

RELAY ASSISTED CODE-DIVISION-MULTIPLEXING-BASED DYNAMIC RESOURCE ALLOCATION FOR ELASTIC OPTICAL NETWORKS

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Abstract

Numerous studies have investigated elastic optical networks (EONs) with the aim of expanding the transmission capacities of core networks. To achieve this goal, it is necessary to solve the spectrum resource wastage problem caused by spectrum fragmentation. Moreover, due to the potentially high traffic demands in future networks, it is important to handle requests that need to be reserved immediately (immediate reservation, IR) as well as those that can be reserved in advance (advance reservation, AR). In networks that support the coexistence of IR and AR requests, IR service degradation by AR requests is a challenging issue because AR requests tend to reserve future resources, which causes a lack of current resources to meet IR requests. Therefore, we address the problem of spectrum fragmentation and the service-level control of IR and AR requests by routing and spectrum allocation (RSA). First, we summarize related research into EONs and resource-allocation methods for IR and AR requests. Next, we propose a novel dynamic RSA method to reduce spectrum fragmentation and control the service level of IR and AR requests in terms of bandwidth blocking probability (BBP) in EONs considering the multiplexing effect of spatial channels. Finally, we evaluate the proposed method based on computer simulations and our results demonstrate that the proposed method can improve the BBP for the entire traffic flow by reducing spectrum fragmentation, as well as the service control of AR requests and IR requests under various network conditions.

1. INTRODUCTION

Human beings are the rare species in the World as they have ability to think and

express. These abilities created the need to share their feelings and their thoughts. The feelings and thoughts can be shared in various ways like body moves, speech, gestures, facial expressions etc.. These sharing processes are well known as 'communication'. The speech is one of the most powerful medium of communication; however, human voice can reach only up to a limited distance to convey someone thoughts. The transmission of signals over a distance for the purpose of communication began thousands of years ago with the use of smoke signals, fire signals, drums and physical delivery like carrier pigeons, horses, runners etc. These processes of sending the signals over a distance for the purpose of communication are called telecommunication in modern times.

The invention of telegraph in 1837, later its patent by S.F.B Morse [1] and deployment of first telegraph link between Baltimore and Washington in 1844 can be taken as starting of the modern telecommunication. This was first big breakthrough in the field of telecommunication, as the information in the form of electrical signals, was transmitted at a very fast speed almost equal to the speed of light through wired line. In 1876, the next important invention was the telephone by Alexander Graham

Bell [2]. The telephone transmitted the voice signals over wire. Since then, the telephone system has been evolving and now it has become the network of the world's public circuit-switched telephone networks popularly known as public switched telephone network (PSTN). Traditional PSTN systems were circuit switched, optimized to carry the voice traffic with the transport technology based on copper cables. With the advances in optical fiber technology revolution came in the transport technology. Optical fibers offer much higher bandwidths than copper cables. Optical fibers are less susceptible to various kinds of electromagnetic interference and other undesirable effects. This led to the replacement of copper cables by optical fibers in the core networks. The brief history of optical network and wavelength division multiplexing technique is discussed in the following sections.

2.LITERATURE SURVEY

An optimization problem was formulated for RSA to maximize the spectrum utilization and guarantee the quality of signals from the perspective of nonlinear interference described by a Gaussian noise model between channels sharing the same fiber links. The basic concept of EONs was described in [1]. The advantage of this network architecture is efficient spectrum resource usage, where it only assigns resources with sufficient bandwidth according to the requirements of the connections. This is possible because EONs can assign spectrum resources to each connection using a flexible grid by selecting modulation formats based on both the requested bit rates and the optical reach, whereas traditional rigid WDM

networks assign resources with a fixed grid [6]. EONs can dramatically improve the utilization of spectrum resources compared with conventional WDM networks, but it is essential to provide further transmission capacity in order to cope with exponential increases in network traffic. Given the expected lack of spectrum resources in the near future, SDM technologies including multifibers, -cores, and -modes have received much attention as promising solutions for extending spectrum resources by adding spatial channels [7–9]. Multi-cores and -modes require the development of fiber-fabrication processes and sophisticated resource-management procedures to reduce crosstalk between channels, but they can increase the capacity per fiber compared with traditional fibers that use a single core and mode. The RSA problem is the most important issue that affects EONs from the perspective of networking [10]. If there is no wavelength converter, the continuity and contiguity constraints must be satisfied in the transmission route and frequency domain in RSA. The continuity constraint requires that the frequency slots (i.e., the unit of spectrum resources) assigned to a connection must have the same index at all links on the transmission route. This constraint is due to the inability of all-optical networks to convert wavelengths at relay nodes without wavelength converters, and is similar to the routing and wavelength assignment (RWA) problem in traditional WDM networks. In addition, the contiguity constraint that must be satisfied in EONs is that the frequency slots assigned to a connection must be a sequence in the frequency domain. This is because EONs select a modulation format according to the distance of a connection and the

minimum necessary bandwidth is assigned in a flexible manner. Depending on the selected modulation format and the requested bit rate, the connection requires some continuous frequency slots with appropriate bandwidth.

3. PROPOSED SYSTEM

We investigated the problem of IR service degradation in EONs that support both IR and AR requests. We proposed two methods to reduce spectrum fragmentation and ensure the service-level control of IR and AR requests. We introduced prioritized areas to reduce spectrum fragmentation by ordering spectrum resources in the frequency domain. In addition, we divided the prioritized areas into IR dedicated and shareable sub-areas, with dynamic control of the border between the two sub-areas in order to control the BBP. We evaluated the proposed methods based on computer simulations.

We propose a novel, dynamic RSA method for reducing spectrum fragmentation as well as controlling the service level of IR requests and AR requests in multi-core EONs. This method configures prioritized areas based on the required frequency slots to reduce spectrum fragmentation. Each prioritized area is divided into two sub-areas: one dedicated to IR requests (IR-dedicated sub-area) and another that is shareable for both IR and AR requests (shareable sub-area). IR-dedicated sub-areas maintain the spectrum resources for IR requests even if the reservations for AR requests increase. Note that we set not ARdedicated sub-areas but shareable sub-areas, because AR requests can be easily allocated compared with IR requests due to flexibility in the time domain. In addition, the border of the IR-dedicated and shareable sub-areas is moved dynamically to obtain the desired ratio for the BBPs of IR and AR requests. Each prioritized area and sub-area follows the same spectrum division in all the cores of the network at all times because this helps to satisfy the continuity constraints on a transmission route in RSA. This method is called AR-limited (AR-L).

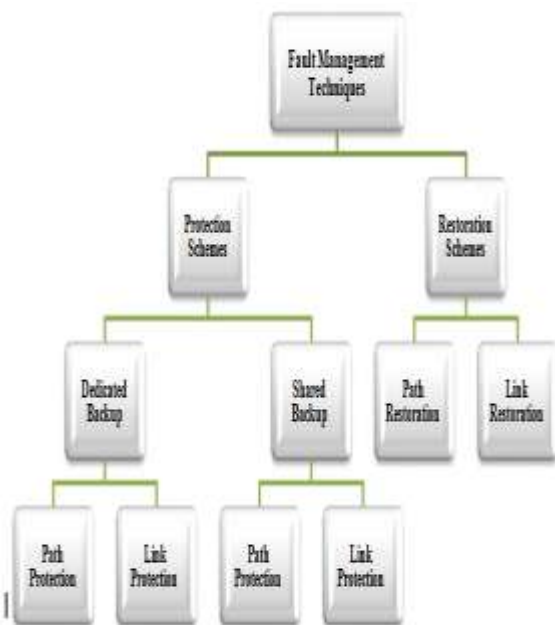


Figure 1 Survivability techniques in optical network.

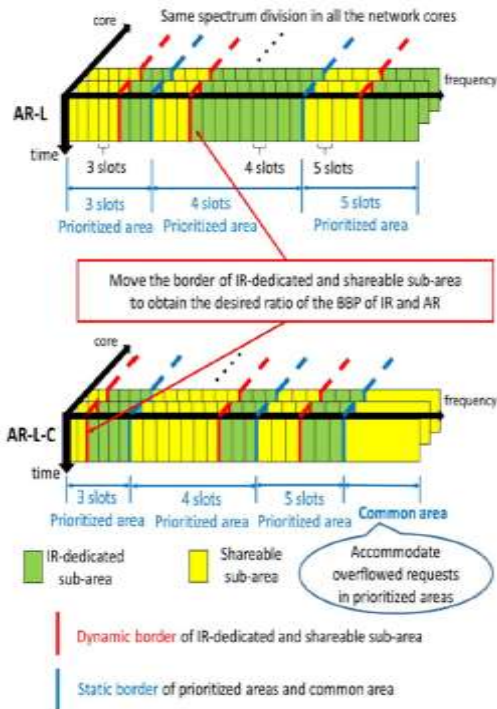


Fig. 2. Virtual resource design of the proposed methods. All the areas and sub-areas follow the same spectrum division in the network, including the core domain, due to the continuity constraint on the transmission route in RSA.

In a restoration model, the new route and available wavelength have to be dynamically assigned for each failed link. The restoration technique is involved in failure detection, new path computations for the failed connections and reconfiguration of switches for the restoration path. These techniques provide efficient utilization of resources. The protection/restoration scheme is further classified in two categories: path protection/restoration and link protection/restoration.

In shared-path protection technique, the resources along a backup path may be shared with other backup paths [18], [60]-[63]. It allows the use of the same wavelength on a link for two different

protection paths if the corresponding working paths are link-disjoint. An example of shared-path protection technique is shown in figure 2.4. Here it is seen that both protection paths used the common link (3, 5) with same wavelength λ . Therefore, only one wavelength on this link has to be reserved for protection, as opposed to two for dedicated-path protection. Shared-path protection is more capacity efficient to compare with dedicated-path protection.

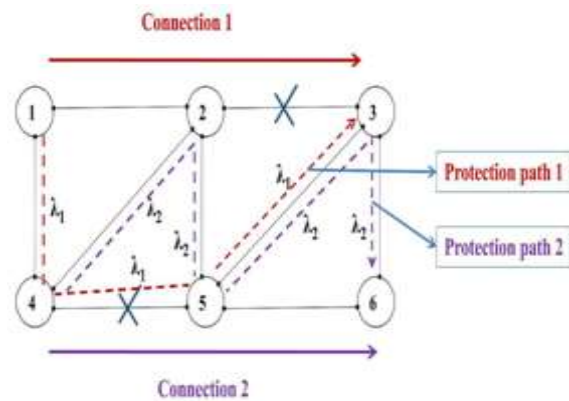


Figure 3 Dedicated-path protections

4.SIMULATION RESULTS

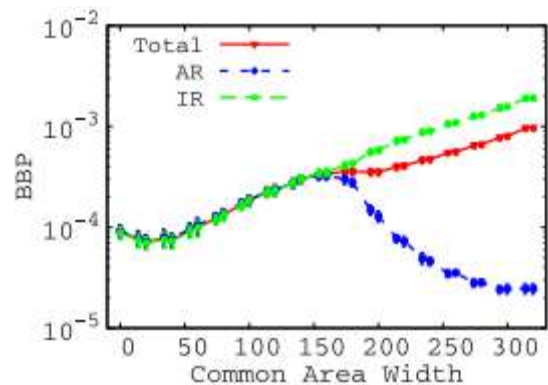


Fig. 4. Common area width versus BBP

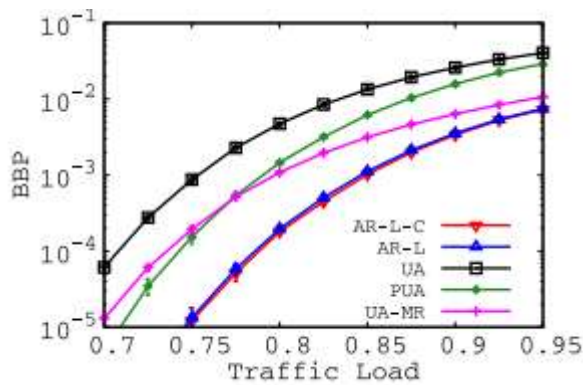


Fig. 5. BBP for total traffic

5.CONCLUSION

Optical network is widely used in various applications such as high-speed supercomputing, real-time medical imaging, scientific visualization and high-definition video distribution. If a fiber cut occurs in such a high speed network, it will result in a huge loss of data. Therefore, all service provider companies ensure survivability and restoration via analysis of recovery mechanism, backup routers and backup capacity of their network. Minimum spare capacity requirement is a very important issue in optical networks to support Tb/s high speed. So in this thesis our main focus is to minimize the spare capacity utilized by optical networks. In this research work, the working capacity allocation, spare capacity allocation and joint capacity allocation planning model in optical networks has been thoroughly analyzed and compared. It was found that for Network A, joint capacity allocation model utilized 33.58% less spare capacity in comparison with *P*-cycle model, 12.82% less spare capacity in comparison with APLR model, 11.43% less spare capacity in comparison with NALR model and 7% less spare capacity in comparison with path restoration model.

The working traffic and restored traffic are jointly routed in the proposed joint capacity planning model.

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