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Techniques for Enhanced Inter-Cell Interference Coordination for LTE in HetNets

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ABSTRACT— *In order to meet the growing demand for mobile broadband and users' expectations, it is necessary improve data performance overall and at cell edges. The success of LTE heterogeneous networks (Het- Nets) with macrocells and picocells critically is contingent on efficient spectrum division between high-power macros and low-power picos. Two important tasks in this situation are: 1) Determining the amount of radio resources that macrocells should offer to picocells, and 2) Influential the association rules that resolve which user equipments (UEs) should associate with picos. In this system, progress a novel algorithm to solve these two joined problems in a dual manner. Proposed algorithm has provable guarantee, and furthermore, it explanations for network traffic load, topology, and macro-pico interference map. Our result is standard compliant and can be executed using the notion of Almost Blank Subframes (ABS) and Cell Selection Bias (CSB) proposed by LTE standards. Simulation result also show general evaluations using RF plan from a real network and discuss self-optimized networking (SON)-based improved inter-cell interference coordination (eICIC) employment.*

Keywords— 4G LTE, enhanced inter-cell interference coordination (eICIC), heterogeneous cellular systems, Almost Blank Subframes, Self-optimized networking (SON)

1.INTRODUCTION

Nowadays, mobile broadband traffic has grown exponentially with exceeding voice. The generation of mobile smart phones, tablets and laptops, considering their services and capabilitie, mobile users has increased their number of connections. Furthermore, cellular operators have in general reported non-uniform traffic distributions in their networks, stating that for instance 50% of the total traffic volume is carried on only 30% of the macro sites. Exact percentages of course vary from network to network [6]. The required capacity has augmented faster than progress in spectral efficiency. The service is migrating from a voice-centralized model to a data centralized model. Subscribers use connected devices not only to access the data with help of Internet, but also to access cloud-based application services, including video and other bandwidth-intensive content. As a result of these trends, overall mobile data traffic is expected to grow tenfold by 2016.

Users' expectations for mobile broadband are growing parallel to traffic and, increasingly, users expect a robust, high-quality and seamless service. Further, more and more, customers are operating inside offices and buildings, where about 70 percent of today's data traffic is generated and where coverage represents a major problem for mobile

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operators. Meet the demand for mobile broadband is specially challenging in certain scenarios; such as:

- Large outdoor hotspots with high traffic demand and a dense macro network, implying high interference. E.g., town squares and commercial streets.
- Large, isolated indoor hotspots, which may be difficult to reach from an outdoor macro network. E.g., businesses and hotels
- Large indoor hotspots, where mobility demands and interference are high. E.g., shopping centers, airports and subway stations.
- Localized, indoor hotspots or minor coverage holes, which represent a challenge of implementation and cost to conventional cellular networks. E.g., small offices and restaurants.

It is necessary improve data performance overall and at cell edges, and, to achieve this, more resources are needed to acquire, deploy, manage and optimize their proper usages Broadband services providers use a variety of technologies in order to meet customers' expectations; namely, improve the existing network, densify current macro cells and, the most important one, add small cells to improve coverage, capacity and power signal when necessary.

1.1 Long Term Evolution (LTE):

In order to support this galloping demand for data traffic, Third Generation Partnership Project (3GPP) Long Term Evolution (LTE) Release 8 is under field trial by most cellular operators. High Speed Packet Access (HSPA) offers significant advantages with respect to its predecessor, which works on lower latency but significantly improves spectral efficiency which results in obtaining larger throughput due to its well structured Internet Protocol (IP) architecture. However, the performance of Release 8 does not meet the International Mobile Telecommunications (IMT)-advanced requirements. That's why, the International Telecommunication Union (ITU) developed the fourth generation of mobile networks to fulfill concerned requirements such as downlink data rates of up to 100 Mb/s and 1 Gb/s for mobile user. The next standard, LTE Release 10, is currently under progress, to enhance the performance of the overall network. It proposes the use of advanced technologies such as, carrier aggregation (CA) which concurrently utilizes different frequency carriers, hence results in efficiently increased bandwidth that can be allocated to end users. Another trend is the enhancement of multi-antenna techniques, based on the principle of multiple-input multiple-output (MIMO) systems with up to 8 × 8 antenna arrays. Coordinated multipoint (CoMP) transmission and reception, where multiple cells are able to coordinate their scheduling or transmission to serve users with adverse channel conditions, is also envisioned to notably mitigate outages at the cell edge. However, all these advanced technologies do not allow significant enhancements as they are reaching theoretical limits.

This brings new challenges to the more complex but efficient communication technologies for: intelligent radio resource sharing among heterogeneous cell nodes and mobile subscribers; distributed cooperative control over transmissions; increased dynamics of inter-cell interworking.[6]

The pervasively increasing trends of wireless mobile subscribers worldwide and the emerging highly data hungry telecommunication services warrant for consistent improvement in the radio coverage and capacities of existing and forth-coming wireless systems and networks. Improving the radio links, especially in radio coverage holes where you cannot make or receive calls, is necessary for successful deployment (i.e., achieving close to theoretical data rates) of high data rate transmission technologies in the emerging 4G cellular systems and networks.

1.2 Heterogeneous networks (HetNets):

A traditional homogeneous cellular network consists of a group of high - power nodes (macro nodes). Heterogeneous networks instead include not only macro but also low - power nodes A traditional homogeneous cellular network consists of a group of high - power nodes (macro nodes).

Apart from macros, heterogeneous networks include low- power nodes. This is a technique to improve the spectral efficiency per unit area, as the low- power cells make possible to remove coverage holes in the macro - only network and increase the capacity in zones with very high traffic volume.

Figure 1 Key options to expand network capacity[12]

The main characteristic of HetNets is the great disparity between the transmit power used by the macrocell and picocell nodes. This makes necessary the usage of interference management techniques as picocell can suffer great interference from macro cells which covers large area in terms of cell radius ranging from 500 meters to kilometers. Other challenges that these networks might face are: Sharing resources (time and frequency) between the different types of nodes in the best way possible so as to avoid coverage holes. Load balancing amongst nodes. Two kinds of deployments have been proposed for HetNets: co -channel is primary deployment strategy consisting all nodes share the same carrier frequency and dedicated carrier which are actually different frequency carriers for the macro and low power layer. [7]

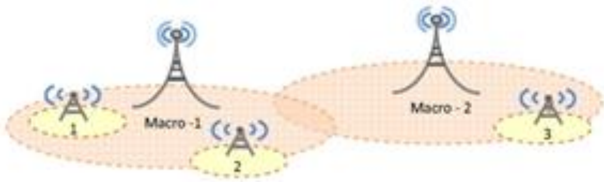

Figure 2 HETNET architecture - low power node 1 is used capacity improvement in a hot-spot; low power node-2 and low power node-3 are used for improving edge throughput

With more than one billion wireless subscribers today and predictions for this number being tripled over the next five years, the wireless industry is confronted with an increasing demand for ubiquitous wireless coverage and larger data rates. The exponential traffic growth in broadband wireless networks is a well established technology, and this is current trend accelerated by the proliferation of advanced user terminals and bandwidth-greedy applications (e.g., mobile TV, file transfer).

1.3 Enhanced Inter cell Interference Coordination (eICIC):

LTE release 10 standard adopts frequency reusability strategy to maximize spectrum efficiency, which covers all the cells using the same frequency channels. But, as far as quality of services (Qos) is considered, it depends on the geographical position of the user equipment (UE) with a particular degradation based on the cell edge. For this purpose, Inter Cell Interface Coordination is first time introduced in 3GPP LTE Release 8 to deal with interference issues occurred generally at cell boundry.[10]

Enhanced Inter cell Interference Coordination (eICIC) is a framework by the 3GPP project to handle inter cell interference in HetNets environments. In this approach transmissions from Macro-eNBs inflicting high interference onto Pico- eNBs users are periodically muted (stopped) during entire subframes, by this strategy, the Pico-eNB users that are suffering from a high level of interference from the aggressor Macro-eNB have a chance to be served. Since RE pico UEs are only scheduled during mandatory ABS in the macro eNB, the number of mandatory ABS (i.e. TDM muting ratio) in the macro eNB should increase or decrease accordingly with the RE in the pico eNB and, consequently, with the number of cell edge UEs in the cluster. There are two alternating implementation strategies proposed in the eICIC mechanism, by which it becomes possible to analyze the necessary conditions for achieving the best result.

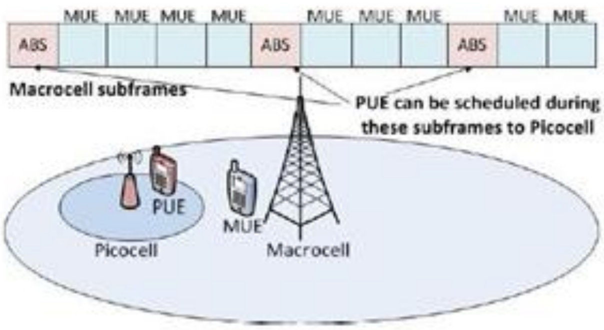

Figure 3 Almost Blank Subframes (ABS) technique

1.4 Self-organizing Networks (SONs):

Self-Organizing Networks (SONs) are the enhancement towards automated operations in mobile networks. SONs reduce the Operation and Maintenance (O&M) cost of mobile networks. In order to achieve this it uses automated and intelligent procedures by which human intervention are replaced without compromising network performance. Some Low Power Nodes such as picocells are user deployable and
used to carry out cellular intervention without cellular operator. This approach is elaborated by SONs features.

HetNets adopt following three processes to implement the SONs features:

- **Self-configuration process**: It is newly deployed cells such picocell or macrocell which downloads required software. Before entering them into the operational mode, it will self-configure itself.

- **Self-healing process:** In this process, cells are automatically recovered whenever failures occur.

- **Self-optimization process:** In this process, cells monitor the network status and adapt their settings to improve performance and reduce interference.

2, LITERUTRE REVIW

A. Stolyar el at. [1] used Subgradient method**.** This method effectively states that Subgradient methods have been used with great success in developing decentralized cross-layer resource allocation mechanisms.Subgradient methods have played a key role in this framework providing computationally efficient means to obtain near-optimal dual solutions and bounds on the optimal value of the primal optimization problem. This method is not effective for Generating approximate primal optimal solutions for general convex constrained optimization problems using dual subgradient methods and preferred to more complex stepsize choices involving several stepsize parameters without a guidance on their selection.

A. Nedic et al. [2] used Dynamic fractional frequency reuse Method. This method effectively states that it is best to set the number of sub-bands such that there is sufficent exibility to achieve the desired reuse but no larger than that and Demonstrated that the algorithm indeed achieves eficient interference avoidance, without any prior planning. This method do not involve signaling between base 1 stations are more practical for Frequency partitioning and/or distributed coordination. Papers do not consider the effect of out-of-cell interference. Dynamic distributed resource allocation in the context of Gaussian interference channels has been considered.

T. Tran et al. [3] used coordinated multipoint (CoMP) transmission/reception technique. The potential advantage, CoMP techniques received a lot of attention at the initiatory stage of the LTE-Advanced standardization. While frequency-domain orthogonality can be achieved in a static manner, it may also be implemented dynamically through victim UE detection. The CoMP method uses half-duplex mode to avoid self-interference problem, until sufficient physical isolation or interference cancellation is secured between transmit antennas and receive antennas at the RN.

Y. Hong et al. [4] used Inter-cell interference coordination. Multi-layer transmission and the inter-cell interference from macro/femto deployment finally, this achieved data rate for the k-th user. The HUE will have a high tendency to request high performance. A dualbased approach to our problem lends to a decomposition that greatly reduces the algorithmic complexity and also makes the approach amenable to distributed implementation while retaining the core essence. EICIC because operators are still debating whether the additional complexity of eICIC is worth the gains

The interference problems summarized above may significantly degrade the overall HetNet performance, which requires the use of eICIC schemes to guarantee its proper operation with help of effective algorithm.

3, SYSTEM ANALYSIS

3.1 Existing System

In the previous techniques there is no proper consideration of ABS sub-frames has been taken effectively to improve the ICIC between picocell and macrocells and also amount of radio frequency they are offered.

3.2 Proposed System

As per the study of existing system in this paper, we develop a novel algorithm to solve two coupled problems,

1) Determining the amount of radio resources that macrocells should offer to picocells, and
2) Influential the association rules that resolve which user equipments (UEs) should associate with picos. in a joint manner.

4, DESIGN FRAMEWORK OF PROPOSED SYSTEM AND MODULES

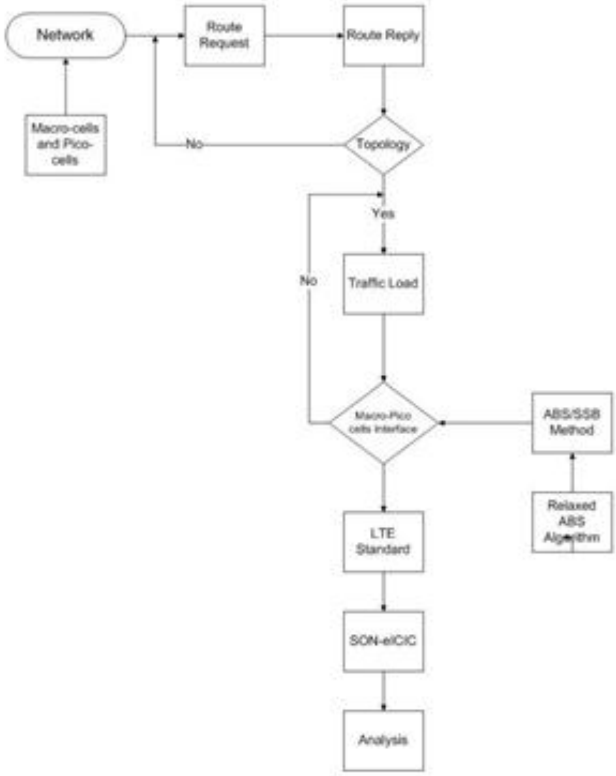

Figure 4 Proposed System Flow line

4.1 Network formation:

Our system model consists of a network of macro and pico (also called pico in this paper) eNBs denotes the set of macros, and denotes the set of picos. We also use and to denote a typical macro and a typical pico, respectively.

4.2 Traffic:

While the macros and the propagation map used in our evaluation are for area network, we create synthetic UE locations for our evaluation because LTE pico deployments are still not very prevalent. In the area under consideration, we chose a nominal UE density of around 450 active UEs/sq-km (dense urban density).

4.3 Microcell-picocell interface:

We now describe our interference model. For the purpose of eICIC algorithms, it is important to distinguish macro-pico interference from the rest. Macro-pico interference: For each pico, the set of macros that interfere with it is denoted.

4.4 SON-eICIC:

A key aspect of LTE networks is its SON capability. Thus, it is imperative to establish a SON based approach to eICIC parameter con figuration of an LTE network. The main algorithmic computations of SON may be implemented in an centralized or a distributed manner.

6, DESIGN DELIVERSIABLES

6.1 Use Case Diagram

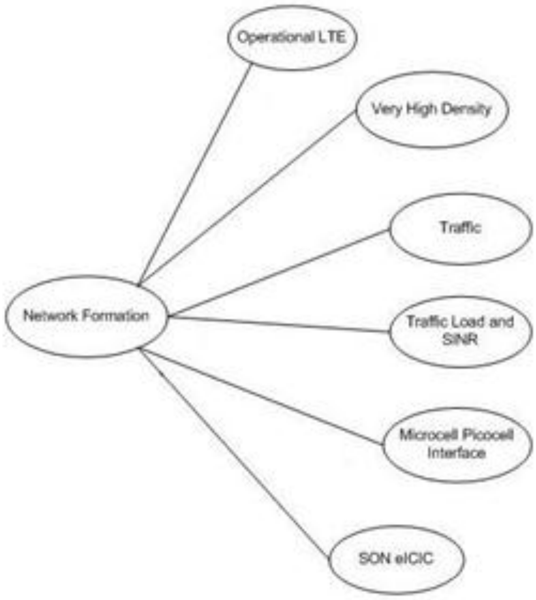

Figure 5 Use case diagram

6.2 Sequence Diagram

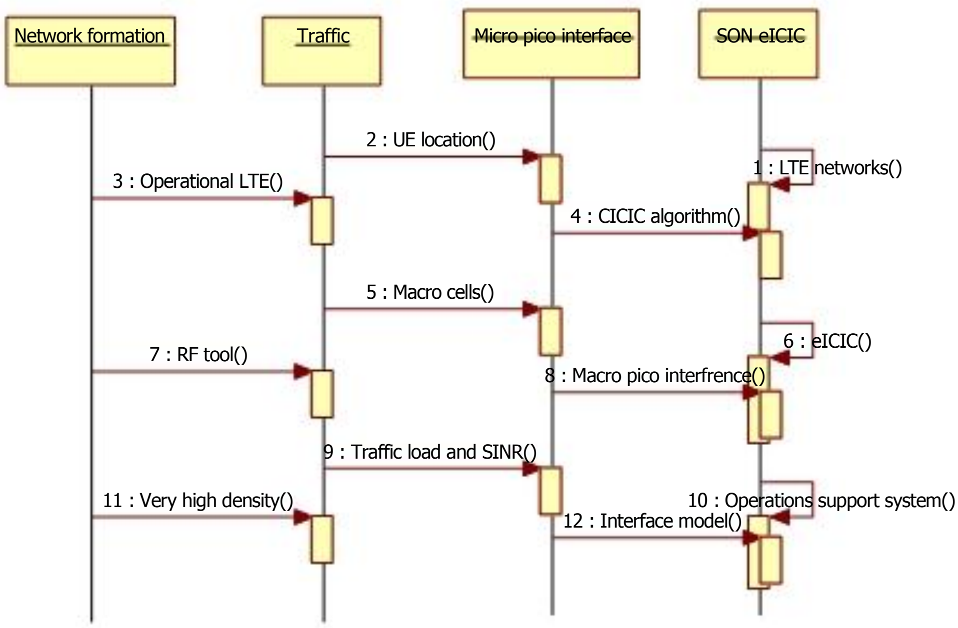

Figure 6 Seqence diagram

6.3 Activity Diagram

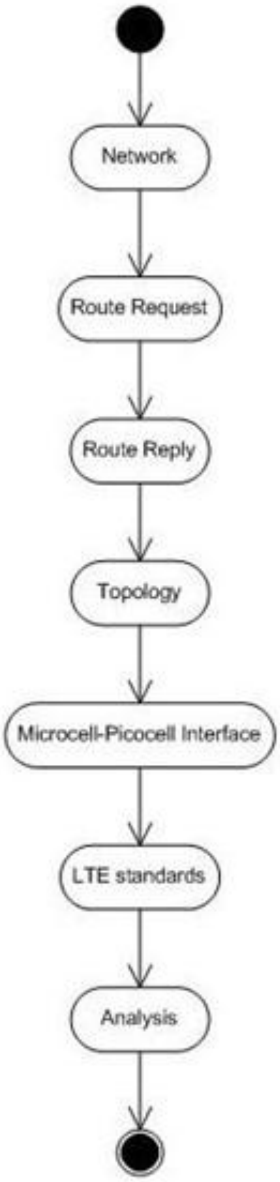

Figure 7 Activity diagram

7, CONCULSION AND FUTUREWORK

To overcome the Inter-cell Interference problem in macrocell- picocell, several eICIC techniques have recently been proposed for time domain. Approaches with a dynamic subframe ratio selection have better performance among proposed time domain eICIC techniques. To enhance the performance of system, we proposed a scheme combining CRE and ABSs scheme. By this scheme, the offset value and ABS ratio can be selected simultaneously based on system throughputs which can lead to improve the system performance.

The performance analysis shows that the eICIC performance for various load condition has been used to reduce the interference between the picocell and macrocell. The pico layer range extension offset should be properly chosen according to the scenario, and especially be adapted to the UE distribution.

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