Energy Savings in 3G Using Dynamic Spectrum Access and Base Station Sleep Modes

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The energy consumption and energy efficiency of mobile telecommunication networks are crucial factors for the sustainability of this industry. This paper targets the reduction of the energy consumption at a Base Station (BS) level through the adoption of sleep modes during the off-peak periods of the day and relying in the existence of co-located and overlaid frequency bands to provide the coverage and capacity backup for the switched-off cells. It relies on the Dynamic Spectrum Allocation (DSA) method to opportunely relocate users during the low-load periods while maintaining the service quality of service (QoS). For the input data, real traffic statistics were used. Using this strategy and the proposed algorithm it was possible to achieve savings of about 43% per-site. The results were furthered to the study of a Portuguese mobile operator case and it was concluded that savings of more than 1.25 million euros were easily achieved.

Initially, it was acknowledged that, by far, the BS devices are the network subsystem responsible for the biggest share of energy consumption. In addition, these devices often operate in a low-load situation, a condition in which they are particularly inefficient. Moreover, by analyzing the daily traffic load fluctuation it is possible to identify this low-load periods, which usually follow a trend. This work aims to set a strategy for implementing a load adaptive strategy through the switch off (or sleep mode) of radio equipment while opportunistically reallocating users to other bands at times of low load and under the assumption that the operator has network equipment operating in many frequency bands at the same location.

An algorithm was developed, which comprehends two stages: In the first one, the periods of the day are characterized (on an off-peak periods). These periods are determined by the algorithm, in order to maximize the Energy Saving (Figure I). The second step of the algorithm identifies the transmitted power in function of the traffic for each site and quantifies the savings of the whole Energy Saving process. Table I indicates the power consumption of a cell site, for each type of region considered, with a 3G dual band system, including a BS for each of the bands which is the typical type of deployment. In all situations the energy savings were over 40 %.

FIGURE I – THRESHOLD SETTING STRATEGY.

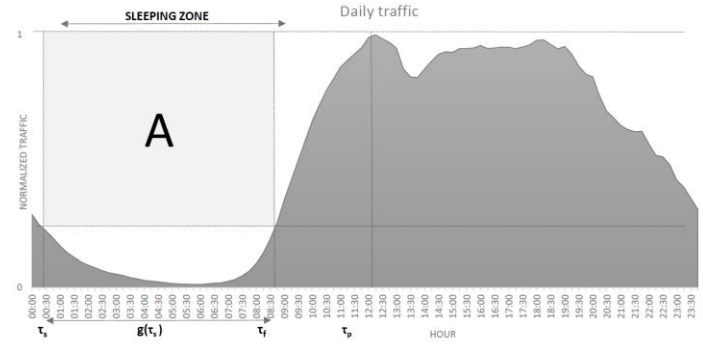

TABLE I - PREDICTED POWER.

Site Location	Savings
Urban	42.83 %
Sub-urban	42.87 %
Rural	43.63 %
Global Average	43.11 %