Energy Efficiency and Yield Optimization for Optical Interconnects via Transceiver Grouping

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In this study, we target the application scenario where fabricated microring-based transceivers are grouped for assembling optical networks of multiple nodes. We propose two algorithms to mix and match the fabricated transceivers so that the three optimization objectives, namely the average energy efficiency, the uniformity, and the yield of the networks assembled, are optimized. We evaluated our proposed algorithms by wafer-scale measurement data of microring-based transceivers, as well as synthetic data generated based on an experimentally validated variation model. Our first algorithm based on simulated annealing (SA) can achieve up to 25% improvement in the average energy efficiency of the networks assembled, up to 94% reduction of the standard deviation of the energy efficiency, and up to 75 percentage points increase of the network yield, compared to a baseline strategy that randomly groups the transceivers. Moreover, our second algorithm based on Pareto simulated annealing (PSA) can efficiently produce multiple Pareto-optimal grouping schemes that significantly outperform the random grouping scheme in all three optimization objectives, namely the energy efficiency, the uniformity, and the yield of the networks assembled.

Incorporating data from wafer-scale measurement ensures that the optimization algorithms are tailored to actual conditions, leading to more reliable and applicable results. The enhanced accuracy and reliability of the models, informed by real process variation data and detailed in another paper of mine, are essential for predicting the performance of optical networks under varying manufacturing conditions. This ensures that the optimization strategies are both robust and relevant to real-world applications. Furthermore, this study emphasizes a top-down, application-driven method for design optimization of optical interconnects. This approach is particularly significant as it addresses the practical challenges in deploying optical interconnects, focusing on end goals like energy efficiency, uniformity, and yield.