2015 IEEE 10th International Conference on Industrial and Information Systems, ICIIS 2015, Dec. 18-20, 2015, Sri Lanka

Pre-configured Backup Protection with Limited Resource Sharing in Elastic Optical Networks

Suthaharan Satkunarajah, Krishanthmohan Ratnam, and Roshan G. Ragel
Department of Computer Engineering
University of Peradeniya, Sri Lanka.

***Abstract*—In this paper, we address the problem of providing survivability in elastic optical networks (EONs). In EONs, unlike the traditional 50 GHz fixed grid, fine granular 12.5 GHz flexgrid is used and the frequency spectrum is used more efficiently. For providing survivability, we consider a recently proposed survivability approach known as pre-configured backup protection with sharing (PBPS) because of its benefits over traditional methods. In PBPS, backup paths can be pre-configured and at the same time they can share resources. Therefore, both short recovery time and efficient resource usage can be achieved. PBPS has earlier been investigated for fixed-grid and flexgrid (EONs) networks using switch architectures with the power splitting feature of variable optical splitters (VOSs) and combiners. A potential problem in PBPS is power loss due to possible repeated power splitting. To reduce the power loss, amplifiers can be used at additional high cost. Alternatively, an approach of limiting backup sharing has been investigated in fixed-grid networks. In this approach the number of power splitting on a backup lightpath at intermediate nodes is limited (to a threshold value) to reduce the total power loss. This approach limits the degree of backup sharing. PBPS with limited backup sharing has not been investigated for flexgrid networks (EONs) and this investigation is the focus of this paper. We carry out this investigation with detailed simulation experiments on different network topologies. Our findings are as follows. (1) As seen in fixed-grid networks, even with the small number of power splitting, significant blocking reduction is seen in EONs. (2) Unlike fixed-grid networks, the blocking performance of PBPS with the small number of power splitting is comparable to the performance associated to unlimited power splitting (unlimited sharing) and, therefore, PBPS with limited sharing is more effective in EONs when compared to fixed grid networks.**

***Index Terms*—elastic optical networks; survivability; WDM.**

I. INTRODUCTION

Wavelength division multiplexing (WDM) optical networks have been considered for handling the explosive growth of the Internet traffic [1]. WDM separates the huge transmission bandwidth available on a fiber with non-overlapping wavelength channels and it enables data transmission over these channels simultaneously. Typically, 50 GHz or 100 GHz fixed grid spectrum spacing has been used for these channels in WDM, based on the International Telecommunication Union (ITU) standards. Recently, elastic optical (or flexgrid) networks (EONs) have received much attention for using the frequency spectrum more efficiently [2]. Unlike 50 GHz or 100 GHz fixed grid spacing, fine granular frequency slots (12.5 GHz) or flexible grids are used in EONs for provisioning lightpaths [3, 4]. The flexgrid technology allows assigning the spectrum according to bandwidth requirements and it enables expansion and contraction of lightpaths according to the traffic volume [5], therefore, the frequency spectrum is used more efficiently in flexgrid networks.

Providing survivability or protection with backup paths is an essential issue in optical networks as huge amount of data can be lost due to component failures such as fiber cut. Traditionally two types of protection methods, dedicated and shared, have been considered which are shown in Fig. 1(a) and Fig. 1(b) with the network topology of eight nodes and ten links. Pre-configured paths (primary (P) or backup (B)) are denoted by solid arrows and non pre-configured paths (backup (B)) are denoted by dotted arrows. In the dedicated protection shown in Fig. 1(a), backup paths B1 and B2 are configured at the time of establishing primary paths P1 and P2 respectively (B1 and B2 are pre-configured). Suppose that, on a component failure on P1, no further configuration is needed as B1 is pre-configured. Therefore, traffic is rerouted through B1 in short recovery time. However, backup resource sharing is not possible among backup paths and, therefore, resource consumption in this approach is high [6] (six backup links used). Unlike dedicated protection, in the shared protection shown in Fig. 1(b), backup paths B1 and B2 are not pre-configured. In this method, backup resources can be shared assuming the single link or component failure model, that is B1 and B2 share the resources on link C-D, therefore, less resources are consumed in shared protection (five backup links needed). In case of a component failure, say, failure on P1, B1 must be configured or established before rerouting. Therefore, it requires more recovery time.

Traditional switch architectures such as MEMS (Micro-Electro-Mechanical Systems) switches [7] do not support setting up pre-configured backup paths while sharing resources, because of architectural limitations. Recently a protection

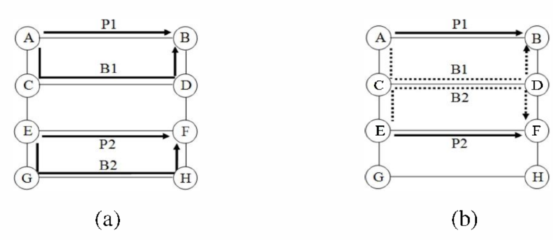

Fig. 1: Traditional (a) Dedicated and (b) Shared protection methods.