A Survey on Analysis and Design of Scheduling Algorithm for LTE-Advanced Heterogeneous Networks

Ammar Hafeez¹, Mohammad Masoom Zafar², Sir Ahmad Mudassir³
Department of Electrical Engineering
COMSATS Institute of Information Technology, LHR
Pakistan
ammarhafeez5@gmail.com
mohammadmasoomzafar@gmail.com
amudassir@ciitlahore.edu.pk

ABSTRACT: Long Term Evolution Advanced (LTE-Advanced) is the one of the fastest growing technologies. As it is new form of Long Term Evolution (LTE) networks. It provides its subscribers with improved service capabilities and improved network performance and this is carried through the intelligent deployment of new techniques and technologies. In 3G LTE the transmission of data is carried in the form of packets and through the smart selection of the users. Long Term Evolution (LTE) support traffics like video conferencing, voice over IP (VoIP), video streaming, file transfer and also the web browsing. Smart packet scheduling algorithms are responsible for choosing fine time and frequency resolution and they play the main role in LTE networks. Some significantly known features of LTE-Advanced are enhancement in heterogeneous networks, carrier aggregation, multipoint transmission and reception, use of relay nodes in the wireless network and advanced multiple inputs and multiple output usage. LTE-Advanced is for enhancement of the radio access part of cellular networks. In this paper, we compare some packet scheduling algorithms for LTE downlink mechanism.

Keywords: LTE-Advanced, VoIP, Heterogeneous networks, Carrier aggregation.

Received: 2 June 2016, Revised 12 July 2016, Accepted 19 July 2016

© 2016 DLINE. All Rights Reserved

1. Introduction

As for the needs of clients, the devices are becoming more fast, useful and advanced. Now a days, the devices are becoming smaller in size as well as their processing power is also increasing. As mobile wireless communication is a fast growing
technology, however there is always a need for improving wireless communication. To meet the client’s desire, a few important cell remote strategies are proposed to meet the specific end goals. The basic need of 4G framework is that it provides the higher data rates to the clients. 1G system was a basic system which consist of simple cell framework with the exchanged circuit system design. As 1G was a basic level system therefore it includes many pros and cons as the wireless system were just basic voice telephony, restricted neighborhood, low data limits and territorial scope. The expanded interest for larger frequency range in the information transfers segment needed a movement in simple to more advanced communication procedures. But in 1990s, second generation (2G) made its way to reach the capacity needs of voice plus telephony, simple text messaging and limited circuit switch data transmission. We can compress our signal more efficiently in digital system than in analog system, and this is done by transferring more packets into the same bandwidth but also propagation with the lesser power [5].

Third generation (3G) system integrate voice and as well as data applications. Operators recently started finding some ways for the new generation technology, called fourth generation (4G) wireless system. And this technology is the basic extension of 3G technology and it is more advanced in terms of bandwidth and offered services than 3G technology. And the 4G provides high quality video and audio streaming for the end to end internet protocol.

4G technology includes many applications like:

- 4G high definition video quality on demand
- 4G HD Television
- 4G super speed internet access
- 4G Tele-medicine
- 4G video gaming on demand
- 4G GPS location-based services

Long Term Evolution (LTE) was introduced by Third Generation Partnership Project (3GPP) and it was introduced to fulfill the need of the emerging applications with different throughput, Packet Loss Rate (PLR), delay, and bandwidth requirements and it emphasize the need of a network capable of supporting vast range of services. LTE network mainly focus on enhancing the data rate for providing the radio resources for different highly demanded services and also considering the QOS requirements to the active user up to a satisfied level. LTE networks uses the Orthogonal Frequency Division Multiple Access (OFDMA) for downlink (DL) and for uplink (UL) stream it uses Single Carrier Frequency Division Multiple Access (SC-FDMA).

The OFDMA technology is basically divides the bandwidth which is available into multiple sub-carriers and on the basis of its QoS requirements, it allocates a group of sub-carriers to end user. Therefore, for effective use of radio resources, the design of efficient resource allocation algorithm plays fundamental role to meet the system performance objectives. Algorithms used for scheduling impart their impact on the performance of the network and can differ according to the algorithm. Smart Packet scheduler at radio base station is in charge of assigning different parts of spectrum that are shared among users. To differentiate the performance of one wireless system from another is depending upon designing an effective smart scheduler. Smart packet scheduler in LTE have main goal to maximize the spectral efficiency and to make the negative impact of channel quality drops to negligible state.

2. Literature Survey:

Radio resource management acts as a way that provides us help or we can say that we can make the packet scheduling and radio resources better and this work is very important for the radio resource management and it must be done. In the field of mobile communications the radio resources is very demanded and to get these radio signals we will be requiring an algorithm which is PS (packet scheduling) algorithm. Now a day wireless channel conditions are highly dynamic in which we can communicate through some resources like internet, and internet provides us different ways of communications like we can send emails or send some kind of voice notes but the levels of service depends upon the type of data service you are using. We want everything fast and if we are not getting enough speed then we will be annoyed by these services if we are chatting with someone and message is not delivering at the right time then it is not good. Now the question raises that why communications gets slow, It is because every quality of service environment has a different type of traffic environment [3].
There comes two types of QoS requirement real time (RT) and non real time (NRT) and the NRT is the dynamic one because of its channel conditions. Dynamic environment changes with the time and to tackle its unstable environment of QoS we have to make channel capacity allocation adaptable to the changing environment and it should be fast enough and the capacity of channel capacity allocation should change with the environment. Because of this unstable environment we have to provide the communication networks a source by which it can govern the communication system in the best way and make it reliable, this source is called artificial intelligence. Artificial intelligence in communication system works by using some sort of algorithms which works by checking the weights of connections of the communication networks in the communication system [3].

![Figure 2. LTE Frame Format](image)

Now we will discuss the learning rules used by the artificial intelligence in the communication systems. In 1949 Hebb proposed a rule which is used by two layer networks as a learning procedure. It is known by his name Hebbian Learning Rule. It tells us that the weight of the connection between two units should increase or decrease for their product. Now we will discuss the working of the Hebbian rule that in which environment it works and how it works what help does it give us? First of all we will see that what are primary users and what is cognitive radio. Primary users (PUs) are the users who have the authority to operate in spectrum band of the wireless service provider. Cognitive radio (CR) is an intelligent radio technology which can change transmission parameters by enabling more communications to run concurrently and automatically detect available channels in a wireless spectrum. It can improve radio operating behavior. Hebbian Learning rule helps by preventing the collisions between cognitive radio and primary users. Because cognitive radio (CR) and primary user (PUs) occurs in the same environment and Hebbian Learning rule is used for the dynamic spectrum management in cognitive radio (CR) in which it estimates the presence of PUs in the environment.

In LTE system its main feature is the scheduling and we know it by the name of packet scheduling. Scheduling means if you have number of resources and you have to decide that how to distribute them in different active users for their QoS requirements.

Packet scheduler works for making the channel quality drop minimum. In cellular technologies we have different types of service of real-time multimedia like online video streaming and voice over IP (VoIP) service. A packet scheduler’s working model for downlink LTE system.

In video streaming the main requirement is to deliver the data packet within the deadline. And the packet scheduler works by prioritizing the user on different aspects like its channel condition, traffic, type of service and packet delay. A genetic algorithm is used to optimize the application-layer video quality which is proposed by the authors in [2]. And its basic function is to improve the accuracy of prioritization.
3. Packet Scheduling Schemes:

The packet scheduling is used to distribute the resources among different users in a useful and efficient way to maximize the system performance, maximize the system throughput and improving the system fairness. In downlink networks, the scheduling is the main phenomenon which determines the downlink performance.

LTE uses Hybrid ARQ for the fast and quick transmission of those packets which are not correct. And HARQ is also used to keep the radio interference to the minimum extent. Link Adaptation (LA) in LTE select varies modulation and coding schemes (MCS) and they are based on CQI which reports to maximize the spectral efficiency of the system [3].

1. Round Robin (RR):
In round robin the scheduler have the number of resources and every single resource is used by all users and every user have the same number of time and this continues in a cycle and the channel conditions are not considered for the scheduling. This approach is best for the fairness purpose because every packet transmission time has the equal share of time. But it have a very big disadvantage that it have the poor performance because of cell throughput. In RR all terminals are equally scheduled and the terminals resource blocks one after the other without considering the CQI (channel quality indicator). However, its throughput performance is low and fairness is high.

2. Proportional fair (PF):
Proportional fair algorithm is for balancing between throughput and the user fairness among the user end devices. It provides the user at least a minimal level of service and at the same time it maximize the total throughput of the system. It was basically proposed to maintain NRT service in the system. This scheduler can affect Proportional Fair (PF) scheduling because it allocate more resources to a user, and with good or better channel quality. It gives high fairness and high cell throughput. Thus, Proportional Fair (PF) scheduling may be the best option [5].

3. Best CQI:
This scheduling works by checking the radio link on the basis of the channel quality, the best radio link will get the resource block. Resource block is assigned to the user with the best CQI because the higher CQI means better conditions of the channel. It works by sending the CQI to base station (BS).

4. Buffer-Aware schedulers:
   In buffer aware the scheduling is done by checking both, the channels and the buffer conditions. Buffer conditions are used to make scheduling. If the transmission rate I satisfies then you can say that it is a candidate users which are selected by channel conditions. It have maximum throughput deduction.

Summary:

1. LTE-A meets and exceeds all requirements for 4G as specified in IMT-Advanced.
2. Three key factors that affect data rate are: spectrum, spectral efficiency, and cell size.
3. LTE-A can aggregate up to 5 carriers to make up to 100 MHz
4. LTE-A has frequency reuse factor of 1 since spectrum is expensive, uses high-order MIMO.
5. LTE-A uses relay nodes to cover remote areas and hot-spots. Also allows Home eNB (Femto cells).
7. Coordinated Multipoint operation (CoMP) allows mitigation of interference at cell edge. CoMP can also be used with cross-carrier scheduling [4].

References:


