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# Cell Selection Techniques in Heterogeneous LTE-Advanced System

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*Abstract*— This survey paper provides a performance evaluation of cell selection techniques proposed for Pico cells in the Long Term Evolution-Advanced (LTE-A) networks. Pico cell is the focus of this study because it can be deployed in areas with high volume of traffic so as to improve the system capacity. Cell selection which plays a important role in improving cell spectrum efficiency especially in heterogeneous systems is the process that allows the user equipment's (UEs) to select a suitable cell in order to access available services. This paper analysis the new interference environment and the limitations of traditional cell selection methodwhich caused by low power nodes, and propose anew cell selection strategy to resolve these problems in order to improve efficiency in LTE-A heterogeneous systems.

***Index Terms***—*Pico-cell, cell selection, heterogeneous, LTE-A;*

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## I .INTRODUCTION

In recent years, the demand for mobile broadband services with higher data rates and Quality of Service is growing rapidly. This demand has motivated 3GPP to work on Long Term Evolution (LTE) and LTE-Advanced to achieve higher data rates and less radio network delay. Since data traffic demand is increasing at an exponential rate, further spectral efficiency improvements are needed. A heterogeneous network is one solution to overcome the space limited dense in urban area and improve spectral efficiency[8].

LTE-ADVANCEDNETWORKARCHITECTURE

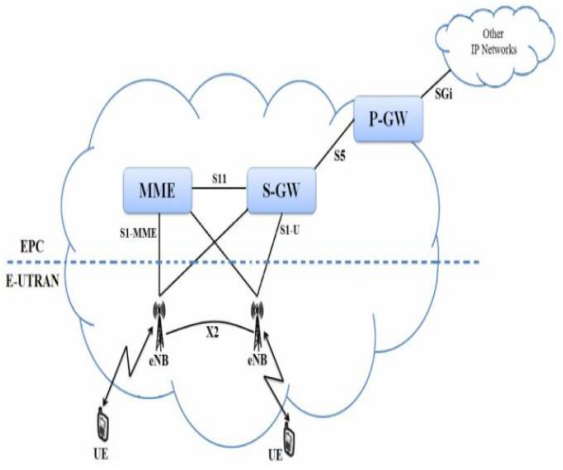


Figure1.1: LTE- Advanced Network Architecture

LTE-Advanced E-UTRAN overview

The core part in the E-UTRAN (Evolved Universal Terrestrial Radio Access Network) architecture is the enhanced NodeB, the evolution of the NodeB in a 3G system, which communicates with Use equipment's and it can serve one or several E-UTRAN cell one time. Thee NB nodes are directly connected to each other (this speeds up signalling procedures) through the called X2 interface.

EVOLVED PACKET CORE NETWORK

The EPC is an all-IP based core network specified to support the E-UTRAN through a reduction in the number of network elements, simpler functionality and most importantly allowing for connections and handover strategies to other fixed line and wireless access technologies, giving the providers the capacity to deliver a seamless mobility experience .The main components and functionalities of the EPC are as follows:

The Mobility Management Entity (MME) is a key control plane element. It is responsible for user mobility, intra-LTE handover as well as security functions (authentication, authorization, NAS signalling). The MME also selects the Serving Gateway (S-GW) and Packet Data Network Gateway (PDN-GW) nodes. It is connected to the eNBs via the S1-MME interface.

The S-GW is the termination node of the EPC. The main aim of the SGW is to route and forward user data packets among different LTE nodes and it also serves as a mobility point for both local inter-eNB handover and inter-3GPP mobility. It is connected to the E-UTRAN via the S1-U interface. S-GW and MME communicates using S11 interface.

The Packet Data Network Gateway (P-GW) provides the UE with access to a Packet Data Network (PDN). The PGW accomplishes policy enforcement, packet filtering for each user or charging support among other functions. P-GW and S-GW communicates with each other via S5 interface.

1.1Main Requirements of LTE and LTE-Advanced Networks

TABLE 1: Comparison of the LTE and LTE-A.

| | LTE | | LTE-Advanced | |
|---|---|---|---|---|
| | *Downlink* | *Uplink* | *Downlink* | *Uplink* |
| Peak spectrum usage efficiency (b/s/Hz) | >5 | >2.5 | 30 | 15 |
| Average spectrum usage efficiency (b/s/cell) | 1.6-2.1 | 0.66-1.0 | 2.4-3.7 | 1.2-2.0 |
| Cell-edge spectrum usage efficiency (b/s/user) | 0.04-0.06 | 0.02-0.03 | 0.07-0.12 | 0.04-0.07 |
| Operating bandwidth (MHz) | 1.4-2.0 | | Up to 100 | |
| User plane delay (unidirectional) (ms) | <5 | | <5 | |
| Connection setup delay (ms) | <100 | | <50 | |

## II .PICO-CELL AND CELL SELECTION

A Pico cell is a small cellular base station typically covering a small area, such as in-building (offices, shopping malls, train stations, stock exchanges, etc.), or more recently in-aircraft. In cellular networks, Pico cells are typically used to extend coverage to indoor areas where outdoor signals do not reach well, or to add network capacity in areas with very dense phone usage, such as train stations. Pico cells provide coverage and capacity in areas difficult or expensive to reach using the more traditional Macro cell approach. Pico cell is one of the important solutions which can be deployed efficiently for local regions with high volume of traffic (such as hotspots) and improves the overall system capacity. Pico cells have lower transmission power rather than macro cells (arrange from 24 to 30 dBm). Since Pico cells usually work in open access mode then all users can access them. In general, the open access mode means that any user in the network can automatically connect to the hotspots. Pico cells are used to improve capacity as well as the coverage of outdoor or indoor regions. Moreover, the communication between macro cells and Pico cells is doneovertheX2 interface [8].

Figure2: Macro-Pico Cell Network

CELL SELECTION

Cellselectionisbasedonthedownlinkreceivedsignalstrengthwhichmeansmobileusers will connect to the site from which the received power is strongest. For example, in3GPP LTE, cell selection is performed according to two parameters measured by a User Equipment (UE): Reference Signal Received Power (RSRP) and Reference Signal Received Quality (RSRQ).“Reference signal received power (RSRP), is defined as the linear average over the power contributions of their source elements that carry cell-specific reference signals within the considered measurement frequency band width”. RSRQ is calculated based on RSRP which provides additional information and reliable cell selection decision when RSRP is not sufficient.

Different Techniques of Cell Selection & Cell Range Expansion:

In recent years, many works have been done on cells election schemes, e.g.[4][5], but there is no explicit study in discussing the scenario of simultaneous coverage of more than one base station. In contribution [1-3] a new cell selection scheme named as "Range Expansion (RE)" which aims at maximize the cell splitting gains and reduce uplink Interference was discussed, in which a bias value of RSRP is used for low power node in cell selection strategy to drive more users selecting low power node as serving node.

1. *Conventional cells election scheme*

In the traditional cell selection method UE can select the serving cell by comparing the Reference Signal Received Powers (RSRPs) received from macro eNBs and Pico eNBs. The cell with the highest RSRP will be selected as the serving cell of Ue.

$$CellIDserving=argmax\ \{RSRP\} \quad [7]$$

Cell selection based on the strongest downlink RSRP is not the best scheme because UEs connect to a higher power node instead of the lower power nodes at the shortest path loss distance. Therefore, traffic load is distributed unequally which can lead to macro cells overloading.

2. *RE cell selection scheme*

To further improvement users select serving cell are based on:

$$Cell\ ID\ serving= argmax\ \{RSRP + bias\} \quad [7]$$

Where *bias* is zero for the macro cell and has a non-negative value for the small cells, resulting in more users being transferred to the small cells. When RE strategy is adopted, more users are access into Pico cells, e.g. PUE 4 to 7, which would originally access into the macro cell using RSRP strategy. Such a strategy may offload significant amount of traffic from the macro cell to the Pico cells, but it can also lead

to more interference from the macro base-station at the mobile which is associated with the Pico base-station. Besides, if the bias value is not properly set, some problems will be introduced [7].

Considering the following two cases:

*The bias is low*: In this case, a large number of users won't access into the Pico cell because of the Pico cells' small coverage. The resources (e.g. frequency band/power) won't be fully exploited, which will lead to a bad system performance [7].

*The bias is high:* In this case, the coverage of the Pico cells will be manually "enlarged", which will admit more users. Many of the users accessing into Pico cells will not be scheduled due to their long distance from the Pico eNode Band bad RSRP, which may lead to scheduling outage. Moreover, those who are relatively close to macro eNodeB will suffer dramatic interference. Thus, the bias value for RE strategy should be carefully designed to get a good system performance [7].

3. Based on Queue scheme

The procedure of BQ cell selection strategy, which details are follows:

1. If there is multi-carrier to use, UE selects a carrier frequency of its capability.
2. Based on the RSRP of neighbour cells, UE make a "priority queue" itself. The criterion of "priority queue" is the top N strongest RSRP cell and the RSRP value of the last cell should no less than that of the best cell subtracting 25dB bias.
3. UE detects and synchronises to the broadcast channel of the best RSRP cell, and judge whether existing low power cell;
4. If there is existing low power cell in the "priority queue", then select the low power cell with the better RSRP, else select the cell with the best RSRP value [6].

III. Performance Algorithm

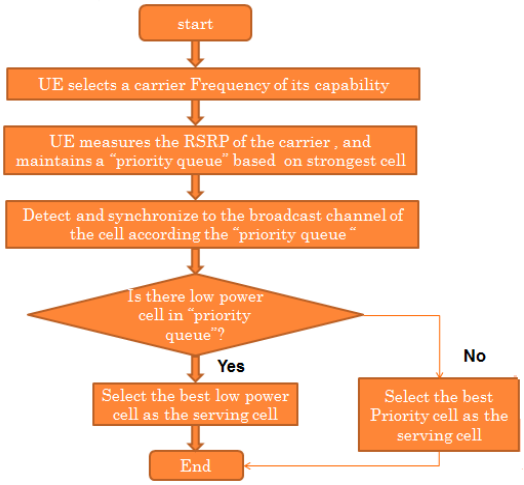


Figure3: Based on Queue [6]

IV. Simulation

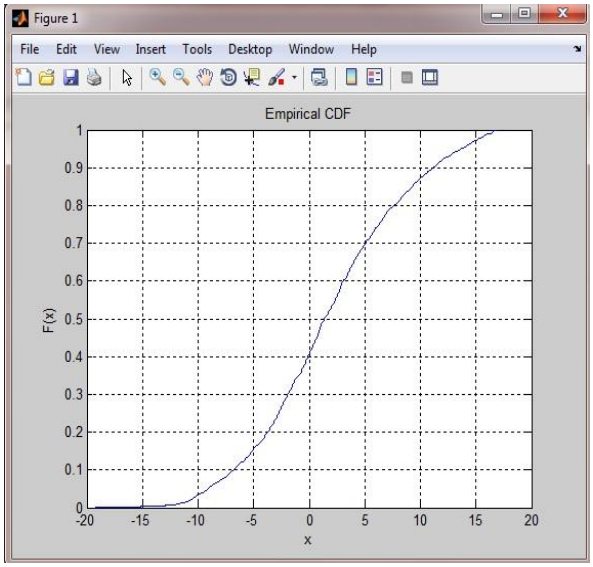


Figure 4 CDF of Heterogeneous Network

V. CONCLUSION

Heterogeneous network is a new and important field in the LTE-Advanced system, and CDF of the heterogeneous network has been implemented. Furthermore, a new cell Selection scheme which can assign users in Pico and macro cells in order to improve cell efficiency. It can be observed that Based on Queue scheme is better in cell throughput improvement Compared to Conventional and RE cell Selection scheme.

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