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Energy Management Through Optimized Routing and Device Powering for Greener Communication Networks

Abstract:

Recent data confirm that the power consumption of the information and communications technologies (ICT) and of the Internet itself can no longer be ignored, considering the increasing pervasiveness and the importance of the sector on productivity and economic growth. Although the traffic load of communication networks varies greatly over time and rarely reaches capacity limits, its energy consumption is almost constant. Based on this observation, energy management strategies are being considered with the goal of minimizing the energy consumption, so that consumption becomes proportional to the traffic load either at the individual-device level or for the whole network. The focus of this paper is to minimize the energy consumption of the network through a management strategy that selectively switches off devices according to the traffic level. We consider a set of traffic scenarios and jointly optimize their energy consumption assuming a per-flow routing. We propose a traffic engineering mathematical programming formulation based on integer linear programming that includes constraints on the changes of the device states and routing paths to limit the impact on quality of service and the signaling overhead. We show a set of numerical results obtained using the energy consumption of real routers and study the impact of the different parameters and constraints on the optimal energy management strategy. We also present heuristic results to compare the optimal operational planning with online energy management operation.