Mobile Network Energy Efficiency Improvement by Power Saving Functionality

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***Abstract*— The mobile network is designed for maximum traffic load, but the traffic load is unevenly distributed resulting in wastage of energy consumption most of the time during low traffic. Objective of this work is to save power consumption in a mobile network from RF devices of the BS with logical algorithm by shutting down some cells during low traffic period and relocate the remaining traffic to neighbor/collocated cells without decreasing network quality and end user performance.**

***Keywords*— Mobile network, power consumption, traffic, shutdown, saving.**

I. INTRODUCTION

Significant attention is currently being paid to reducing the energy consumption of mobile networks, since it takes a major part of the total energy consumption of information and communication technology. In future, the effect of the energy consumption of the mobile communication network will be more serious, since more traffic load will be expected in forthcoming 5G networks [1, 2].

Reducing power consumption in a mobile network, and more specifically in a base station (BS), is possible with respect to two main constraints: (i) the minimum required coverage and (ii) the minimum required quality of service for all users. The basic principle of the work to reduce the power consumption of a BS is to turn off the components of the BS as much as possible, when they are no longer needed [3].

Fig. 1 shows that the BS can be turned off to save energy more significantly, if there is low traffic of a BS. "Shutdown" cells can be automatically "re-activated" when traffic increases.

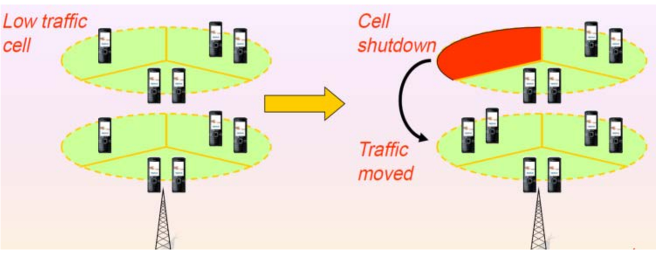

Fig. 1. Low traffic cell and cell shutdown

It should be noted that in BS, the power consumption of the Radio Frequency (RF) part accounts for 80% of the overall power consumption [4]. Therefore, it is advisable to automatically shut down the cells of unloaded BS during low traffic periods by reducing RF power consumption.

In this work, we present a logical algorithm, which illustrates the power consumption of a BS during different traffic periods. For optimization purposes, we suggest how and when to turn the RF devices of the BS off in order to reduce the power consumption.

II. METHODOLOGY

Fig. 2 shows the cell shutdown order in the proposed energy saving scheme. Cells, which belong to power saving functionality, must be logically grouped to have target inter frequency handover candidate, and based on the grouped cell's the traffic will be triggered shutdown or re-activation. Cells, belonging power saving, must be allocated a "shutdown order" to categorize the first shutdown candidate, the second and "Remaining cell". 'Remaining cells' do not shut down because of low traffic, but may shut down during pre-defined time intervals.

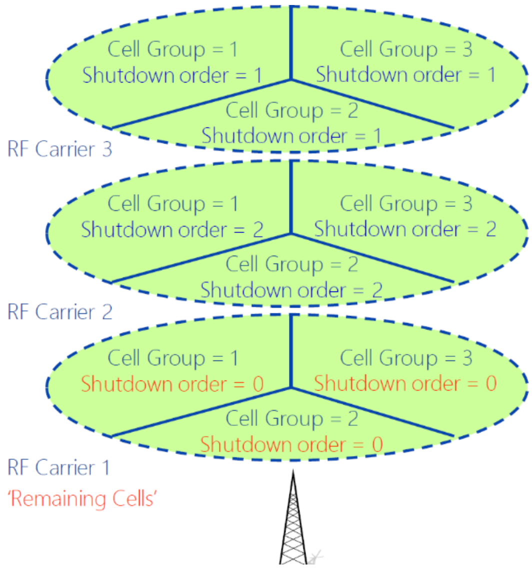

Fig. 2. Cell shutdown order

Fig. 3 describes the algorithm for cell shutdown. The algorithm depends on automatically switching off the unnecessary RF devices of the BS when the traffic is low and switching on the required RF devices when the traffic starts to increase. With this technique, BS dynamically adjusts the number of RF devices to be enabled based on the user traffic and required channels without compromising the service quality.

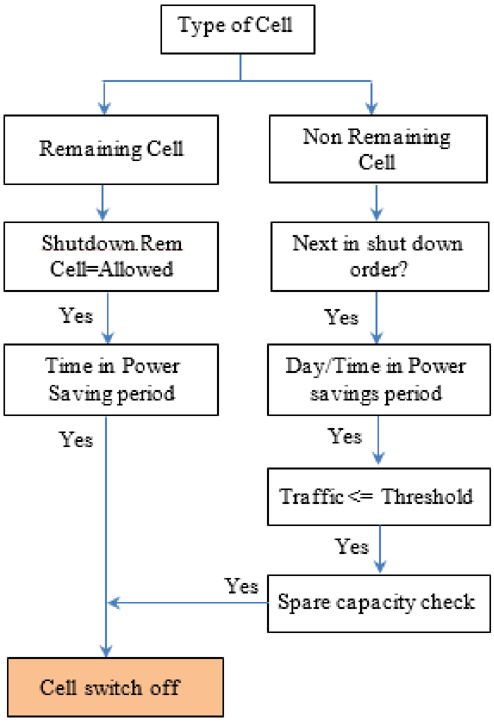

Fig. 3. Algorithm for cell switch off

III. Test Results

Tests were performed on non-collocated 8 Node Bs with different power consumption and traffic. 3 carriers on U2100 band and 1 carrier on U900 band were available in tested network.

For numerical examples, we obtained power consumption due to traffic processing and power consumption due to state switching on following RF devices: UMTS 900 (FRDA, FRDB) and UMTS 2100 (FRGL, FRGM, FRGP). Comparable with the actual used power, the average used power per day is around 50% of the theoretical daily power consumption.

Fig. 4 shows the power consumption on different sites for the following testing features:

- Site I. The feature was implemented on November 2 to deactivate the 3rd carrier, and then on November 8 to shutdown 2 carriers.
- Sites II-V. The feature was implemented on November 17 to deactivate the 3rd carrier and then on November 22 to shutdown 2 carriers on site II.
- Sites VI-VIII (sites with collocated 2G). The feature was implemented on the sites on November 01 to deactivate the 3rd carrier, and then on November 21 to shutdown 2 carriers on site VI.

Fig. 4 squared indicates the power saving results due to state switching.

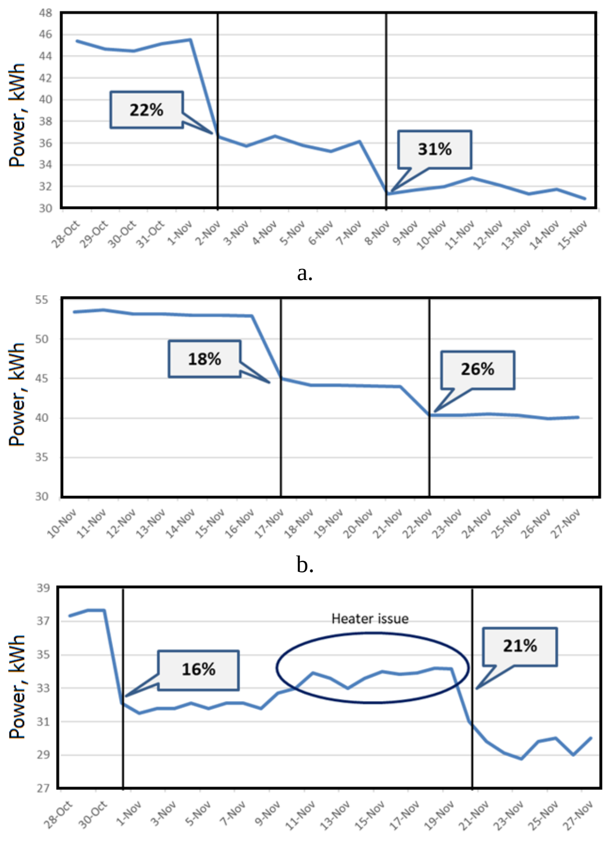

Fig. 4. Power consumption on sites I (a), II-V (b) and VI-VIII (c)

From the obtained test results, it follows that when the proposed algorithm is applied in a real mobile network, switching off the cell provides significant energy savings: ~ 16% - 22% when switching 2 carriers and ~ 21% - 31% when switching 3 carriers.

IV. Conclusion

In this paper, the energy efficiency optimization of a mobile network with a logical algorithm by shutting down some cells during low traffic period and relocating the remaining traffic to neighbor/collocated cells was presented. The algorithm was tested in a typical network with different power consumption and traffic. The test results showed that the proposed scheme can reduce power consumption in a mobile network, while maintaining adequate throughput and providing full-service coverage.

References

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