Interference Reduction Techniques for Heterogeneous Network in 4G LTE-A System

Manju Sangar  
Dept. of E.C., R.G.P.V., Bhopal

Shailendra Mohan Khare  
Dept. of E.C., R.G.P.V., Bhopal

Dr. Vivek Singh Kushwah  
Dept. of Electronics, Amity University, Gwalior

Abstract: In this paper, we discuss about 4G LTE-A (Long Term Evolution-Advanced) which is used for Heterogeneous Network for providing higher data rates and greater spectral efficiency. Some of the methods to improve the spectral efficiency are to be discussed in 4G (LTE-A) systems. The main cause of reduction of performance of systems is due to Intervention. In this paper, we will present and discuss the methods for deficiency of interference in LTE-A system. The methods to reduce interference in both UL (Uplink) and DL (Downlink); will be discussed. The basic approach we will discuss about how Interference signals can be utilized in the form of useful signals especially at cell edges to improve QoS (Quality of Service). One of the ways to reduce Intervention is by reducing the transmitted power and managing it carefully - which is a topic of extensive research for more than two decades. By carefully managing the type of interference, power control and frequency reuse Higher Spectral efficiency can be archived.

I. INTRODUCTION

The providing High speed data traffic and to make the system performance much higher than previous system (i.e. 3rd Generation Technology) there was a need for a new Communication Technology and Standard. This evolved in this form of 4th Generation mobile communication system, set for meeting the requirements of ITU-T was evolved as LTE-Advance (Long term evolution-Advance).

In 2009, it was submitted as a candidate 4G system to ITU-T as meeting the requirement of IMT-Advance standard, by the 3GPP (3rd Generation Partnership Project), but it was released officially in March 2011. In the 3rd Generation WCDMA and TD-CDMA the speed was high, but the data traffic was so more, so to make the system performance higher than previous system LTE-Advance techniques was submitted in October 2009. The Long term evolution of 3GPP is also known as E-UTRA (Evolved-Universal Terrestrial Radio Access) Network. It is considered as a Potential next generation mobile techniques.

For IMT-Advance System, there a harsh requirement for frequency efficiency and Peak data-rate. LTE-Advance is expected to enable peak data rates. Such as over 1gbps at 100MHz bandwidth and in the uplink peak data rates greater than 500mbps. LTE-Advance will utilize the diverse spectrum bonds already applicable for LTE as well as further IMT-Advance bands. LTE-Advance is an evolution of the LTE with a strong demand for full backward compatibility. Some degree compatibility for features where the advantage is truly compelling. At the same time the cost per bit should be reduced e.g., by addressing the backhaul challenge, enhancing self organizing network functionality, defining additional multivendor interfaces, and allowing for innovative deployment concepts such as relaying and multi-cell cooperative techniques.

II. LTE-ADVANCE

IMT-Advanced requirements can be archived by adopting low power nodes, limiting the frequency band resources; the relay, home eNB (HenB), Micro cellular base station, (Pico), remote radio head (RRH) to network with Macro base station is discussed widely. This is called Heterogeneous Cellular network (Het-Net).

Fig 1: Het-Net Network Example

When the users interfered with each other over the carrier bandwidth problem of Interference (ICI) arise. Inter-cell intervention also constrains spectrum efficiency and restricts the data rate of cell
edge users. For reducing the inter-cell intervention over the carrier bandwidth some advanced were employed to reduce the same cell interference which is employed by the design in LTE. It is called low power technique for setting user’s transmit power and managing uplink interference in the downlink and inter-cell intervention consist of CDMA technique when users interfered together over certain bandwidth, that time the receiver and sender device create same loss of carrier bandwidth which is also main cause of interference in the LTE-Advance System.

A. LTE CoMP (Coordinated Multipoint):

The LTE CoMP is a range of different methods that enables dynamic coordination of transmission and reception on a Variaty of different BS (Base Station). The Motive of LTE CoMP is to improve overall utilization as well as improving the quality for the user of the network essentially; LTE-Advance CoMP turns the inter-cell interference (ICI) into useful signals’ especially at the borders of the cell where performance may be affected.

![Fig2: Concept of coordinated Multipoint in LTE Advanced CoMP](image)

The concept of Coordinated Multipoint (CoMP) has been the focus of many studies by 3GPP for LTE – Advanced as well as the IEEE for their WiMAX, 802.16 standards.

B. UL-LTE CoMP:

In the downlink, the principle could be used for realizing joint transmission. The basic concept to make this format is to utilize antennas at different sites, for e.g. - Where one UE (User Equipment) is simultaneously served by multiple base stations. The received signals of eNodeB are then merged and produce the final output signal. By the use of this technique not only the signal strength of the signal increase for the respective UE, but at the same time also the interference originating from transmission to other UEs can be reduced. The low signal or marked signals by interference. This provides two-fold performance gain. Since the exclusive assignment of certain radio resources in multiple cooperating cells to one particular UE would come along with a loss of spectral jointly served by the set of cooperating cells at the same time for e.g. by employing well-known multi-user MIMO transmission across the various cells. In The Uplink in Contrast, Cooperating base stations could exchange appropriate information in order to improve signal detection. Similar to joint transmission in the downlink, a two-fold gain can be obtained in this from. Same recent theoretical result revealed in the fundamental potential of CoMP technique it has been show that in principal termed us performance gain may be realized in this way. In a Particular system like the 3GPP LTE, the achievable gains generally are expected to be below the theoretical gain, but it seems to be Significant. This reduction in gain is due to various practical issues such as geographical vicinity. The CoMP scheme is operated by coordinating scheduling decisions among eNodeB to minimization of interference. In downlink, this method provide a reduced load in that Network, because only scheduling the data required to be transferred between some other eNodeB that are coordinating with each other. For managing the uplink interference in 4G, we have to manage the power control which is a topic of research for more than two decades. However, uplink interference in LTE network required to be managed over multiple narrow bands (each corresponds to the collation of a few sub-carriers) ever the entire bandwidth, which enhances Unique Research Challenge. In Het-net model the system consist of heterogeneous networks (Cells) all of which share the carrier frequency i.e. the frequency reuse ratio is 1:1 in the network microcell have high transmitting power (low) While pico cell has low transmitting power (~40 W) while Pico cells has low transmitting power (~1-5 W). In Het-Net network the pico-cell are deployed by operators in traffic hotspot locations or in locations where the Macro coverage is poor. Let C-denotes the all cells which include macro and Pico-cells. The Het-Net networks are designed to achieve high special efficiency by reusing frequency in each cell.
III. INTER-CELL INTERFERENCE

4G networks are designed to achieve high spectral efficiency by reusing the same frequency resource in each cell. However, this approach increases the inter-Cell Interference (ICI) and may degrade the channel quality especially for cell edge users. In this work, we propose a method for inter-cell interference coordination (ICIC) to reduce ICI through efficient distributed power control. Power control does not only reduce the impact of interfering signal by lowering their power level (signal usually belonging to cell-center users,) but it can increase the power level on resource blocks that suffer from bad radio conditions (usually RB allotted for cell edge users). Several works have been proposed studied power control algorithms in OFDMA-based system. In a hybrid algorithm combined power control with adaptive modulation. It permits using high order modulation schemes at low signal to Noise radio values without degrading the system performance. In authors proposed an adaptive power control scheme to reduce inter-cell interference by applying a “Fair SINR “strategy, where power allocation is distributed among user is away to obtain the some signal to interference and Noise Radio (SINR) at the receiver. In, a distributed power control algorithm is proposed where each cell aims independently at minimizing its own power consumption under user’s rate constraints. The power allocation scheme takes into account the inter-cell interference. It is performed iteratively according to the proposed “Bit Allocation Algorithm” until the allocated power levels remain invariant after two consecutive iterations. In, a semi-distributed neighboring gradient information based algorithm and one fully distributed nontrivial heuristic based algorithm are proposed to automatically create soft a Fractional Frequency Reuse (FFR) pattern in OFDMA based system. The goal of the proposed algorithms is to adjust the transmit power of the different RBs by maximization of the overall network utility. The work in build upon the work in. The work in] extends the proposed algorithms for multi antenna OFDMA-based system with space division multiple accesses. The work in differs mainly by of power control spatial granularity, where the power is set on a per-beam basis. Finally in, the author addressed the problem of interference with a decentralized eICIC algorithm; they used Almost Blank Sub-Frame (ABSF) and Cell Selection Bias (CSB) to manage the interference between cells. Our work belongs to the category of decentralized ICIC. Resorting to non-cooperative game theory is suitable to model the way eNodeB compete in a distributed manner for limited resources. Devising an optimal power level selection scheme depends on the existence of Nash equilibriums (NE) for the present game. In this paper, we prove that the model at hand is a sub-modular game. Such games have always a NE and it can be attained using a greedy best response type algorithm (called algorithm I in both references). A comparison is made with a centralized CoMP system to access the price of anarchy. Noise Ratio values without degrading the system performance.

IV. RELATED WORK

Cellular Phone Power Control:

The uplink power control mechanism of cellular phones has been an active research field for around 3 decades. Power control algorithm on a shared carrier was primarily formulated in the pioneering works and then extended in a higher manner in [10]. However, these all models are applicable for the CDMA (3G) systems ULs. We prefer the readers for a better survey of the huge body of research in the power control. However, the UL model in Long Term Evaluation is basically different from these models for two reasons: First, LTE obstruction has very classifiable characteristics comparatively with CDMA, and second, LTE models have assigned cell-specific power control quantity for UE Signal to Interference and Noise Ratio targets.

Self-organized (SO) networking:

There was little latest work on SON algorithms for DL interference and power control in Long term evaluation. Study of downlink inter-cell interference co-ordination (ICIC) is proposed in [13]. DL transmit power chart for different frequency carriers are proposed in [14], which is used to develop analyze the data-driven SON algorithms for UL power control in LTE.

Fractional Power Control for LTE:

FPC-based LTE power control is which has led to some latest work [15], [16], [17] and [18]. In this work, framework and algorithms are not developed for optimization of the Fractional Power Control parameters supported on measurement data. Recognizing the issues of setting FPC values in
LTE and measures closed-loop power control procedures for instantly adjusting SINR targets so as to have an interference focus at each cell. This work has mainly two demerits: First, it is not clear that how the obstruction targets could be supported on network and traffic dynamics, and second, the method does not maximize any “network-wide” Self Organized Network object.

**LTE UL AND FRACTIONAL POWER CONTROL:**

Terminologies which are used in the Paper, is: A resource block (RB) is a block of twelve subcarriers and seven OFDM symbols and it is the smallest allocation resource in the frequency-time domain. ENodeB (eNB) refers to an LTE BS (base station), and it hosts the critical protocol layers like PHYSICAL, Radio Link Control, etc. User equipment (UE) refers to user end-device, and we also takes Uplink. Finally, reference signal received power (RSRP) is an averaged received power of all DL reference signals across the whole bandwidth as measured by a User Equipment. At UE RSRP is a measure of downlink signal strength.

**Uplink Transmission in LTE:**

SC-FDMA multiple access schemes is used by LTE UL. It reduces mobile station's peak-to-average power ratio $P_{av}$. It depends on the number of Resource Blocks which are assigned to the UE. Also, each Resource Block assigned to a UE is mapped to adjacent subcarriers by suitable frequency-hopping mechanisms [16]. For mitigate frequency selective fading At the BS receiver, the each-antenna signal is merged in a frequency-Domain MMSE combiner before the M-point Inverse DFT and decoding method is performed. The detail information of the above ways is not continual for our requirement; we have noted two key properties which will be helpful from an interference management perspective.

**V. SYSTEM MODEL AND PROBLEM FORMULATION**

While an FBS is doing downlink communication with an FUE under its service, it will create interference on FUEs not connected to it, as illustrated in Fig.1. When FBS 1 and FUE 1 are performing downlink communication, significant interference will be experienced by FUE 3 which is also doing downlink communication using the same frequency. Even FUE 2 which is far away from FBS 1 will also get minor downlink interference from FBS 1. So, investigating the downlink interference caused by FBSs can help in alleviating interference. This article considers the interference when FBSs and FUEs are performing downlink communications. For simplicity, we neglect the interference on FUEs caused by communication between MBS and MUEs. The scenario examined assumes that all FBSs use the same frequency at the same time and co-tier downlink interference is manifested. Then, FBS power control is used to attain the goal of mitigating the interference on surrounding FUEs not served by the FBS under consideration. In Section I, several methods to avoid interference have been mentioned. Neither partial fractional frequency reuse nor power control can completely eliminate the problem of interference in practical situations. Conventional partial fractional frequency reuse will still suffer cross-tier interference. Muting scheme as used in [4] avoids interference on the target by not overlapping the use of frequency in the same band by neighboring FBSs. But even if FUEs are not under the coverage of specific FBSs, they still may receive minor co-channel interference from them because of the nature of wireless communication. Another approach applies power control in conjunction with game theory [5]-[7] for mitigating FBS co-channel interference. In general, calculations involved in these methods are quite complex. In a constantly changing environment, we need solutions that incorporate a faster computing mechanism. First, based on [4], FBS A will shrink its coverage by power control and thereby reduce its heavy interference on the FUEs served by FBSs B through E and H, and a slight decrease of interference on the FUEs served by FBSs F and G. This article assumes that in a community where the network deployment is carefully planned, the network consisting of the FBSs and FUEs is under the jurisdiction of a femto cell management system (FMS) [4]. In contrast, in a community where network deployment is not planned in advanced, Mobility Management Entity (MME) and other system management functions are responsible for network management. In this article, the system administrator will be referred to as FMS. At the beginning, each FBS uses large enough transmit power to expand the communication range to twice the normal communication distance in order to establish a neighbor list. As shown in Fig.2, FBS F...
recognizes FBS E as a neighbor; namely areas covered by the two FBSs overlap and communication might be mutually disturbed, resulting in slow data transfers. The concept of neighbors is important and is the target of power control.

Figure 3: Interference mitigation by power control in 4G LTE

VI. CONCLUSION & DISCUSSION

In this paper, we studied about the new macro-pico summary of the 4G LTE (Long Term Evaluation) Het-Net system which consists of very speed data suffering which makes the communication and the data transfer process much higher than previous 2G & 3G systems. In this technique there are some interferences arises which affects the data transmission process which are inter-cell interference, uplink interference (UL) and downlink (DL) interference etc. in this we discussed about the uplink interference which arises when data (or Signal) is send from the mobile to macro base station and the losses occur in this UL interference are generally various power losses and the ways to over-come them with two properties to reduce them are mentioned and the downlink interference which occur due to the signaling between data transmission from base station to the mobile station and the power loss occurred in the signaling is considered and next interference considered is the inter-cell interference and various losses in it.

REFERENCES


