Abstract

This thesis explores the growth of optical transport networks using a novel Reconfigurable Optical Add-Drop Multiplexer (ROADM) design that incorporates a photonic integrated multi-band Wavelength Selective Switch (WSS). This sophisticated technology was designed specifically to greatly improve the capability and effectiveness of multi-band optical transport networks. It achieves this by facilitating operations across the S, C, and L bands, hence enabling transfers ranging from 400G to 1.2T. The architecture utilizes the existing fiber infrastructure and incorporates real-world network topologies from different countries such as Germany, Italy, Spain, and the USA. It aims to demonstrate the practical advantages of transitioning from traditional C-band only systems to more flexible multi-band configurations. This change not only attempts to enhance network performance and capacity, but also effectively decreases capital costs by decreasing the requirement for further fiber deployments

In addition to enhancing this study, machine learning methods are used to forecast control and routing states in the photonic switching systems, enabling the dynamic administration of network traffic. These algorithms are specifically developed to be independent of network topology and technology, allowing them to be applied in various network contexts and improving their effectiveness in controlling switch planes in real-time. The machine learning technique enhances data flow efficiency and enhances the Quality of Transmission (QoT) by evaluating viable pathways and improving network element design.

Comprehensive network simulations and performance assessments have shown that the utilization of the multi-band method, coupled with the WSS amd WBSS, not only fulfills but surpasses the limits of traditional networks. This technique effectively manages higher volumes of data traffic with improved efficiency and decreased operational expenses.

The findings of this study emphasize the significant and revolutionary effect of incorporating advanced photonic and machine learning technology into optical networking. The results emphasize the most effective network setups that optimize both performance and capacity, providing a future-oriented viewpoint on network administration. This study lays the foundation for future progress in optical networking technology, with a focus on scalability and efficiency in situations with high demand. It also offers useful insights into the strategic implementation of next-generation optical transport systems.