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Review Article

A REVIEW ON UPLINK AND DOWNLINK IMPROVEMENT OF LONG TERM EVOLUTION ADVANCE SYSTEM

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ABSTRACT:

These years' there is a rapid development in the field of wireless communication. Increased demands for the broadband mobile wireless connections and the materialization of new wireless multimedia implementation have constituted the enthusiasm for the development of broadband wireless accessible technologies. Long Term Evolution (LTE) system that has been standardized by the Third Generation Partnership Project (3GPP) to the approach towards fourth-generation (4G) mobile for the assurance of the 3GPP keeping the dominance of the mobile communication technologies. The Long term evolution (LTE) is a 3GPP (Third Generation Partnership Project), 4G technology, which improves the development in the area of telecommunication and also improves the performance of the system for the different types of traffic stream. Since it is an all IP technology it is the most rising technology these days. The reality that 3G long term evolution which is a packet based network, brings some development in the form of lower latencies, higher rate of bits, and a variety of other services. In recent past, it has observed that there have been significant advantages of multiuser MIMO (MUMIMO) in the area of wireless communication system. MU-MIMO system has been now introduced in different ways and is being considered to be as new age of wireless standards. For illustration: 802.16m and LTE-Advanced. In addition, the growing concern is about the green communication which relates to the special effects of the radiation that is emitted from wireless devices on the human body. The paper presents a survey of the different enhancement algorithms under variable conditions and hence accordingly, the variation in their results in terms of the performance metrics resembling packet loss,

throughput, fairness, delay time, spectral efficiency etc. has been discussed. Basic concepts of LTE Advance for uplink as well as MIMO communication system have also been discussed.

Keywords: Long term evolution (LTE), Channel Quality Indicator (CQI), Physical downlink common control channel (PDCCH), User Equipment (UE), Quality of Service (QoS).

Introduction

LTE system is a global standardization for the fourth generation of the mobile broadband (4G) which is supported by all major operators in the industry which was introduced by 3rd Generation Partnership Project in the year 2008. It has been anticipated that LTE system will provide an expansion in capacity and a there will be improvement in the performance as compared to the existing HSPA (High Speed Packet Access) based networks [1]. Here the basic idea of LTE is to build up an environment which presents benefits likke high data rates required for proper communication, minimum delay which is termed as latency and higher range of spectral efficiency for a wide range of bandwidth. The objective in the evolution of LTE networks is to raise the data-rates to fulfill the needs of the user.

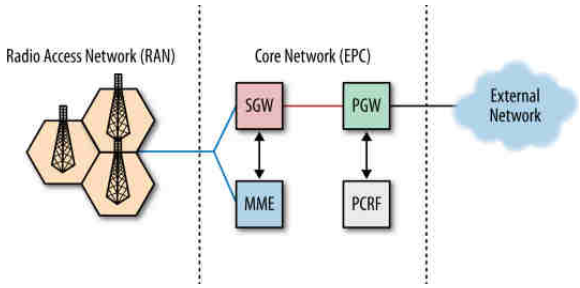

Fig.1: Signal Interface

In LTE the Radio resource is divided and is shared efficiently amongst different active users with maintaining a satisfied level in terms of QoS to all the active users. So as to fulfill the needs, the LTE system depends on orthogonal frequency division multiple access (OFDMA) technique in the downlink. The OFDMA technique separates the available bandwidth into many narrow band sub-carriers thereby allocates a group of sub-carriers to any user based on the current system load, requirement and system configuration [1]. The SC-FDMA (Single Carrier Frequency Division Multiple Access) is used in the uplink and multi-antenna technology [3]. Transmission bandwidth can be chosen between 1.4MHz to 20MHz [1]. The bandwidth of 20MHz can provide downlink user data rate up to 150Mbps in 2X2 MIMO system and 300 Mbps data rate with 4x4 MIMO systems. So as to support downlink services with higher transmission rates, the BS transmits the data or information using shared channels

to which the information or data that comes from many sources or users is multiplexed in frequency and time domains. Hence different scheduling approaches are proposed considering different requirements and necessities of the users along with the performance. The LTE-Advanced (Long Term Evolution-Advanced) is a standard for cellular networking system that offers high throughput as compared to its predecessor which is known as LTE (Long Term Evolution). The Long Term Evolution-Advanced system can transmit data at a rate of 1 GB per second that is reasonably higher as compared to LTE networks which have a maximum data transmission rate of 300 MB per second. Consequently, the higher need of the cellular bandwidth illustrate that carriers may need to use the standard LTE-Advanced which results as the increase in system capacity and it isn't necessary to deliver extensively higher speeds. The system of LTE-Advanced network uses multiple-input and multiple-output (MIMO) technology to deliver or produce the data transmission faster using greater than one signal. MIMO needs multiple antennas to get input or to receive those signals, that can limit its utilization in compact devices like smart phones, tablets and mobiles [2].

SCHEDULERS

2.1 Maximum Throughput Scheduler

The approach that is known as Maximum Throughput (MT) intended at maximizing the overall throughput that assigns each RB (Resource Block) to the user that can gain the maximum throughput in existing TTI.

2.2 Modified Largest Weighted Delay First

The Modified LWDF (M-LWDF) is a channel-aware extension of LWDF and surrounded packet delivering delay is provided. In the course of shaping the behavior of MLWDF, PF it utilizes information about the accumulated delay, assuring a good balance amongst airness, spectral efficiency and the QoS prerequisite. It has been developed to support multiple real time data users.

2.3 Proportional Fair Scheduler

A classic way of finding a trade-off between the requirements of fairness and the spectral efficiency is nothing but the Proportional Fair (PF) scheme and the idea behind this is that the past average throughput may act as a weighting factor for the expected data rate, such that users in bad situation will be served inside a certain amount of time.

Transmission Modes in MIMO LTE

In the MIMO systems there are two types of modes and are known to be the most popular modes which are used in the LTE analysis, which can transmit in Diversity mode as well as in Spatial Multiplexing mode. Hence Diversity modes can be used either in the Transmit

Diversity side or in the receive Diversity; where in the side of receive diversity it is known for simply combining the operations of various types of copy of the same broadcasted signal. The Transmit Diversity needs the transmission of signal by Space Time Coding operation. In the LTE there are various modes of Transmit Diversity defined as below.

3.1 Transmit diversity mode

The methods of Transmit Diversity where only the transmitted signal replicas are utilized to reduce error rate at the receiver section. The Transmit Diversity which includes two antennas at the transmitter side and one antenna at receiver side with a data stream is defined as codes shown below. The SFBC (Space Frequency Block Coding) are defined where two eNB antennas are available for transmit diversity function. The SFBC derived from Space Time Block Coding which is commonly known is Alamouti codes. Range created by the transmitter uses diversity of time and space as well as the frequency diversity. The Alamouti's space-time coding scheme can achieve full gain in spatial diversity. The TxDs issue exists for single ranks meaning that it does not sustain multi stream transmission [7]. In the method of LTE for SFBC transmission, symbols are transmitted from two eNodeB antennas ports on adjacent subcarriers and is given by

$$\begin{bmatrix} Y^0(1) & Y^0(2) \\ Y^1(1) & Y^1(2) \end{bmatrix} \ldots\ldots\ldots\ldots (1)$$

Where $Y^P(K)$ represents the information transmitted from antenna port p on the k^{th} subcarrier. One of the important characteristic of these code is that the signal streams are orthogonal that are being transmitted and for optimal performances a simple linear receiver is required. By diversity gain utilization, reliability of diversity scheme increases. As a consequence of diversity gain, there is a reduction in the error rate. Data rate also is logarithmically enhanced as per the quantity of antennas, since the antenna diversity increases the linearly of SNR.

$$C=B \log_2(1+SNR) \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

The diversity gain of MIMO system is mostly distinguished by the quantity of the branches of independent fading diversity, also known as Diversity Order. The curve between slope of SNR curves and BLER on a log-log scale is given as diversity. In a MIMO system Nt are number of transmit antenna and Nr are the number of receive antenna that are presented in a MIMO system and it has a diversity order of Nd = Nt.Nr. This diversity order has effect on the system reliability since the probability of one of the diversity branches having high SNR is higher compared to only one branches.

3.2 Spatial multiplexing mode

As compared to the diversity mode that is mentioned in the above section, the mode of Spatial Multiplexing scheme which relates to the splitting of received high data rate stream into Nt transmit data rate streams. In the data throughput point of view the spatial mode of multiplexing is most important in LTE system. In MIMO system the nominal spectral efficiency can be enhanced successfully with Nt transmit antennas. By a number of Nt stream at receiver side the information can be successfully and separately decoded. Here multiplexing gain is defined in terms of factor Nt. In the spatial multiplexing system i.e. Nt x Nr MIMO system, the highest data rate grows as [8]. Spatial Multiplexing mode in the LTE system is designed as mode 4 and is recognized as a system of closed loop Spatial Multiplexing mode. The SISO OFDM systems is influenced by the parameter of the OFDM signal and available bandwidth, the maximal data throughput is influenced. For illustration, the number of subcarriers and the modulation order like QPSK, 16QAM, 64Q AM. The maximal data throughput that is calculated in bits per second are for given Frequency bandwidth B. The throughput calculated in bits per second can be approximated as shown below:

$$\text{Throughput(T)} = \frac{N_{FB}.N_{SC}.N_{OFDM}}{T_{sub}}.\text{ECR} \quad \ldots (3)$$

Where number of frequency Block is represented by N_{FB} in the certain frequency band (B); Number of subcarrier in one frequency block is represented by N_{SC}, N_{OFDM} which is the number of OFDM symbols present in one sub frame equal to 12 and 14 respectively. Now 5 MHz bandwidth i.e. N_{FB}=25, N_{SC}=12, N_{OFDM} =14, in LTE system has 16QAM modulation scheme so Nb= 4 and ECR=0.369, also here sub frame duration is of 1ms. Subsituting all this values in equation (iv) got maximum data Throughput for 5 MHz bandwidth equal to 6.1Mbps [8].

LITERATURE SURVEY

In 2013, Biswapratap singh Sahoo et.al [1] studied the downlink packet scheduling algorithms and mainly focuses on the three scheduling algorithms known as: FLS (Frame level scheduler) in which basically two different algorithms are implemented in two different levels, EXP rule which explains the queue length and waiting time for servicing a queue and LOG rule which gives a balance between delay and robustness. Simulation is done in a vehicular environment by using LTE-Sim for the video traffic and the performance is analyze and the number of users taken for the simulation vary from 10 to 60 and the simulation is done in a region having radius of 1 km and is a bounded region. Simulation results showed

that the FLS algorithm performed better than the rest two algorithms in terms of all the parameters.

In 2012, Ali Alfayly et.al [2] focused on analyzing the performance of the LTE algorithm in a single cell with a set of users at different speeds. As real-time flows like VoIP is considered to measure the impact on Quality of Experience (QoE). The LTE simulation was built based on LTE-Sim with three LTE scheduling algorithms (i.e., PF, EXP-PF, and MLWDF) for a single-cell scenario. Four different scenarios were developed using a single cell: static, pedestrian and vehicular scenarios using different speeds. EXP-PF is only considered for real time flows.PF has best end to end delay which is not suitable for VoIP applications and MLWDF and EXP-PF have less end to end delay.

In 2011, Wei Nie et.al [3] studied the scheduling problem and proposed a two- level scheduling scheme with support for quality of service and fairness guarantees for downlink traffic in a WiMAX network and analyzed the performance of the two- level scheduling scheme and compared it to round robin and weighted round robin algorithms. In the two level scheduling, in first level strict priority packets are classified by scheduler according to the quality of service then they are arranged into different priority queues and in the second level fairness oriented scheduling schemes for different service flows are used. A simple WiMAX network is simulated by using OPNET simulation and concluded that as compared with round robin algorithm and weighted round robin algorithm, the QoS priority and fairness scheduling scheme for downlink traffic guarantees the delay requirement and maximize the throughput in the downlink.

In 2013, Oana IOSIF et.al [4] evaluated the performance of downlink LTE using System Level Simulator .Sector throughput, user throughput and Block error rate (BLER) are the performance indicators analyzed and in this basically three scheduling strategies are used i.e. Round Robin, Best CQI and Proportional Fair and the results showed for the different scenarios. For the bandwidth of 20MHz, when the speed of user equipment is 5 Km/hr, the throughput and network BLER are higher as compared to the results for the user equipment speed of 20 Km/hr and for a bandwidth of 10 MHz, the results get halved. For 2x2 MIMO, the performance of Best CQI is better as compared to other two algorithms.

In 2013, Arkadiusz Biernacki et.al [5] evaluated the performance of three scheduling algorithms proposed for LTE downlink transmission. The three scheduling algorithms i.e.PF, MLWDF and EXP/PF are used for the comparison. A proportional fair (PF) scheduler basically assigns the resources to the users considering the CQI and the past user throughput. The Modified Largest Weighted Delay First (M-LWDF) scheduler supports multiple data

users with different QoS requirements. The EXP/PF algorithm supports the streaming services and the best effort data services. Simulation results showed that the packet delay is maximum but the throughput is minimum in case of proportional fair scheduling algorithm and packet loss ratio performance is quite similar in case of MLWDF and EXP/PF scheduling.

In 2013, Bin Liu et.al [6] proposed a packet scheduling strategy known as Modified-Earliest Deadline First- Proportional Fair (M-EDF-PF) algorithm which is an extension of Earliest Deadline First (EDF) and Proportion Fair (PF) algorithm and having low complexity for real time traffics like video and VoIP in LTE systems. For, verifying the high efficiency of the proposed algorithm, several other well known algorithms are also taken such as EXP/PF, MLWDF etc. for the real time traffic and simulation is done. During the simulation, the proposed algorithm which is designed for the real time traffic services performed better than the other algorithms as it is having low complexity. The proposed algorithm is very efficient and is very suitable to use for the wireless systems.

In 2013, Huthaifa AL-Jaradat et.al [7] explored the performance of three well known packet scheduling algorithms i.e. Proportional Fair (PF) algorithm, Maximum Largest Weighted Delay First (MLWDF) and EXP/PF for the real time traffic. In this paper, LTE-Sim is used to perform the entire simulation. A single cell of 1 km with inter cell interference is used and out of the total number of users half of them having VoIP flows and remaining half are having video flows. Performance of these scheduling algorithms is tested for five parameters i.e, fairness index, packet loss ratio, total spectral efficiency, packet throughput and packet delay. Simulation results showed that the MLWDF performed better than the PF and the EXP/PF algorithms in terms of all the parameters and for the both the traffics.

In 2013, A.S Sravani et.al [8] proposed two algorithms known as Max Round Robin and Max Throughput algorithms for high speed packet access giving higher capacity and fairness than other conventional algorithms Max SNR, Round Robin and Proportional Fair are the three. As the users are not fixed and most probably they are randomly situated so for every instant, the active users are changed Simulation results showed that the two proposed algorithms achieved higher values of efficiency, average cell goodput etc. Than the conventional algorithms but Max throughput scheduling is used in place of Max SNR because by using this, the performance is improved in terms of capacity of the system and fairness in all the users. So, the proposed scheduling algorithms performed better than the conventional algorithms.

In 2011, T. Ali- Yahiya et.al [9] investigated the performance of PF, M-LWDF and EXP/PF in LTE and in this a single cell with interference scenario is used. There are 40% of users using video flows, 40% of users using VoIP flows and 20% of users using best effort flows and considered that users are constantly moving at speed of 3kmph in random directions. LTE simulator is used for the simulation because LTE – Sim provides a support for radio resource allocation in a time – frequency domain. This concluded that M-LWDF and EXP performed far better than PF when using real time flows.PF is not considered as a good solution for real time services.EXP/PF scheduling algorithm seems an optimal possible solution for guaranteeing a good QoS level. Multi-user MIMO communication can give significant gains by using spatial multiplexing. However, it needs better feedback to provide correct channel state information at the transmitter (CSIT) for minimizing the interference of multiuser. 3GPP LTE provides support for MU-MIMO, but it is not enough to extract sizable gains. In this paper, our basic and primary goal is to exploit the system's resources efficiently for MU-MIMO in LTE. We observed that the TM5 i.e. known as the transmission mode 5 committed for MUMIMO (Multi-user Multiple input Multiple output) utilizes wideband feedback method which is very useful for providing channel directional information (CDI) or precoding matrix indicator (PMI) in the existing LTE standard of 3GPP (Rel. 8). Therefore in this work, we recommend to take advantage of the sub-band feedback for providing more and more accurate and frequent update of PMI. However, in order to support this or maintain this feedback method, we have to or need to propose a new downlink control information (DCI) format for TM5 i.e. transmission mode 5 that will contain additional fields or supplementary data when it compare with the existing DCI format 1D [12]. MU-MIMO transmission scheme has drawn a lot of attentions during the modern development of Long Term Evolution (LTE) systems. Multiuser multiple-input multiple-output plays a apparent role in the transmission. Based on the feedback information or response of the downlink channel, evolved NodeB may accomplish multiple accesses via MIMO technology in MU-MIMO Transmission Mode and allow user equipment's to distribute resources in frequency as well as time domain. In this paper, we review several signal detectors and on the basis of which evaluate their performance in MU-MIMO transmission. The review work targeted or aimed as to check it or to evaluate the feasibility study of receivers in LTE systems. Different scenarios and correlations have been considered in the evaluation as well as in assessment progress, for example low and high spatial correlation, feedback delay and real channel estimation. Adaptive algorithm for MIMO detection under LTE-A system is based on the detection of sphere is proposed in this paper. The algorithm proposed in this paper uses M-algorithm for

reference to eliminate unreliable constellation candidates before the search is being performed, and the number of constellation reservation is adaptively tune up according to SNR. Simulations show about the LTE-A downlink performance of BER also represents as the proposed detection algorithm which is nearly the same as maximum likelihood (ML) detection algorithm. On the other hand, the complexity is reduced by on an approximation of 30% as compared with full constellation sphere detection [16].

RESULTS

In the year 2011, T. Ali Yahiya et.al [9] analyzed the consequences for different parameter of metrics. And the value of fairness calculated is shown below:

Table.1: Result

Scheduling Strategy	Fairness Index
ASA	0.774
OFDM-TDMA	0.527
RSA	0.830
Max. SNR	0.705

In the year 2013, Oana IOSIF et.al [4] has given his analysis on the value of throughput for the various schedulers for variable bandwidth,

Table.2: Result

Schedulers	Throughput (Mbps)
ROUND ROBIN	45.06
PROPORTIONAL FAIR	63.89
BEST CQI	80.72

CONCLUSION

Different scheduling method are studied for various downlink traffic flows in terms of the parameter metrics i.e. the delay time, throughput, packet loss, fairness index, spectral efficiency and analysed various outputs by comparing the parameters and scheduling scheme that is proposed in the different papers. This survey summarizes the improvement in LTE-Advanced that has been evaluated and specified throughout with the respective study and the work item phase in 3GPP. The different features convey varying activity gains and will show

certain effects on the system cost and complexity. The LTE-A is an development of LTE and had been finalized about three years after LTE Release 8 in 3GPP group. Paper presents a crucial beginning to the units of Uplink LTE-A method of communication. The Uplink LTE-A is based on radio communications technique or the RF technique which is being mentioned & used in various new technologies. Basically different technologies of Uplink LTE-A has been surveyed and shows that for better uplink high speed, communication approach are distributed to the end user.

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