Ebcqi: Enhanced Bcqi Downlink Scheduling Algorithm For Voip In Mobile Networks

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Abstract: Long Term Evolution (LTE) is a currently growing technology. It gives high speed data with several useful applications. Voice over Internet Protocol (VoIP) is one of the top most applications in that LTE. Scheduling is the main issue in LTE. This paper proposing an updating version of Best Channel Quality Indicator (BCQI) downlink scheduling algorithm. The proposed algorithm assigns the highest priority to VoIP users followed by video traffic and then other remaining traffics in next priority order. The simulation reports give the better results of increased average throughput in all users, as well as the spectral efficiency development is also increased. Here, in the proposed algorithm, the percentage of packet loss is also consistent with the existing BCQI algorithm. And, it totally emits positive results in both rural and urban area environments with different mobility. Number of user access is also high when compared with BCQI algorithm.

Index Terms: Best Channel Quality Indicator, Voice over IP, Transmit Time Interval, Resource Block.

1 INTRODUCTION

From several past decades to till now, the evolution of Mobile Networks has been astonished. 4G technology provides the quickest response than the other technologies. It is possible through multi input multi output antennas. Even though several issues are still in pending in this 4G network [1]. Due to large number of social networking sites and several interactive applications, the attraction is increased in day by day by the user of LTE technology. It has been growing at outstanding rate without any ends. This technology has been developed to increase the overall system throughput in both uplink and downlink methods when compared with other 2G, 3G networks. Communication over wireless needs to be aware of bandwidth, delay, packet loss etc., in Packet Switching (PS) method. This PS [2] provides the service without the connection establishment. Heterogeneous wireless network provides lot of remedies in case of severe congestion. Scheduling is one of the biggest issues of heterogeneous networks. Because, this should concentrate the user movement, reference signal, channel quality, needed number of resources, interference ratio, and transmit power, application requirements and much more. Not only those problems but also the customer satisfaction is very important. It is termed as Quality of Service (QoS). LTE has wider bandwidth which varies from 1.4MHz to 20MHz [3]. The number of blocks is calculated based on the available bandwidth at the base station. Generally, the resources are allocated to the user in time and frequency domain and it is done by the scheduler. LTE has composed one frame with 10 small sub frames. And each sub frame lasts for 1ms it is known as Transmit Time Interval. It is made up of 2 time slots. Each slot is divided into several numbers of Resource Blocks (RB). It is a combination of 12 sub carriers and 7 OFDM symbols. One subcarrier and one symbol are called Resource Element (RE). This RE can have 3 numbers. For QPSK modulation each RE transmit 2bits, 16QAM modulation 4bits and finally the 4QAM can carry 6 bits. This paper is structured as follows. Section 1 starts an Introduction of LTE network. Section 2 discusses the several related papers that are helped to prepare this article. Section 3 explains the proposed Enhanced BCQI Algorithm. Section 4 shows the simulation results of the Enhanced BCQI Algorithm. Section 5 concludes this paper and finally, section 6 accepts the list of references.

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2 RELATED WORKS

Nsiri Bechira et al., [4] proposed a novel algorithm for achieving high system capacity and compromised fairness levels. Also they developed one adjusting factor to balance the throughput and fairness between overall users. Ibrahim Khider et al., [5] analyzed the functionality of Round robin and Best CQI Scheduling Algorithms in throughput comparisons. After that, they proved BCQI algorithm does the allocation of RBs based on high channel quality to low, whereas round robin takes one by one. They achieved these results through Vienna LTE Link Level Simulator. Maina et al., [6] reviewed about CQI values and its importance. Mohamad et al., [7] given the detailed study about the LTE scheduling algorithms RR and BCQI, their benefits and issues are also stated. Mahnaz Sotoudeh Bahreyni et al., [8] proposed a new algorithm for improving fairness among other schedulers. The poor performance of BCQI is also proved by them. They maintain the fairness level. Even the users are away far from the base station. This is better than Proportional Fair scheduling algorithm. Salman A. AlQahtani et al., [9] explained the merits and drawbacks of several existing algorithms, how the scheduler affected for yielding the best throughput also explained by them. They compared their own new algorithm with different environments and confirmed that the proposed work maintains the better throughput and system capacity.

3 EBCQI: Enhanced BCQI Algorithm

A modified BCQI scheduling algorithm is proposed that prioritizes the VoIP traffic among all the others. This priority setting enhances the average throughput of the overall users in the particular cell coverage area. Existing BCQI algorithm treats all users with equal grade which leads poor assignment for real-time applications. Due to their sensitivity, in delay and packet size, VoIP needs in a position to get fast access when compared with others traffics. In addition, the large non real-time users with good channel condition may limit the resources to real-time users. Channel Quality Indicator (CQI) is a main parameter for scheduling in BCQI algorithm. It ranges from 0 to 15. And it is measured based on the Reference Signals of Users, 0 indicates the users are in the poor range (Very Far Away to Base Station) and 15 indicates the users are in good channel condition (Very Close to the Base Station). Existing BCQI looks at the highest CQI value only not the applications that the user uses. If CQI is 15 and the application is non real-time get faster access, even the real-time user with CQI 14 or 13 could not access in time. It redirects the waiting time delay of these kinds of users. If the TTI is full for all non real-time users, the real-time should wait until their turn to come for proceeding with their resources. In order to overcome those problems this Enhanced BCQI Algorithm is proposed. Figure 1 illustrates the steps of an Enhanced BCQI algorithm in detail.

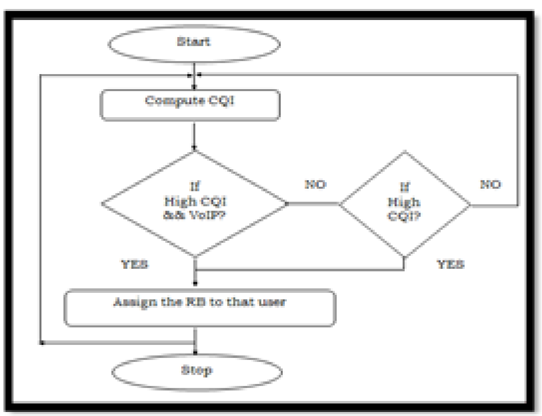

Figure 1: *Enhanced BCQI Algorithm*

Buffering user packets need more resources but, due to these buffering users could be slow for requesting the resources. Generally, the non real-time packets would be coming continuously to the scheduler without any waiting delay (No buffering delay), and also put more number of requests compared with real-time packets. So, this should be mind for designing algorithms. BCQI algorithm assigns the resources as much as it can through the downlink channels. The main reason for considering this BCQI algorithm is their CQI based assignment. The reason for developing this proposed algorithm is, usually, the voice user always tries to come closer to the Base Station. So, they will have a good CQI value but the large number of user presence of non real-time users, the resource may be delayed to real-time users. Other algorithms like Round Robin, Proportional Fair consider equal priority and not give much importance to channel conditions compared with BCQI. That's why, this priority model could be added to BCQI algorithm only.

Priority Model in BCQI Algorithm

Initially, the equal priority (0.2) is assigned all the traffics and results are taken. Then, the enhanced BCQI started to assign 1 priority to all individual traffics. Example, FTP has 1, remaining all 0's, then, HTTP gets priority 1 and remaining all 0's, then, Video, VoIP, Gaming and finally Full buffer. All the throughput results are low when compared with VoIP traffic. This Priority model, in BCQI is compared in 2 ways. One is Full buffer mode and other one is General mode. For full buffering, the priority value 1 is fixed and remaining all traffics is fixed as 0's in BCQI then results are taken. Then, for VoIP traffic, the priority value 1 is fixed, and remaining are 0's. Then, it is observed the VoIP traffics shows high average throughput when compared with full buffer mode. Similarly, did same thing for general mode, again it shows the improved results. For VoIP based priority model increases the average throughput of BCQI algorithm. So, it is renamed as Enhanced BCQI Algorithm. Figure 2 shows the priority assignment value of various traffic models in an Enhanced BCQI algorithm. It is located in LTE_trafficmodel.m file of Vienna System level simulator.

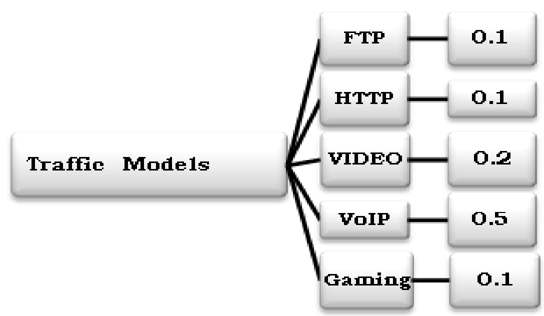

Figure 2: *Priority model in Enhanced BCQI algorithm*

There may be a chance that at least one RB assignment in, Round Robin and Proportional Fair [10] algorithms to real time VoIP users, but, BCQI is not like that, resources only based on the channel quality of the users. So, this work considered in BCQI algorithm.

4 Simulation Results

The following paragraph explains the simulation parameters and their descriptions used by this Enhanced BCQI Algorithm. For this, LTE Vienna System Level Simulator version LTE_System_Level_1.6_r885 [11] is used. This tool is mainly used for implementing the scheduling algorithms, interference models and much more. Scenario 1In the first scenario, 3 Base Stations (eNodeB) 13, 14 and 15, Winner+ channel model and Mobility speed 1.38 m/s, 15 Users are taken for sample simulation shown in Table 1. These values are configured for both Existing and Enhanced BCQI algorithms. It runs for only 5 TTIs with 5 users per sector. This work only focuses the tri_sector_tilted type simulation in different path loss model environments.

***Table 1**. Simulation Parameters and their descriptions*

Parameters	Descriptions
Bandwidth	1.4 MHz
Frequency	2.1 GHz
Simulation Type	Tri sector tilted
Base Station	13, 14, 15
Scheduler	Best CQI with VoIP 1st Priority
Simulation TTIs	5,10
UEs per eNodeB	5
Path loss Model	TS36942, Free space
Path loss Model Environment	Urban, Rural
Transmit Power	40
Channel Model	Winner+
UE Distribution	Constant UEs per cell
UE Speed	5/3.6 (1.38 m/s)
Users	61 to 75

After performing simulation, the results are listed in Table 2. Initially, results are taken for existing BCQI (with equal priority) and then, Enhanced BCQI priority is applied. And it depicts the results of the existing and proposed algorithms. It clearly explains that the Enhanced BCQI gives positive results in both average and spectral efficiency in Mbps. But, this proposed BCQI has one demerit which is the energy factor. VoIP [12] consumes more energy than the other traffics. Because, VoIP is an interactive application. That is, both parties must be available while on communication which consumes more energy.

***Table 2.** Simulation Results of BCQIand Enhanced BCQI Algorithm*

Model eNodeBs (13,14,15) UEs (61 to 70)	BCQI (Without Priority)			BCQI (with VoIP 1st Priority)		
	Average Throughput	Average Spectral Efficiency	Energy per bit	Average Throughput	Average Spectral Efficiency	Energy per bit
TTI = 5, TS36942, urban	19.656	24.6682	2.74	18.844	31.3611	2.74
TTI = 5, TS36942, rural	9.308	15.2552	1.27	10.804	17.4892	5.77
TTI = 5, free space, urban	6.5	12.5238	1.37	11.968	15.5978	4.20
TTI = 10, TS36942, urban	10.1405	19.8461	1.44	11.8011	25.3661	8.12
TTI = 50, TS36942, urban	13.76	21.2860	8.18	17.2874	52.2683	1.63

According BCQI the channel quality is important, but whereas as far as traffic concern, their usual sensitivity never change. Especially, VoIP must have certain resources for establishing the communications. Therefore, this priority is edited in existing BCQI and renamed as Enhanced BCQI. Figure 3 provides the comparison graph of an average throughput values in Mbps for both existing BCQI and Enhanced BCQI algorithms. It runs from 5 TTIs to 50 TTIs with urban, rural, free space models. In all the environments the proposed BCQI has given good performance results.

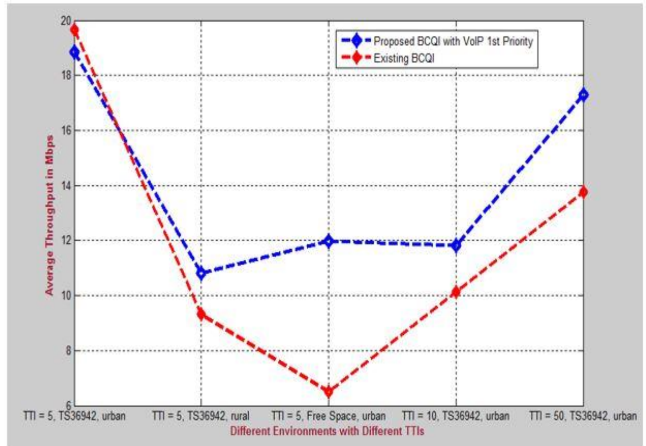

***Figure 3.** Average Throughput values of Existing BCQI and Enhanced BCQI Algorithm*

Spectral efficiency improves the proper utilization of spectrum up to the Shannon's limit [13]. It is also an essential factor in expanding the system capacity. Figure 4 shows the spectral efficiency results in Mbps of both BCQI and Enhanced BCQI algorithms. And Enhanced BCQI proves the priority model increases the spectral efficiency values.

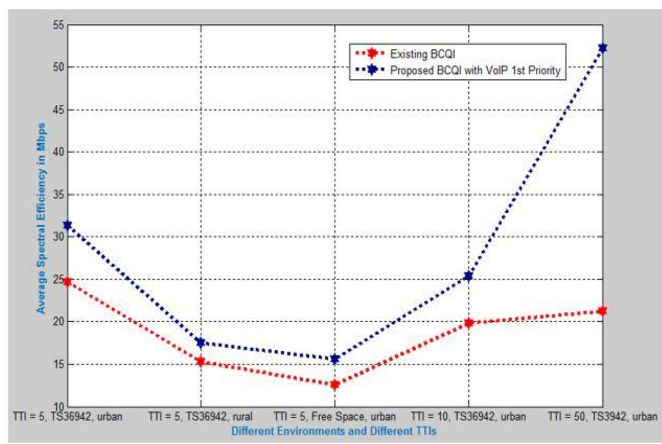

***Figure 4**. Average of Spectral Efficiency of Existing BCQI and Enhanced BCQI Algorithm*

As far as real-time traffic concern energy is the biggest problem in mobile networks. Even, this Enhanced BCQI fails to save the energy values in optimum levels. Figure 5 displays the energy comparisons per bits of existing BCQI and Enhanced BCQI Algorithms. For real-time packets, energy level is almost raised to edge because of their sensitivity and high consuming power in nature.

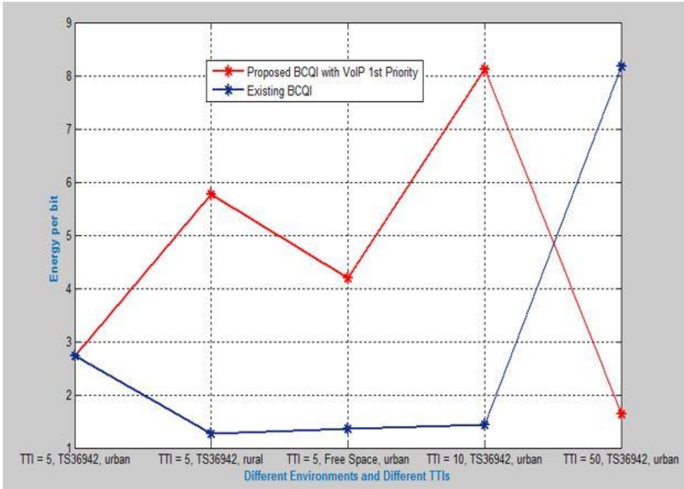

***Figure 5**. Energy per Bit comparison for BCQI and Enhanced BCQI Algorithms*

Again the Enhanced BCQI is simulated by taking same environments with various priority assignments in scenario 2. Scenario 2 Here, initially the value 0.2 is assigned for all traffics and verify the results which is listed in the second column of Table 3. After that priority 1 is assigned to FTP and remaining traffics are given to 0 values. Then, results are taken. Similarly, it did for all traffics and calculations are shown in below Table 3.

***Table 3.** Priority Assignment of various traffic models and their results*

Particulars	Equal Priority (0.2)	FTP(1)	HTTP(1)	Video(1)	VoIP(1)	Gaming(1)
Average Throughput	37.412	40.16	33.78	35.044	45.592	41.1
Average Spectral Efficiency	74.7418	71.2010	72.4483	58.6381	100.1341	84.6657
Energy per bit	1.04	7.51	0.000119	7.21	9.58	0.000102
No of Users accessed	13	11	14	10	15	14

From the scenario 2 and based on the results the calculations are drawn in figure 6. It shows the average throughput values in Mbps of various traffic models in both the existing BCQI and Enhanced BCQI algorithms.

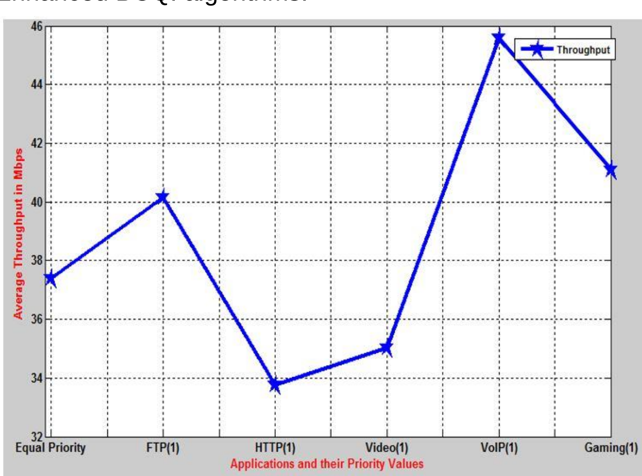

***Figure 6**. Average Throughputs of Users with various traffic models*

Like scenario 1, the Enhanced BCQI gives increased performance of spectrum efficiency values and that is shown in Figure 7.

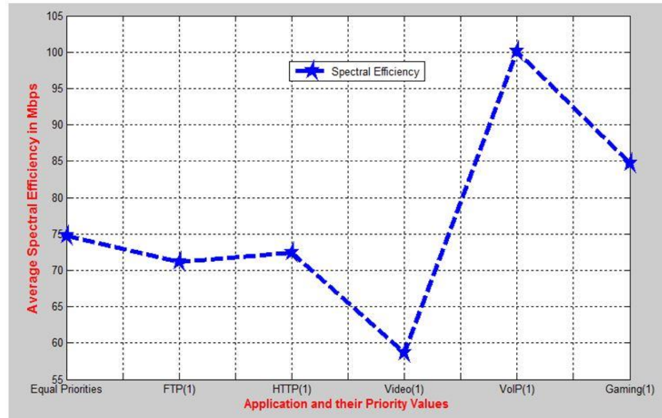

***Figure 7**. Average Spectral Efficiency of Users with various traffic models*

Energy bit comparison of BCQI and Enhanced BCQI algorithm is shown in Figure 8. After allotment of resources during scheduling, the energy may create problems for both the BS and mobile devices by restricting the others access.

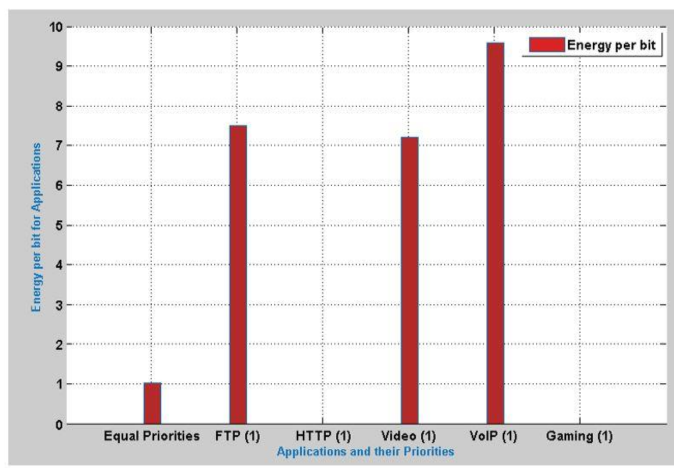

***Figure 8**: Energy per bit comparison with various traffic models*

Enhanced BCQI not only increasing the average throughput, but also it increases the number of admissions of real-time users. Figure 9 depicts the number of users in existing and Enhanced BCQI algorithm.

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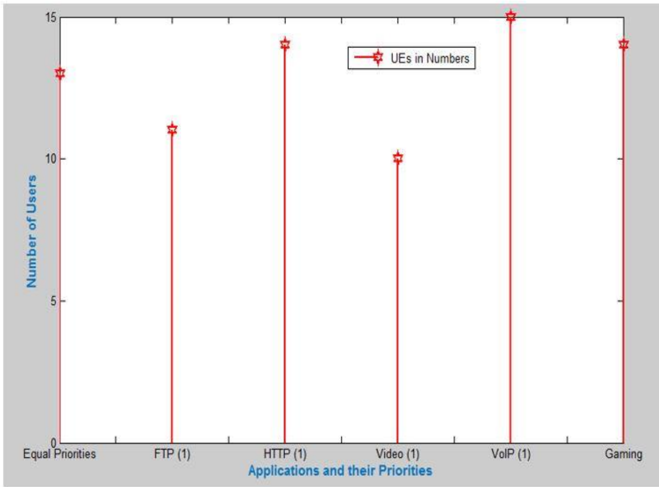

***Figure 9**. Number of Users got RB allocations with various traffic models*

From the scenario 2, the Enhanced BCQI observed the improvement in average throughput values, spectral efficiency results, number of users and finally the energy values. So, the Enhanced BCQI outperforms well except in energy.

5 CONCLUSION

Finding a suitable scheduling algorithm for VoIP users is still in research. This paper explains an Enhanced version of BCQI algorithm to VoIP users in the downlink packet scheduling on LTE technology. It increases the average throughput of the users and also the spectrum efficiency. BCQI and Enhanced BCQI algorithms have simulated using Vienna LTE system level simulator. Proposed algorithm offers better results than BCQI. One drawback of the proposed algorithm is energy consumption. It is a worst factor on this proposed algorithm.

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