# Optimization for Time-driven Link Sleeping Reconfigurations in ISP Backbone Networks

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Energy efficiency in operational ISP networks has been regarded as an increasingly important research issue in recent years. Towards this end, network resource optimization through sleeping reconfiguration has been proposed to reduce energy consumption when the traffic demands are at their low levels. The strategy is to configure a subset of network devices to the sleep mode when it is not required for the network to work at its full capacity during the off-peak time. Since it has been observed that most operational backbone networks exhibit regular diurnal traffic patterns, this offers the opportunity to apply simple time-driven link sleeping reconfigurations for energy saving purposes. Instead of relying on complicated ?on-the-fly? and reactive network adaptations based on continuous network monitoring, it is possible to apply predetermined network reconfigurations on daily basis to reduce energy consumption. Such a strategy substantially simplifies relevant configuration operations from the view point of practical network management.

This paper is the first work that proposes a time-driven network topology control scheme that optimizes both the number of the links that sleep and the duration of their sleep period. The algorithm presented in the paper produces a reduced network topology, together with its off-peak enforcement duration, which achieves the same level of performance as the one for peak-time operation, while significantly reducing energy consumption. The basic strategy is to initially compute a synthetic traffic matrix (TM) derived from multiple real TMs that capture the actual traffic behavior patterns. To make the synthetic TM robust to traffic uncertainty, the actual traffic matrix data is collected at the same time points on each sampled day. The synthetic TM is used as input to the optimization algorithm that aims to put the maximum number of links to sleep without sacrificing (i.e. significantly shortening) the duration of their sleep. The unified sleep window within each day is computed in a synchronized way based on a selected expansion point where the overall traffic demand is at its lowest level during the off-peak time.

Our simulations are based on the GEANT network topology and its real traffic traces. According to our experimental results, the proposed scheme is able to achieve up to 18.6% energy saving without causing any traffic performance deterioration. The distinct contribution from this work is a practical and efficient scheme for energy efficiency based on legacy network elements, without requiring any hardware upgrades or protocol extensions.

**Title and author(s) of the original paper in IEEE Xplore:**
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*Author:* Frederic Francois, Ning Wang, Klaus Moessner and Stylianos Georgoulas
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