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A Novel Study on Capacity Improving Algorithm for High Data Rate LTE-A Downlink System

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Abstract: LTE and LTE-Advanced have provided a major step forward in mobile communication capability. It helps for enabling mobile service provisioning to approach for first time. In LTE-A system, heterogeneous networks are important to improve system throughput per unit area. This paper presents a review on high data rate LTE-A system. In this, OFDMA technique is used in downlink and SC-FDMA technique is used in uplink. In downlink, the combined usage of inter-cell interference that reduces the interference from macro cell and cell range expansion is very effective for improving throughput performance. This paper focuses on improving capacity in LTE-A system by concept of increasing power. It also focuses on reducing PAPR value of system by using suitable filtering technique. All simulations will be implemented in MATLAB.

Keywords: LTE, PAPR, OFDMA, SC-FDMA etc.

I. INTRODUCTION

During the previous two decades, telecom industry has developed aggressively. The enormous fame of smart phones has brought the requirement for broadband networks in mobile phones. Aside from voice communication, the present mobile networks may offer users with a range of services that include real time gaming, web browsing, video live streaming, etc. Various users require faster speed for access and also require lower latency while operators require large capacity and also high efficiency. Due to this, for fulfil these demands, 3GPP deployed the LTE standard (Release 8) and finalized with Release 9 as its final version. In the communication system, the structure with high data rate take part an important role in daily life, so it is important for research. The enormous number of applications concerning scheme with high data rate made it necessary to attain the finest achievable performance with the least probable cost. Generally, these high data rate network experience from the existence of multipath channels.

In order to meet the ever increasing thirst for high data rate brought by mobile devices, the 3GPP proposed the LTE-A standard release10 providing improvement of release 8/9. LTE provides simplicity in architecture as compared to previous systems that promoted this architecture on the way to simpler & effective flat system. The main aim of LTE is to provide optimization for packet switching services which is required for higher throughput & high data rates and also improvement in packet delivery delay. There is also consideration of optimization of inter-networking with other platform like different access networks.

In its Release 8, 3rd Generation Partnership Project (3GPP) [1] has standardized Long Term Evolution (LTE) as the successor of the Universal Mobile Telecommunications System (UMTS) standard. LTE was designed such that all its services would be packet switched not the circuit switched. So, it provides the trend from evolution of GSM (Global System for Mobile communications) to GPRS (General Packet Radio Service), High-Speed Packet Access & UMTS etc. During this development, the main focus has been moving towards accessibility of broadband communications in addition to voice & text communication capabilities.

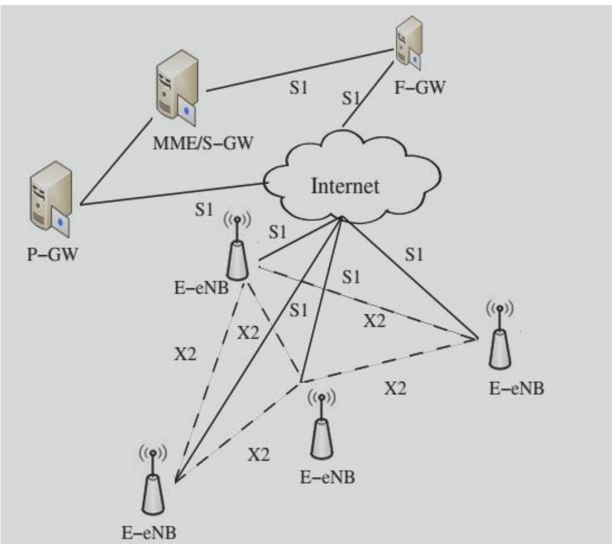

Figure 1: Architecture of LTE Network [1]

The LTE is based on Orthogonal Frequency-Division Multiple Access (OFDMA) in the downlink, and single-carrier FDMA in the uplink, which both switch the wide-band frequency discriminating channel into a set of fading sub channels through a Cyclic Prefix (CP). In the case of MIMO transmission, optimal receivers can be implemented with reasonable complexity, as conflicting to W-CDMA systems, where time-domain equalization is desirable. This is the main advantage of this system. Furthermore, OFDMA allows for frequency domain scheduling, building it possible to assign Physical resources to users with optimal channel circumstances. This provides huge potential throughput gains in the downlink due to multi-user range.

OFDM is known as Orthogonal Frequency Division Multiplexing and is used in modulation of digital information & in many of networks with high data-rate mainly Digital Audio Broadcast (DAB), Digital Video Broadcast – Terrestrial (DVB-T), Wireless Local Area Network & high speed telephone line communication. In OFDM System, one OFDM symbol is a set of a large quantity of signals called waves that are orthogonal in nature.

Table 1: Major Requirements in LTE System

Bandwidth	1.4,3,5,10,15,20 MHz	
Peak data Rate	DL	100 Mbps
	UL	50 Mbps
Spectrum Efficiency	DL	3-4 times
	UL	2-3 times
User Throughput	DL	3-4 times
	UL	2-3 times

In this paper, it explores the downlink control process in carrier aggregation based LTE system where users are multiplexed together for transmission. The equivalent capacity is representing maximum number of users for each class. The remainder of this paper is organised as follows. Section II Introduces the related work of LTE and LTE-A system. Section III represents the system model related to LTE system. Finally Section IV concludes the paper.

II. RELATED WORK

Cheng-Chung Lin et. Al. [4] introduced the related work of LTE system. It proposed a handover algorithm which was capacity integrated. The main aim of this algorithm was to provide assurance that radio resources were proficiently used in the system. These were used in channel quality & capacity domains while decreasing needless feedbacks. The simulation results showed that this algorithm improved the system throughput which was its main advantage. It also minimized the system delay and packet loss. The main problem in this was the handling of handovers. In this, capacity integrated proposed handover algorithm minimized 32% system delay than general handover algorithm.

Cheng-Chung Lin et. Al. [5] presented a handover algorithm in LTE-A system. It was implemented in C/C++ simulation tool. The Simulation results showed that this algorithm improved the system throughput & also minimized the system delay and packet loss. It was compared with standard handover algorithm in LTE system & proved to be better. The main problem in this was this algorithm could lead to system capacity burden and system throughput issues when dealing large amount of UEs in the system. The system throughput improvement between LTE-A and LTE in 30, 50, 80, and 100 UEs is 42%, 47%, 49%, and 27%, respectively.

X. Zhang et. Al. [6] proposed a novel two-step network flow based mobility LB (NFT-MLB) algorithm in self-organizing network (SON). Network flow theory is applied in the first step to optimize the procedure of overload traffic transfer, and then the user equipment (UE) capabilities are considered to select the specific handover users. The cell physical resource variety is also assumed in the presented algorithm to support the key feature in (LTE-A) long term evolution-advanced systems, i.e., aggregation of carrier. The simulations based on System level were conducted to exhibit the improvement of performance of proposed LB algorithm. It is shown from the results that the load distribution index and average load ratio are improved significantly.

S.P. Thiagarajah et. Al. [7] introduced that offloading of data from macro-cells to pico-cells helps to ease capacity demand in hotspot areas where user distribution is dense and often demanding high bandwidths per user. This study uses a heterogeneous network using combined LTE– WiFi IEEE 802.11n coverage for improving the performance capacity of system. The heterogeneous network uses the offloading mechanism to enhance the per user capacity of the heterogeneous network. The simulation results show that although around 50% of the users are offloaded to WiFi, the LTE network is only relieved 2.75% of the total capacity usage. The overall LTE system capacity only increased by 2.747%, this released capacity translates to almost 100% increase in capacity per LTE user after all the offloading.

J Xu et. Al. [8] studied various algorithms for load balancing for solving localized congestion problems. These were implemented by reinforcement Q-Learning algorithm. It was used to forecast load status for every node and used the concept of self organization. Due to this, the matching between network resources and traffic demand was optimum. In this, call blocking ratio was an important parameter to assess performance of system. In this, they improved 25% better value and congestion was relieved by proposed system. It balanced the load system but did not improve the capacity of system.

Jean Avocanh et. Al. [9] proposed a scheduling algorithm which was used to optimize resource assignment in overbooking scenario. The main function of this algorithm

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is to serve available resources. There was a trade-off between spectral efficiency, QoS (Quality of Service) requirements and fairness. The performance was evaluated by simulation. It allowed a good level of fairness and also improved system capacity.

S. Zhao et. Al. [10] proposed a Frequency Selective SRS (FS-SRS) system for improving the quality of system. In this, the base station scheduled each user to send signal only on available bandwidth. The results showed that the proposed system provided better accuracy as compared to current scheme. The proposed method was robust to channels that was frequency selective and also didn't affect by offset in timing.

Xuanli Wu et. Al. [11] introduced two parameters for Guaranteed Bit Rate (GBR) and Non-GBR traffics into TD-LTE-A system. In this, it proposed a beam forming algorithm for user-satisfaction. This provided a parameter that adjusted weights for SNR. It also considered the weights for different traffics so that user satisfaction parameter may be modified based on requirement. The results showed that this work can improve user fairness and satisfaction. But it depends upon priority parameter for adjusting traffic. The proposed algorithm can improve user satisfaction by more than 2%and8%in comparison with the weighted algorithm.

Su Yi et. Al. [12] proposed an effective channel measurement scheme for band relaying system. It was a channel quality reporting scheme that was based on sub frame grouping. The proposed channel measurement scheme anticipated the level of interference at different sub frames. This helped scheduler make decisions in different sub frames. From the results, the evaluations showed that the proposed structure can further improve the cell average and cell-edge user performance for different exploitation scenarios. Results showed that this "Grouped" scheme will give benefit especially under heavy traffic load condition.

Lexi Xu et. Al. [13] employed a user relaying model and proposes a user relay assisted traffic shifting (URTS) scheme to address this problem. In URTS scheme, a shifted user selects a suitable non active user as relay user to forward signal, thus enhancing the link quality of the shifted user. Since the user relaying model consumes relay user's energy, a utility function is designed in relay selection to reach a trade-off between the shifted user's link quality improvement and the relay user's energy consumption. The proposed results showed that the URTS scheme can get better SINR and capacity of shifted users. The CLB with utility function user relay scheme can increase the capacity by 31%, and the CLB with WTS user relay scheme can increase the capacity by 35%, fewer than 700 users' scenario.

Ran Zhang et. Al. [14] presented the admission control process in downlink in LTE-Advanced System with carrier Aggregation. It was used to compare the ability of LTE and LTE-A users. This system was modelled as a birth-death process for each user that was based on traffic generation model. After this, it derived the relation between capacity and system bandwidth for a single user LTE-A system.

Dr. G. Indumathi et. Al. [15] proposed optimum physical layer architecture of a high data rate LTE uplink transceiver using SC–FDMA multiple access scheme with error correction mechanism using Low dense parity check codes (LDPC) to provide lesser Bit Error Rate (BER) and avoiding packet loss by Interleaving. The optimum physical layer (PL) architecture for the 4^{th} generation (4G) wireless communication systems is chosen by comparing the LDPC coded SC–FDMA with the LDPC coded OFDMA. It provided Less PAPR value in high data rates.

III. DESCRIPTION OF SYSTEM

Long Term Evolution-Advanced (LTE-Advanced also known as LTE-A or LTE Release 10) is a mobile communication standard proposed by 3rd Generation Partnership Project (3GPP) in 2009 as a major enhancement of LTE standard. The LTE is based on Orthogonal Frequency-Division Multiple Access (OFDMA) in the Downlink, and Single-carrier FDMA in the Uplink. It studied the performance of LTE-A systems with CA for LTE and LTE-A users under two bandwidth allocation strategies. The concept of effective bandwidth has been introduced to map the user throughput requirement into the bandwidth requirement considering the wireless channel statistics. In this, users didn't have MIMO capabilities.

Then, closed-form expressions of Equivalent Capacity have been derived with the binomial-normal approximation. Proportional fair scheme deals with spectral efficiency and fairness but never considers any QoS parameter, thereby giving no guarantee to flows with high priority. Some provided a simulation for finding the optimum pair for the high data rate LTE uplink transceiver. Interleaving is done to improve the reliability of the system and LDPC codes are used which is more suitable for higher data rates. But in this, PAPR value is high which costs energy efficiency. The problem of high PAPR value in the System decreases energy efficiency of system. And the problem of high traffic creates high energy usage in the network which decreases the channel capacity of system. The secondary transmission capacity gets worse with the increase of throughput improvement ratio and it becomes zero when throughput improvement ratio is larger than a critical point. The concept of Carrier Aggregation (CA) allows scalable bandwidth extension via aggregating multiple smaller band segments; each called a Component Carrier (CC), into a wider virtual frequency band to transmit at higher rates. Due to which LTE-A System has a scope for improving channel capacity.

The problem of high PAPR value in the system ultimately decreases energy efficiency of system and high traffic demands high energy usage in the network which decreases the channel capacity of system. In downlink, the transmission capacity gets poorer with the increase of throughput improvement ratio and it becomes zero when throughput improvement ratio is larger than a critical point. Due to this, it will design a high data rate LTE-A system for improving capacity under Rayleigh fading channel by Analytical or iterative approach. In this, it uses SC-FDMA in Uplink & OFDMA in Downlink under different modulation formats.

IV. CONCLUSION

In this work, it reviews the performance of LTE-A system with carrier aggregation for users under bandwidth allocation strategy. It also provides a review on finding optimal result for high data rate LTE downlink receiver. For high data rate, high modulation format will be used. The main objective is to reduce high PAPR value. For this, it will use suitable filtering concept for reducing PAPR value. Also it will prefer the optimal method for improving capacity of system. If system has less PAPR value then its energy efficiency is better.

In future, LTE with mimo system with minimum error must be considered for better results.

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