Waveband Selective Switch: A Network Analysis for Advanced Optical Transport Networks in 6G and Beyond Technologies

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INTRODUCTION

- Recent strides in technology, including 5G and the impending 6G, cloud computing, and high-bandwidth applications, have led to an exponential surge in Internet traffic.
- The growing demand for data capacity necessitates the development of cost-effective optical networks capable of handling massive data loads.
- Optical switching systems like ROADM and OXC play a crucial role, often employing wavelength-selective switches (WSSs) for efficient operation.
- While cascading WSSs is a common approach to achieving port count requirements, it comes with challenges such as increased transmission loss and the need for additional amplifiers, contributing to system noise.
- As optical transmission systems evolve towards multi-band and multi-core configurations in the era of 6G communication, traditional wavelength switching becomes costlier and more complex.
- Introducing **waveband (WB) switching** provides a simpler and potentially more economical alternative. WB switching involves routing grouped wavelengths simultaneously, simplifying hardware and reducing costs.
- While WB switching may lead to a slight performance hit due to a lack of fine-grained routing, this can be effectively mitigated through proper spectrum assignment and routing schemes.
- The research delves into the networking performance of an optical node switching system designed for multi-band optical networks. The system employs a two-stage switching process, first grouping wavelengths and then switching them as waveband pathways.

The study advocates for waveband routing as a simple and cost-effective alternative to traditional wavelength routing.

ARCHITECTURE

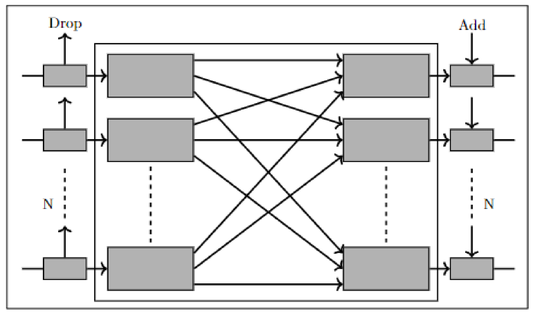

Fig. 1 Wavelength enabled node architecture

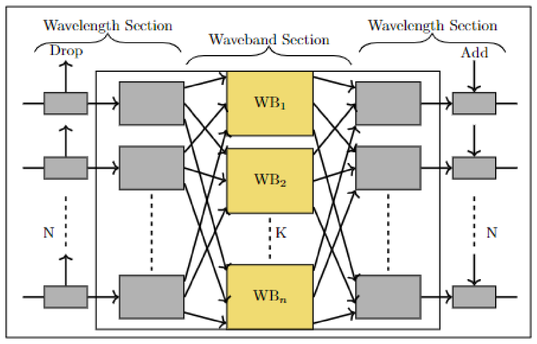

Fig. 2 Waveband enabled node architecture

- Fig. 1 illustrates the conventional optical cross-connect (OXC) architecture employing wavelength-granular routing, representing the traditional wavelength-based switching system.
- Contrasting this, Fig. 2 showcases a coarse-granular routing scheme, specifically waveband (WB) routing, as an alternative approach.
- The waveband routing scheme involves three key steps:
  1. Grouping optical paths from incoming fibers into *M* wavebands (WBs), maintaining wavelength continuity and contiguity.
  2. Independently routing the *M* wavebands to their respective outgoing fiber ports.
  3. Coupling arriving wavebands at any fiber port to facilitate their distribution to additional outgoing fibers.

The research focuses on the networking level analysis of the OXC architecture, specifically assessing the impact of wavelength (WL) and waveband (WB) routing

RESULTS

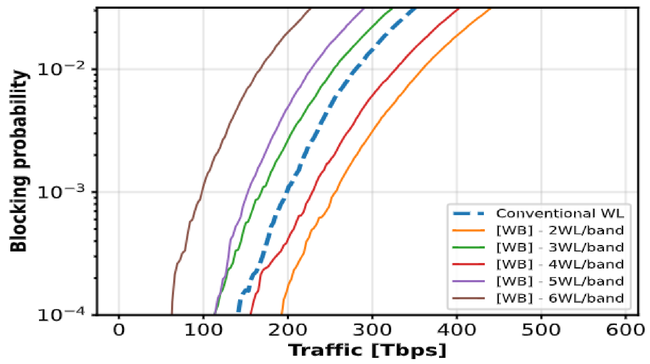

Fig. 3 BP vs. traffic for WL and WB enabled network

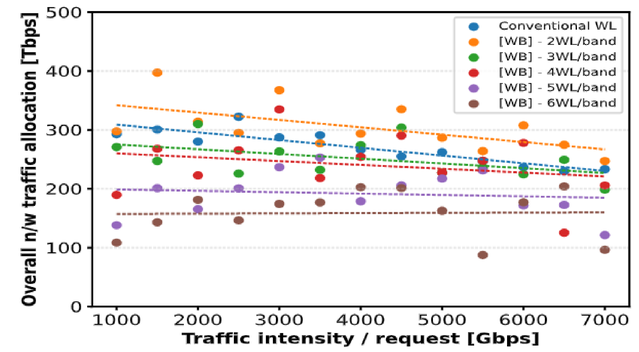

Fig. 4 Impact of WB size (M) on overall network traffic

- Fig. 3 provides a comprehensive comparison of network traffic distribution and blocking probability (BP) between the conventional WL architecture (M = 1) and WB architectures for varying values of M (ranging from M = 2 to M = 6).
- The comparison between conventional WL and WB architectures reveals that, as traffic intensity per request rises, the WB configurations show a more gradual reduction in overall network traffic allocation, hinting at their potential to outperform the WL case as traffic intensity further increases.

The study affirms that waveband switching outperforms conventional wavelength approaches, presenting itself as a promising solution to meet the escalating demands for high-intensity bandwidth in the rapidly evolving technological landscape.

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