The International Journal Of Engineering And Science (IJES)
||Volume||2 ||Issue|| 4 ||Pages|| 78-81 ||2013||
ISSN(e): 2319 – 1813 ISSN(p): 2319 – 1805

Mitigation of Co-Channel Interference in Long Term Evolution

Vishnupriya.P

Electronics & Communication Engineering
[1,] *Christ College of Engg. & Technology Moolakulam, Pondicherry, India.*

Abstract

Co-channel interference in Long Term Evolution (LTE) cellular network is caused due to usage of same frequencies between the cells (cross-tier) at the same region. Here the term co-channel interference is otherwise known as inter-cell interference. It is important to mitigate this cross-tier co-channel interference between macrocells and femtocells in-order to improve the communication performance of the cellular network. In this paper, we describe the various approaches that exist to mitigate the co-channel interference by improving the user's throughput, coverage, capacity, SINR.

Keywords: *co-channel interference, long term evolution, cross-tier, macrocells, femtocells*

Date of Submission: 29 March2013 Date Of Publication: 20, April.2013

I. INTRODUCTION

The Long Term Evolution (LTE) is a fourth generation wireless communication standard exploited in mobile phones to achieve high data rate during mobility. This standard [1] is developed by the 3rd Generation Partnership Project (3GPP) by redesigning the radio network and core network. Is marketed as 4G LTE, the next major step in mobile radio communication and is specified as Release 8. It is based on the GSM/EDGE and UMTS/HSPA network technologies. The capacity and speed is increased using new modulation techniques. LTE employs Orthogonal Frequency Division Multiple Access (OFDM) for downlink data transmission and Single Carrier-Frequency Division Multiple Access (SC-FDMA) for uplink data transmission. The LTE specification provides downlink peak rates of 100 Mbit/s, uplink peak rates of 50 Mbit/s in 20MHz channel. LTE is Internet Protocol (IP)-based network architecture. Different scalable carrier bandwidths are possible ranging from 1.25 MHz to 20 MHz (more specifically:1.25 MHz, 2.5 MHz, 5 MHz, 10 MHz, 15 MHz and 20 MHz) and supports both Frequency Division Duplexing (FDD) and Time-Division Duplexing (TDD). LTE provides low latency, high throughput and supports packet switched domain only. Here the frequency is separated into different channels in order to avoid disturbance.

The author of the paper [2] proposes a dynamic FFR mechanism that selects the optimal frequency allocation based on the total throughput and user's satisfaction. Particularly, the mechanism divides the cell into two regions (inner and outer) and selects the optimal size as well as the optimal frequency allocation between these regions with main target to maximize the overall throughput and user satisfaction. In paper [3], a frequency reuse selection mechanism is proposed, aiming to reduce cross-tier CCI between macrocells and femtocells. Each macrocell is divided into inner and outer region and frequency is allocated with reuse factor 1 and reuse factor 3 respectively. The frequency band that will be used in each region is calculated for every possible combination of inner cell radius and subcarrier allocation. For femtocells, frequency allocation is done according to the femtocells's position in the network. Each femtocell chooses a frequency band which is different from the sub-band already used for the macrocell located in the same area and this frequency allocation is expected to further improve network's performance. The rest of this paper is organized as follows: Section II describes the theoretical background of co-channel interference and the problems caused by it. Section III describes the existing techniques for mitigating the co-channel interference in LTE cellular system. Section IV describes advantages & disadvantages of the existing techniques. Proposed technique is described in Section V. Section V: Conclusion.

II. CO-CHANNEL INTERFERENCE

In cellular mobile communication (GSM & LTE Systems), the frequency resource is partitioned into non-overlapping spectrum bands and is assigned to different cells. Co-channel interference (CCI) is the type of interference that exists between any two cells (cross-tier) in LTE cellular networks due to the sharing of same channel. Here this type of interference is a serious issue as it degrades the performance of the system in terms of data rate and spectral efficiency particularly at cell edge. Actually to improve the efficiency of spectrum the frequency reuse methods are adopted. But on the other hand this method leads to co-channel interference as the same set of frequency is used by several cells in the network. The term co-channel interference is also known as inter-cell interference (ICI). It is not possible to mitigate the co-channel interference by increasing the power of the transmitter. As this increased transmitter power might increase the interference among the neighboring co-channel cells. To mitigate co-channel interference there exist several simple approaches that is by physically separating the co-channel cells with minimum distance and by using the cell sectorization in the seven-cell system. The co-channel interference can also be controlled by cell planning, cell selection, modulation schemes, dynamic channel allocation and power control. By mitigating co-channel interference (CCI) the link quality and throughput for cell edge users can be improved.

III. EXISTING TECHNIQUES

3.1 User-centric coordinated scheduling

The coordination scheduling is done by central resource manager (CRM) which is located at the center macro base station (M-BS). This scheduling consists of two parameters namely, (i) Dominant interferers and (ii) Conditional channel quality information (CQI). During this scheduling process the list of dominant interferers are reported to central resource manager (CRM) through its serving BS. And the conditional CQI is defined by signal-to-interference-plus-noise ratio (SINR). Through this scheduling the laud neighbor problem can be tackled with the requirement of less signaling overhead. But there exists a problem in this approach that is in the idle mode the target BS's broadcast messages cannot be received by macro mobile stations (M-MSs) which is located near a femtocell. Thus coordination is not possible. To overcome this problem the power control mechanisms are proposed [4].

3.2 Power Control Mechanism

The power of the transmitter must be controlled in-order to avoid interferences. In various femtocell base stations (F-BSs) the fixed power setting scheme is used in which the value of transmit power is preconfigured. This scheme is simple and easy to implement. But it is difficult to adapt to the surrounding RF conditions of macrocell and thus might cause large interference in the network [5]. As in CDMA, here too exist near-far problem. Thus to overcome this problem the power of transmitting base station is controlled according to the distance between the serving BS and MS. In self configuration scheme, the femto-BS measures the initial configuration phase reception power and sets its transmit power accordingly. In [5] the author proposed an adaptive power setting scheme in which femto-BS measures the UL and DL reception power of the macro-BS and optimizes its transmit power. Thus this proposed scheme increased the femtocell average user throughput at the edge of the macrocell by 36% and 73% greater than that of self-configuration and fixed power setting schemes respectively. In [4] the femto BS's self power control minimizes the outage by controlling the power of the macro MS with respect to received signal power of the macrocell. Hence macro MS can hear the target macro BS's broadcast messages. But the weakness of this scheme is that it cannot guarantee that all macro MSs will be free from trapping and full power cannot be used by some of the femto BSs so the MS associated to this BS cannot provide better services. Thus the user requested femto BS power control is proposed to solve the above said problems by directly sending the request to BS from MS for maintaining the power level of dominant interferers to average received power of the BS.

3.3 Spectrum Management

The co-channel interference between femtocells and macrocells occur if the cell planning or the spectrum management is not considered in the network. Resource allocation is one of the efficient way to address the interference problem between macro and femto base stations. In [6] self-configuration fractional frequency reuse scheme, subset of sub-carriers (SCs) are allocated to cell edge of femtocells and all SCs are utilized at the cell center. According to this scheme the F-BS gets the periodic report about the user equipment (UE) from F-UE. If interference level is higher than the threshold value then FFR is performed at the neighboring F-BS by selecting distinct set of SCs for cell edge and also reduces the cell-center radius till the user lies at the cell-edge. Thus this scheme reduces the interference by enhancing the throughput of the system.

3.4 Spatial Channel Separation

In [7] the interference between macro-cell and femto-cell is mitigated by using separate spatial channel. That is different spatial channels are used at M-BS and H-BS for separate transmissions. But practically, spatial channel selection is very critical. Thus Gibbs sampler is used to overcome this challenge. Here the Gibbs sampler used to minimize the global energy. As a result the SINR of macro-UE and femto-UE is improved.

3.5 Physical Cell Identity (PCI) Manipulation

This approach [8] manipulates the cell ID of the home evolved nodeBs (HeNBs) and also reduces the interference caused from common reference symbol, physical downlink control channel etc to trapped macro UE. This method is compliant incase of closed access femto-cells and signaling is not required. Thus by transmitting data to femto UEs from HeNB the performance of trapped macro UEs is improved.

IV. COMPARISON

EXISTING SCHEMES	ADVANTAGES	DISADVANTAGES
Fixed Power	Simple and easy to implement	Does not adjust with the surrounding RF conditions of macro-cells and so might lead to interference
Adaptive Power Setting (based on DL reception power from M-BS)	F-BS at the edge of macrocell experience less interference with the nearby M-MS as the transmit power decreases.	Interference increases if power offset is set large as penetration is small.
Adaptive Power Setting (based on DL reception power from M-BS & UL reception power from M-MS)	If penetration loss is small, transmit power is decreased and hence macro-femto interference is mitigated.	-
Spatial Channel Separation	Does not require macro-femto coordination and feedback information for the case of implementation.	-
Coordinated Scheduling	-	In idle mode, M-MS situated nearby femtocell cannot receive the serving BS's message. Thus coordination is difficult in idle mode.
No Coordination	-	Radio link failure exists for the trapped macro UE.
Sparse Control Region	Combats interference between femto-cells.	Trapped M-UE's data is affected by interference from Home Evolved NodeBs (HeNB).
Physical Cell Identity (PCI) Manipulation	Does not require any signaling and no backward compatibility issues for legacy UEs.	-

V. PROPOSED SCHEME

In-order to reduce the co-channel interference in the network the cell size must be taken into account. With the integration of pico-cell over macro-cell the handoffs can be increased and also the amount of power consumption can be reduced in the network. Here we propose an adaptive fractional frequency reuse [3] concept on integrated pico-cell over macro-cell. The macro-cell is divided into two parts namely: inner region and outer region. To utilize the frequency resource efficiently the concept of frequency planning is considered here. The available spectrum is partitioned into four unequal parts and is reused in LTE cellular network. The frequency is allocated with the reuse factor 1 and reuse factor 3 in the inner region and outer region of maco-cell respectively. And for pico-cell the frequency is allocated according to its position in the macro-cell. Thus this network would provide seamless handoffs and also improves the capacity of mobile data. Which in-turn reduces the transmit power and increases the throughput of the users available at the cell edge of the network.

VI. CONCLUSION & FUTURE SCOPE

This paper gives a brief survey about the existing techniques for combating the co-channel interference in Long Term Evolution (LTE) cellular network so as to improve the performance of the network by increasing the capacity, coverage, user throughput, SINR etc. The LTE system is employed in mobile phones for achieving high data rate during mobility.

The future work could be the shrinking of cell size in the network to manage the interferences. For example: Integration of pico-cell over micro-cell consecutively to further reduce the transmission power in the LTE cellular system and also the channel model can be replaced with COST 2100. Is an extension of the existing model COST 273 which is contributed to the MIMO-advance and LTE system.

REFERENCES

[1] Martin Sauter, From GSM to LTE: An Introduction to Mobile Networks and Mobile Broadband, ch.4, pp.450-205, John Wiley and Sons, Ltd, Feb.2011

[2] Dimitrios Bilios, Christos Bouras, Vasileios Kokkinos, Andreas Papazois, and Georgia Tseliou, "A Performance Study of Fractional Frequency Reuse in OFDMA Networks", IEEE Wireless and Mobile Networking Conference, pp.38-43, Sept. 2012.

[3] Christos Bouras, Georgios Kavourgias, Vasileios Kokkinos, Andreas Papazois, "Interference Management in LTE Femtocell Systems Using an Adaptive Frequency Reuse Scheme", IEEE conference, pp.1-7, April-2012.

[4] Seokhyun Yoon, Joonyoung Cho , " Interference mitigation in heterogeneous cellular networks of macro and femto cells", ICTC International conference , pp. 177-181, Sept. 2011.

[5] Motoki Morita, Yasuhiko Matsunaga, Kojiro Hamabe,"Adaptive Power Level Setting of Femtocell Base Stations for Mitigating Interference with Macrocells", IEEE Vehicular Technology Conference (VTC fall), pp. 1-5, Sept.2010.

[6] Avani Dalal, Hailong Li, and Dharma P. Agrawal, "Fractional Frequency Reuse to Mitigate Interference in Self-Configuring LTE-Femtocells Network", Eighth IEEE International Conference on Mobile Ad-Hoc and Sensor Systems, pp. 49-54, Oct.2011.

[7] Feng-Seng Chu, Kwang-Cheng Chen, "Mitigation of Macro-Femto Co-channel Interference by Spatial Channel Separation", IEEE Vehicular Technology Conference (VTC spring), pp.1-5, May. 2011.

[8] Zubin Bharucha, Gunther Auer, Tetsushi Abe and Nobuhiko Miki, "Femto-to-Macro Control Channel Interference Mitigation via Cell ID Manipulation in LTE" IEEE Vehicular Technology Conference (VTC fall), pp.1-6, Sept.2011.