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LTE Advanced Technology- A Step Towards 5g

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Abstract: ***In recent year's mobile phone and smart phone users has increased rapidly. Due to increasing the number of users, the 3gpp worked in the direction of enhancing the technology to overcome the crisis of the resource allocation, interference due to another cells etc. Various technologies viz. Carrier aggregation, collaborative multi-point, and enhanced inter-cell interference coordination under the Long Term Evolution-Advanced. Various algorithms are proposed by researchers in some couple of years. In this paper recent works on Carrier Aggregation, Collaborative Multipoint, Enhanced Inter-cell Interference Coordination are reviewed.***

Key Words: LTE, LTE-Advanced Carrier Aggregation(CA), Collaborative Multi-Point(CoMP), enhanced inter-cell interference coordination(eICIC), Heterogeneous Network(HetNet).

I. INTRODUCTION

The LTE Technology is promising technology for betterment of networks in the field of network communication. 3rd Generation Project Partnership (3GPP) uplifted the feature of communication technology[1]. Here we will discuss the three main technology of LTE and LTE advanced. LTE, comes under ITU (International Telecommunication Union) family is a wireless data communication technology[2].The article lights on performance, efficiency, and technology used in the LTE- Advanced related to Carrier aggregation, collaborated multi point, and enhanced inter cell interference coordination. The first release of 3GPP was for GSM system in 1999. Long Term Evolution (LTE) was introduced in Release 8. In release 9, there is a complete integration of the femto-Cell concept and evolved features e.g. self-organizing network, evolved multimedia broadcast and multi-cast service (eMBMS), positioning support, a new spectrum band also added[3]. But, still there was a need to increase spectral efficiency, high data rate, lowering the short round trip time and increasing flexibility in frequency and bandwidth. So, release 10 focuses on these services. DL and UL speeds went up to 300Mbps and 75 Mbps respectively. It supports FDD(Frequency Division Duplex) and TDD(Time Division Duplex)[4]. The architecture of LTE[5] is named as Evolved Packet Core (EPC). EPC replace GPRS(General Packet Radio Service) for both voice and data services using IP protocols. In the EPC part, it contains MME (mobility management entity), HSS (home subscriber server), SGW (server gateway) and PDN-GW (public data network gateway). In EUTRAN(Evolved Universal Terrestrial Radio Access Network), it consist base station and user. EUTRAN and EPC make EPS. Tunneling is used to make more efficient handover from a routing prospective. Tunneling[6] is a process of putting an IP address in front of original IP packet.
It provides both basic capabilities access and mobility. CA technology mainly used to increase the bandwidth as to increase efficiency of the network[7]. In CoMP, multiple transmissions are rendered to increase the signal strength[8]. In eICIC, various neighboring cells coordinated to each other.

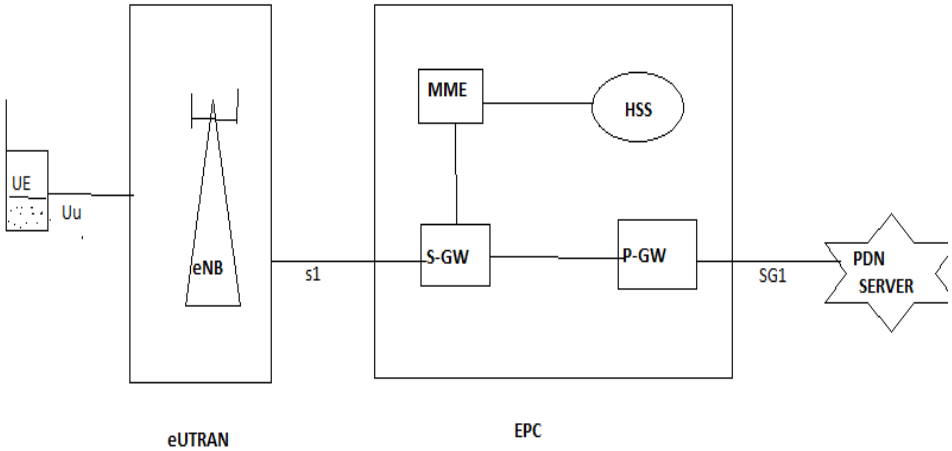

Figure.1 EPS Architecture

II. LITERATURE REVIEW

In LTE-Advanced, researchers did work for the enhancement of the technology. In LTE-A, there is a need of high peak data rates and high throughput per cell. This can be achieved by wider bandwidths. For this purpose *carrier aggregation* is used. Each aggregated carrier is a component carrier(CC) and maximum five CC can be aggregated, one is primary and four are secondary[4].

A. Another advantage of CA is adequate use of fragmented spectrum. In LTE-A there are 3 types of CA[7].

1) Intra-band contiguous CA,
2) Intra-band noncontiguous CA
3) and inter-band CA

B. There are 2 types of Component Carrier [9].

1) Backward compatible Carrier (accessible to all UEs of LTE Releases)
2) And Non-Backward compatible carrier (not accessible to User Equipments (UEs) of earlier releases).

Latter works more efficiently on LTE-A UE. Further release 8 compatible components carriers' bandwidths increased as carrier segments. Some carrier cannot be operated as single carrier, these are extension carrier. These are the part of standalone carrier[9]

C. CA Configuration

Every UE can be connected up to 5 serving cells in which one cell is primary [10]. A UE operated in a Primary serving Cell(PCell) can change their PCell during handover. SCell are configured as serving cells. SCell can work only when there in one Pcell. Scell comprises four processes viz. Addition, release, activation, and deactivation [9].

DL CA operations are performed by Physical Downlink Shared Channel (PDSCH) transmission, which plays role in determining the health of the channel by Cannel Quality Index(CQI), Rank Index(RI) and Pre-coding Matrix Indicators(PMI). Channel is shared among the UEs. DL control channels works on scheduling assignments and power control.
In UL CA, whenever the some information is arrived on UE, it sends scheduling request to the evolved Node B(eNB) on control channels and then eNB sends Uplink(UL) grants, and then UE sends data[9]. In CA scheduling, there can be 2*2 Multiple Input Multiple Output(MIMO)[11] on all cells in LTE-A e.g. 10 with 5 CCs. Radio Resource Management(RRM)in Release 8 is a mechanism of exchanging and updating relevant measurements between eNBs. In, at UE level bandwidth extension scheme is used by using NxSC-FDMA[12]. This is very helpful for decreasing the peak to average power ratio at UE. Band widths can be increased up to 100 MHz. A low complexity post IFFT technique is used to decrease PAPR in UL transmission
Further resource allocation is resolved in parallel transmission [13]. It focused on efficient use of parallel transmissions using noncontiguous carrier aggregation using OFDM techniques. OFDM is a technique that is used to reduce intra cell interference[14]. For massive parallel transmission it used a concept virtual CC[13] for multiple CCs to carry on. For implementation BBU part is focused. A filter bank is used between the baseband unit and radio frequency module for analyzing like signal to noise ratio. Another approach[14] for optimizing resource allocation is by increasing quality of service using joint transmission. It is based on eeliest deadline first[14] for downlink traffic. In [15], CQI is used to mitigate the interference that would enhance the quality of service of the channel in a femto cell network scenario. In [16], multiband traffic is discussed by using multiplexers. It focused on the downlink traffic mainly. It can be used 8 filters simultaneously. And UL and DL both speed can be increased using game matching theory[17]. Using this scheme for CA DL speed can be increased up to 1 Gbps. CQI, carrier selection and QoS parameters are used for resource allocation process. In multiband telecommunications acoustic filters is useful technique to overcome its challenges[18].Two techniques of relaying viz. decode and forward, and amplify and forward are very useful in for cognitive radio networks[19]. Joint relay selection and dynamic power selection are used for secondary user and primary user respectively. In heterogeneous network bandwidth is increased by multi stream carrier aggregation but high energy is consumed. In[20], proposed an algorithm for power balancing among the base stations.

D. Collaborative multi-point (CoMP)

Within a cell, at edges signal is faded due distance, coverage is decreased and interference increased, at cell edge the throughput is also decreased. To overcome these shortcomings CoMP came into existence[21]. There is coordination among the multi-transmission point in DL, and multi-receiving point in UL. Co-located multi point can be in same eNB or not. It can be done for both homogeneous and heterogeneous network. There is 2 case, joint transmission and dynamic point selection[22]. In Joint

transmission multiple antennas transmits in same frequency and same sub frame. With joint transmission, coordinated scheduling and coordinated beam-forming is considered for transmission in DL CoMP[23]. In dynamic point selection[24], scheduling is done from one transmission point among 2 or more transmission point in each sub-frame. According to coordination nodes, two types of CoMP are intra-eNB and inter-eNB CoMP. According to coordinated users, it is SU-MIMO and MU-MIMO[25].

In LTE-A, there are two types of reference signal[26], channel state index and demodulation as to reduce RS overhead. DMRS is cell specific and pre-coded RS, and used for coherent DM in DL channel estimation. To Implement DMRS, LTE-A used rank independent power allocation. There are 3 types of mechanisms for CoMP feedback[27]

1) explicit (observed by receiver),
2) implicit (using hypotheses of different Tx/Rx processing),
3) And time division and frequency division based. CoMP transforms the inter-cell interference into useful signal.

Where the users are more in numbers then the signals are faded and interference also increased then the small cells (femto or pico)[22] can be embedded in the macro cells. Whole network is divided in the partitions then in each partition a small antenna is established for better throughput on cell edge users.

E. Downlink CoMP

There are 3 steps for DL CoMP processing

1) 1st is to identify victim UE.
2) 2nd is UE sends feedback to serving eNB.
3) is scheduling by network[26].

In Joint Processing, data is transmitted by multiple transmission points to single or multiple receiving points to reduce interference. It requires both data and CSI[28]. If there is limited backhaul capacity then coordinated scheduling or beam-forming is suggested[23]. Various point transmit the same signal at same carrier to enhance the signal strength. All other signals are muted as not to create interference. GRRA is used to support the multimedia transmission in downlink in LTE-A system[29]. It works on the priority order and minimum bit required by users.

UL CoMP

For UL, when the SRS received on cooperating eNBs, the UE is identified and SRS measurements is shared among the coordinated eNBs. Then received signal is shared. Fangzhou Chen et al.[30] presented a scheme that enhance the performance the system mainly in UL CoMP. Information is exchanged among the users rough back haul network, checks the channel state and sends the signal by keeping balance between SNR and INR to nearby base station by controlling the power of signal. Kyuhwan Kwak et al.[31] present a novel solution for the same issue, during CoMP JT delay as UE increase in number.

In LTE CoMP Transmission a central unit plays an important role. There is timing offs(TO) between the UEs and eNBs. A Random Access technique is used for UEs[32]. This is used to get the knowledge of TO and power of the network. To increase the cell edge UEs throughput a spectrum sharing method is used by allocating spectrum to other users temporarily, so that resources can be reused. It increases the interference at cell edge. To control the interference, information is shared. Scheduling and coordination among the base stations is done, for fairness in transmission. Generally the fairness and QoS are inversely proportional to power efficiency of CoMP transmission. It means when power is reduced the QoS also reduced green radio resource allocation is a method to maintain both optimum simultaneously[29]. To enhance QoS, Radio Resource allocation should be done in an effective way. A central unit can be used to enhance the coordination among the base stations. Base stations and central unit are connected via a back-haul network. Due to back-haul network, Transmission in UL and DL can be done in a more cooperative way by allowing the active users only to transmit the signal [33].

When the traffic is large on the back-haul network, it congests the network. Hence deteriorate the network performance. A cache enabled back-haul network can be a solution to this problem [23]. In this system the cache enabled base stations are used for CoMP JT operations as a result the speed of the network increased.

For energy efficiency in the CoMP based system grid based system is used[34]. In grid based system, both conventional and renewable energy providing system is used and so that in DL and UL energy consumption can be established according to the necessity. For efficient use of energy, Fei Zheng et al.[35] proposed an mechanism in which the performance in the clusters is optimized by dividing the problem into parts. It determines home cell and cooperative cells using greedy algorithm. A threshold is used to cover the limitations of the cell system as it restricts the user control on access the network. Shirish Nagaraj et al.[36] worked for small cells to optimize cooperation among them, as choosing the helping cell under backhaul network constraints. Using

feedback from the network SELCUK BASSOY et al.[37] presented a load aware algorithm. Access is provided according to the load of the cluster for the efficient use of the resources.

F. Enhanced Inter-Cell Interference Coordination

In LTE, when two neighboring cell are operated, there is signal cross talk between them, that result in interference [38].Heterogeneous network enhances the Quality of services like throughput, coverage etc. Interference is a factor that affects the network performance. Especially in multi-cell network and heterogeneous network it is a serious problem. Enhanced Inter-cell Interference Coordination (eICIC) is applied to suppress the interference between the cells and increase UE throughput[39]. It can be done by interference avoidance, suppression and ICIC[40]. ICIC is a frequency domain technique, where eICIC is a time domain technique. EICIC works on principle time domain resource sharing instead of CQI feedback with packet scheduler. In eICIC base transceiver station synchronization is required. In eICIC, solution for frequency domain is mutually exclusive resource block allocation and for time domain are ABSF[41]and MBSFN[40]. Solution in power control is- adjusting power in HeNB. In HetNet ABS plays an important role. ABS is almost blank sub-frame which some sub-frames are protected for pico cell or femto cell transmission. During the transmission in pico or femto cell, there is no transmission in macro cell.

Hao Zhou et al.[42] a technique named alternating direction method of multipliers (ADMM) in which ABS and Cell Range Extension Biasing is considered for problem solution of interference. Macro and pico base stations coordinated to each other as they had divided the problem in sub problems.

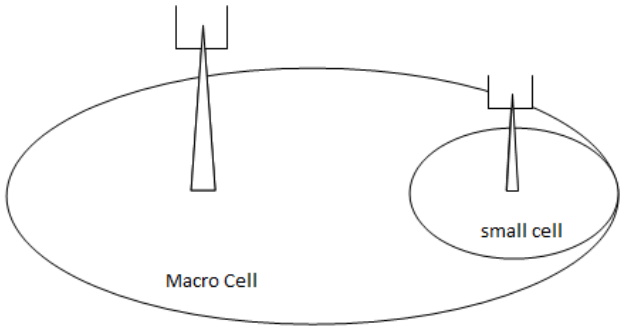

Figure 2. Heterogeneous Network Scenario

In heterogeneous network, reuse of resources is a big advantage. The macro base stations and small base stations provide the best service to the users by using cell range extension. Subramanian Vasudevan et al.[43] used the mechanism for optimizing the performance based upon the ABS and CRE Biasing[44] by coordinating the macro and micro cells. Pico cell cover the area for transmission larger than femto cell. Usually these small cells are used for signal empowerment, betterments of throughput, especially on macro cell edges. Supratim Deb et al.[45] gave an algorithm that work on the basis of self organizing network. It is used for calculating the ABS and cell selection bias. In [52], a mechanism works on reducing the power consumption by offloading the macro cell in cell expansion region. A capacity analysis is done in [46] where sub-frame power is reduced and system parameters are sets accordingly. Among different frequency used in range expansion region the load balancing [47]and joint optimization [48] can increase the throughput. In [49]a comparison is done between non- eICIC and eICIC system in HetNet network, which shows that earlier is better. [50] and [51] shows the decrement in interference within cells using radio resource heads.

III. CONCLUSION

it can be concluded that all of the three technologies viz. Carrier aggregation, collaborative multi-point and enhanced inter-cell interference coordination plays a great role for increasing bandwidth, increasing throughput at user end, and managing interference. These all will lead the present technology in better communication environment that will profit the users directly. The users that are in dense region in the sense of number of mobile users, eICIC together with coordinated multipoint is proved very efficient technique for them. In heterogeneous network system hotspots areas are considered as the victim points. Both the techniques are provides the solution. Carrier aggregation was used for increasing throughput at that victim points and provide the efficient coverage. In a nut shell, these technologies collaboratively are step to 5G.

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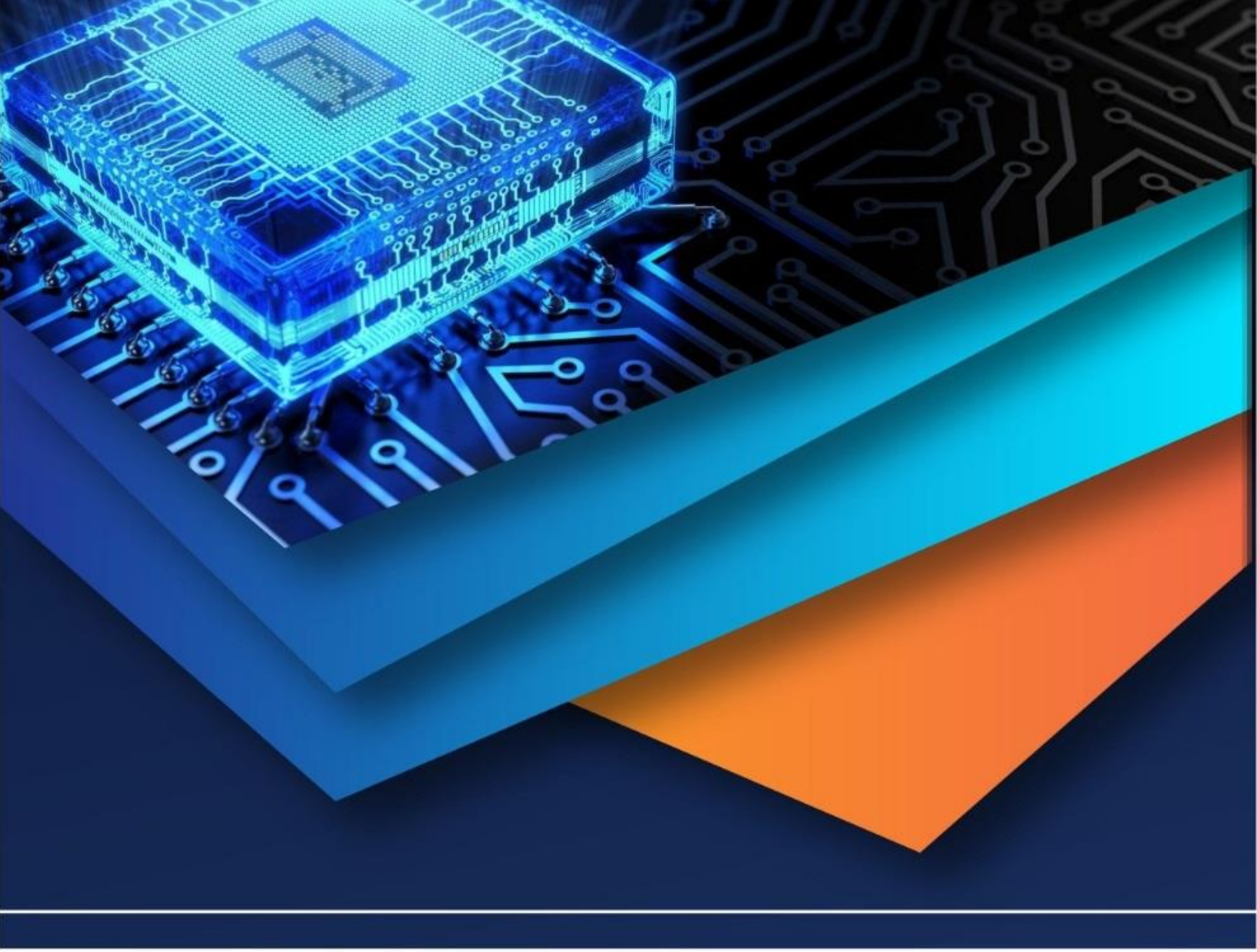

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