fig.3: Average UE throughput of 20 users

Fig.4: Average cell throughput of different scheduling algorithms

It is shown that the Fig.3 represents the average UE throughput of 20 users for Round robin, Proportional fair and Best CQI. Fig.4 represents the throughput of the proposed enhanced scheduling algorithm compared with that of the PF and the best-CQI scheduling algorithms. It is exposed that the best-CQI is evidently capable to exhaust the possibilities of cell throughput, though, it accomplishes unfair resource sharing meanwhile users with poor channel will only acquire a low percentage of the available resources. Alternatively, the proposed enhanced scheduling algorithm and the PF scheduling algorithm are able to assure high fairness level. For the proposed enhanced scheduling algorithm as the value of \(\alpha\) decreases (from 1 to 0), the average cell throughput considerably increases while the fairness level slightly decreases. For example, with \(\alpha=0.8\), the proposed algorithm improves the average cell throughput by more than 10.3%, with approximately the same fairness level (2.6 %)
reduction) as compared with the conventional PF scheduling algorithm.

CONCLUSIONS

This paper explains the downlink packet scheduling framework in LTE by suggesting an Enhanced PF Scheduling algorithm, and its performance is compared with the Round robin, best-CQI and PF algorithms. The modified PF algorithm permits fair distribution of accessible resources with the increasing spectral efficiency. Simulation results show that the implementation of this modified PF algorithm supports improvement of the overall system capacity and also be responsible for fairness in the distribution of the resources. In future, we plan to implement idea of including the sub-band measurements within the network. Moreover the time domain scheduling in event of an improved number of users can lead to a corrupted performance of other servicetypes, particularly the FTP services. Consequently otherparameters need to be advance deliberated in order to gratify the minimum QoS demands for non-real type of traffic.

REFERENCES