

Traffic-Adaptive Power Reconfiguration for Energy-Efficient and Energy-Proportional Optical Interconnects

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In this study, we proposed POLESTAR, i.e., Power LLevel Scaling with Traffic-Adaptive Reconfiguration, for microring-based optical interconnects. Featuring a collection of runtime reconfiguration strategies that target the power states of the lasers and the microring tuning circuitry, POLESTAR demonstrates remarkable effectiveness for improving the energy efficiency and energy proportionality of underutilized datacenter/HPC interconnects. Through traffic-adaptive adjustment of the reconfiguration mechanism, POLESTAR achieves a reasonable balance between energy saving and application execution time. Good scalability across topologies, network loads, and potential advances in optical device design is also observed. POLESTAR is extensible by incorporating more reconfiguration strategies and improving existing ones. With future work targeting better traffic prediction techniques and the possible inclusion of runtime traffic scheduling, POLESTAR paves a promising way to the energy-efficient and energy-proportional optical interconnects for future datacenter/HPC applications.

This work makes a significant contribution by proposing the concept of effective energy efficiency. This concept is particularly noteworthy for its focus on the runtime management of power-consuming components in optical interconnects, which, if not cleverly executed, could inadvertently offset the benefit from device- and link-level optimization efforts. This leads to the realization of the utmost importance of runtime reconfiguration capabilities for optical interconnects in data center/high-performance computing settings to achieve high energy efficiency and proportionality.