GREENER

Alcatel·Lucent

Green, Energy-Efficient NEtwork Re-organization

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Project Profile

Green Energy Efficient NEtwork Reorganization Economic and environmental drivers have made energy efficiency a critical concern for telecommunications operators worldwide. Both wireline and wireless operators are seeking hardware and software solutions to reduce mounting energy bills. The situation is worse in emerging markets like India due to various factors like unreliable grid power, dependency on diesel generators, high ambient temperatures etc. While the equipment vendors are thriving to make each individual network component (e.g. DSLAM in fixed-line access, BTS in wireless access etc.) more and more efficient, Greener project takes a different approach and attempts to make the entire network (e.g. DSL network or GSM network for an entire metropolitan city) energy-efficient either by altering network topology or by scaling network resources according to the current demand.

We have shown significant power saving in two scenarios

1) Proposal of controlling DSLAM line driver power through a centralized system like ALU NA 5530 shows a potential of 15% energy-saving for a Indian wireline operator

2) Algorithm to periodically find out a set of cells in a dense-urban area, whose deactivation does not interrupt the coverage or demand shows a potential of 25% energy-saving for a Indian wireless operator

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Problem & Opportunity

Energy consumption has become a serious concern for the telecommunications industry world wide. Both wireless and wireline operators are attempting to streamline their energy usage for environmental as well as economic reasons. The economic impact of energy is particularly dire in emerging markets. For example, in India energy costs for large operators amount to several hundred million dollars annually and are close to half of their overall operating expenses.

The main reasons for the high energy-related expenses include the lack of access to a reliable grid supply and high ambient temperatures requiring significant cooling. Some sites don't have access to any electric grid at all, and are operated entirely on diesel-powered generators. At most other sites, diesel generators are routinely run as back-up for several hours during the day. They not only lead to high emissions, but suffer from the high cost of diesel fuel and maintenance, as well as diesel pilferage.

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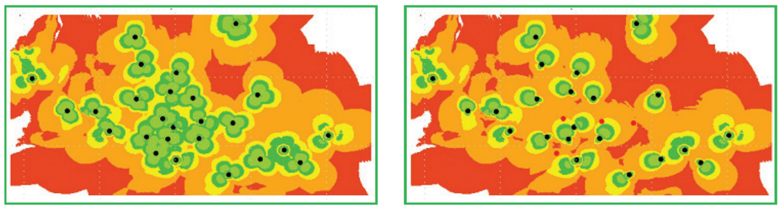
Solution

There has been little study of what cell sizes are the most power efficient in a wider, macrocellular setting. Intuitively, since receive power falls rapidly with distance from the base station,1 the smaller the cell size, the lower should be the total power consumption of the access network. However, there are several unavoidable energy costs involved in simply keeping a base station active with full coverage but minimal capacity.

For example, the circuitry, the paging channel, the backhaul and the power amplifier all consume power.



Default

Offpeak

Effect of our technique on a metropolitan area with 84 sectors. Left diagram (Default) shows the signal level when all sectors are active (Red is minimum acceptable signal level). Right diagram (Offpeak) shows 42 sectors (50%) are turned off at off-peak period (6 AM) and the acceptable signal level is still maintained through out the area.

The solution is to find the "sweet spot" for cell sizes in terms of energy consumption. We find that different cell sizes are most energy efficient for different loads. Since traffic demands change significantly over the day, no single cell size will always be most power efficient. We proved with our experiments that by constantly and arbitrarily (at fine granularity) varying cell sizes with traffic demands, the energy consumption can be reduced by up to 46%. Clearly, arbitrarily varying cell sizes while maintaining coverage may not be practical since base stations can only be installed in certain fixed locations.

Therefore, we introduce a multi-layer cellular architecture that automatically detects traffic demands at different locations and selects the best cell size from a few alternatives. Limited cell boundary adjustments or "cell breathing" automatically takes place in today's CDMA networks; a highly loaded cell shrinks due to interference and mobiles get handed off to neighbouring cells. In our scheme, we stress the importance of completely turning off some cells. Thus all the cells are turned on and operate at a small cell size when high capacity is required. At times of low loads, the lower-layer cells turn themselves off and the higher-layer cells expand to take over their coverage area. Automatic management of such a dynamic architecture becomes a key requirement and we suggest some techniques towards this goal. Our simple 2-layer architecture that is compatible with current cellular standards can save up to 40% power compared to a traditional static cellular network.

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