An Optimal Switching-off eNB Selection Algorithm in LTE Hyper-dense Networks

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ABSTRACT

Although the application of the exhaustive search (ES) algorithm in the energy conservation strategy can realize the simultaneous switching off of multiple eNBs in the existing eNB-based (Evolved Node B) networks, it fails to satisfy the practical requirement of network deployment with the heavy computation burden. On account of this, this paper proposes an optimal switching-off eNB selection (OSS) algorithm in homogeneous networks. By selecting a certain cell within the coverage of multiple eNBs, the OSS algorithm can make an evaluation of the increment of network load caused by the switching off of various eNBs in the coverage area. Then it can sort one by one all of the eNBs that are to be switched off under the condition that the QoS (Quality of service) requirement of all of the users has been met. Afterwards, the OSS algorithm will switch the users according to the principle of least network load increment and eventually find an eNB that shows the optimal energy saving effect in sleep mode. The simulation results reveal that the OSS algorithm can satisfy the requirement of efficient energy conservation in wireless networks. Additionally, with low computational complexity, it also will facilitate network deployment.

Keywords: Energy Efficiency, Evolved Node B, Long Term Evolution, Sleep

INTRODUCTION

Recently energy cost and carbon emission in wireless networks have become an urgent problem faced by the whole industry of ICT (Information Communication Technology) (Malmolin, 2010; Azeddine, 2014; Boujelben & Elias & Elmirghani, 2015). Actually, of the whole Long Term Evolution (LTE) network, eNB-based (Evolved Node B) networks account for the largest...
proportion of energy consumption, which is around 57% of the total energy consumption in the whole network (Son, 2012). Regarding the existing eNB dormancy strategies, all of them have been developed based on the characteristics of the uneven distribution of communication traffic in the base station (BS) to selectively turn some of the eNBs into sleep mode. The facts and figures that highlight the importance of green mobile networking and then reviewed the existing green cellular networking research with particular emphasis on techniques that incorporate the concept of the “sleep mode” in base stations is investigated (Wu, 2015). However, the factors that must be taken into account for node dormancy are quite complex. Accordingly, not only the judgment on which eNB will be in sleep mode, but also how to switch the users served by the dormant eNB onto the neighboring nodes will be considered, besides the resulting impact on the overall network load.

There have been numerous research achievements on the improvement of network energy efficiency (EE) through cell sleeping. For example, previous researches (Marsan, 2009; Marsan, 2012; Zhou, 2014; Xiang & Tong & Syama Varma, 2015) have proposed an eNB dormancy strategy based on the traffic characteristics of a fixed BS to turn this BS into sleep mode when there is low traffic load (such as in the night time) on a single BS. However, due to the fact that load fluctuation varies in real networks, it would be very hard to accomplish the adaptive application of this strategy when network loads vary irregularly with time. Additionally, other studies (Marsan, 2009; Abdulkafi, 2012) introduce a FTB (Fixed Threshold-based) eNB sleep algorithm to automatically turn all of the BSs into sleep mode when the traffic load of these nodes is lower than the preset fixed threshold. This algorithm is applicable to such a network scenario where network traffic load varies frequently. Some flexibly variable threshold-based solution to adjust the relevant load threshold after the changes in both of the network traffic loads at night and in the daytime is proposed (Kongluan & Zhong, 2011; Stefanatos & Ni & Migliorini, 2013). In the case where the loads on multiple cells are lower than the threshold, the algorithm will turn the BS with the minimum load into sleep mode first and then the BS with the load next to the lowest. Another researches (Migliorini & Eunsung, 2013; Tong, 2015) studies a variable threshold-based eNB sleep algorithm and makes an analysis on the energy-saving effect on LTE networks with the application of this algorithm. Their result proves that it would be hard to achieve the optimal energy-saving effect through this algorithm. This is because that although this algorithm can be applied in the network environment where there are changes in the traffic load, it fails to take the optimal energy efficiency of the whole network into account.

For hyper-dense LTE networks, the adoption of the exhaustive search (ES) method to make a selection on the eNB in sleep mode requires a rather complicated system. However, in many cases switching multiple eNBs simultaneously into sleep mode will bring the risk of making the service provider unable to provide an efficient service to the users. Accordingly, this paper proposes an optimal switching-off eNB selection (OSS) algorithm for hyper-dense LTE networks to meet the requirement of effective energy conservation in the system. By selecting a typical network coverage area where every cell is within the coverage of an eNB, this algorithm will quickly pick an eNB to switch off. With the application of this algorithm, the network system is of will have more robustness when the users are gaining access to the services.

**SYSTEM MODEL**

It is assumed that a hyper-dense LTE network consists of $K$ users and $M$ eNBs. Every eNB contributes to the establishment of a cell that is in a radius of $R_c$ with the maximum coverage radius of $R_m$, as shown in Figure 1. Also the neighboring cell of the Cell $i$ is indicated with
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