Design Methodologies for Impairment-Aware Elastic Optical Networks

Abstract

Elastic Optical Networks are considered an effective solution to overcome the limitations of the wavelength division multiplexing networks. The flexible spectrum allocation capability of elastic optical networks results in high-speed transmission. Even though many investigations and studies involving elastic optical networks are reported in the past years, the evolution of this network necessitates more work in some critical aspects that limit its capabilities. On exhaustive research, we find that the issues related to spectral fragmentation, four-wave mixing, guard-band slots, a limited number of transceivers, link failures, etc., are critical factors that impair the network functionalities and need further investigations. We also observe that optical-to-electrical-to-optical conversions at intermediate nodes strongly influence network design costs. Hence, this thesis considers the essential aspects of elastic optical networks while designing routing and spectrum allocation algorithms, thereby improving spectrum utilization.

At first, a dynamic routing and spectrum allocation algorithm is framed, considering both the fragmentation and linear impairment awareness that evaluates the required transmitted signal power to achieve a quality of transmission. Thereafter, we proposed a new spectrum allocation scheme to suppress the effect of four-wave mixing in elastic optical networks. Subsequently, we designed a transceiver-aware routing and spectrum allocation algorithm to estimate the number of transceivers per node in the network. Next, the impact of guard-band slots on spectrum utilization and blocking performance is analyzed in protected and unprotected elastic optical networks. Finally, we developed a static routing and spectrum allocation algorithm based on single-hop optical connectivity to limit the optical-to-electrical-to-optical conversions at network nodes.

In this thesis, new algorithms have been proposed to solve the routing and spectrum allocation problem in realistic networks and to compare the results with the already established algorithms. An effort has been made to modify and reformulate the benchmark algorithms by emphasizing the different attributes that impair the operational capabilities of elastic optical networks. With the help of simulations, it has been shown that the proposed new approaches for impairment-aware static and dynamic routing and spectrum allocation algorithms improve the performance of elastic optical networks.