Your Name: Xiaojun Cao
Your E-mail address: xcao2@cse.buffalo.edu
Your Dissertation Proposal Title: Waveband Switching in Wavelength Division Multiplexing Networks
Your Committee:
Chair: Chunming Qiao
Members: Xin He, Jinhui Xu
Your Dissertation Proposal Abstract:

Optical networks employing wavelength division multiplexing (WDM) are promising solutions to meet enormous bandwidth requirements. The rapid advances in dense WDM technology with hundreds of wavelengths per fiber and world-wide fiber deployment have brought about a tremendous increase in the difficulty of managing such large number of wavelengths, the size (i.e. number of ports) of photonic cross-connects, as well as the cost and difficulty associated with controlling such large cross-connects. In this dissertation, we investigate a novel switching paradigm, called WaveBand Switching (WBS). We study waveband switching in conjunction with new multi-granular optical cross-connect (MG-OXC) architectures to maintain the cost and complexity of the cross-connects at a reasonable level. %We explore several major %critical but challenging problems in WBS networks

For the case with static traffic, we develop an Integer Linear Programming (ILP) model to determine the routes and assign wavelengths to the lightpaths so as to minimize the number of ports needed. Since the optimal WBS problem contains an instance of Routing and Wavelength Assignment (RWA), which is NP-complete, the ILP model is not feasible for large problem sizes due to its huge computational time and space (memory) complexity. Hence, we develop near-optimal heuristic algorithms. We also provide analytical methods for obtaining the total number of ports in a network using MG-OXCs. Our analysis and simulation indicate that both the Single-Layer and the Multi-Layer MG-OXC architectures can reduce the number of ports (hence the size and cost) of the switching nodes compared to using ordinary OXCs (without waveband switching), and the former provides a greater reduction than the latter. Our study also provides valuable insights into the effect of wavelength band granularity and the benefits of multi-fiber system, as well as the trade-offs between the wavelength-hop and the port count required in WBS networks.

In our next research, we propose reconfigurable MG-OXC architectures for on-line (dynamic) traffic and compare their performances in terms of the blocking probability and weighted (request) acceptance ratio. We develop an on-line ILP model, and an efficient heuristic algorithm, called Maximum Overlap Ratio (MOR). Our results indicate that MOR perform better than the On-ILP, First-Fit, and Random-Fit algorithms. With incremental traffic, we show that using the Multi-Layer MG-OXCs is more beneficial than Single-Layer MG-OXCs.

As wavelength conversion is still an expensive and evolving technology, we investigate efficient usage of wavelength conversion in WBS networks. We propose an efficient heuristic algorithm to satisfy fluctuating requests and apply it in WBS networks with full, intra-band, or limited number of wavelength converters. We show that the proposed algorithm performs significant better than other heuristics in terms of the blocking probability as well as the number of used wavelength converters. To analyze the blocking performance of WBS networks with or without wavelength conversion, we develop analytical models based on techniques such as multi-dimensional Markov chain.