Efficient Switch Architectures for Pre-configured Backup Protection with Sharing in Elastic Optical Networks

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***Abstract*— In this paper, we address the problem of providing survivability in elastic optical networks (EONs). EONs use fine granular frequency slots or flexible grids, when compared to the conventional fixed grid networks and therefore utilize the frequency spectrum efficiently. For providing survivability in EONs, we consider a recently proposed survivability method for conventional fixed grid networks, known as pre-configured backup protection with sharing (PBPS), because of its benefits over the traditional survivability approaches such as dedicated and shared protection. 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. We find that the existing switch architectures do not support both PBPS and EONs. Specifically, we identify and illustrate that, if a switch architecture is not carefully designed, several key problems/issues might arise in certain scenarios. Such problems include unnecessary resource consumption, inability of using existing free resources, and incapability of sharing backup paths. These problems appear when PBPS is adopted in EONs and they do not arise in fixed grid networks. In this paper, we propose new switch architectures which support both PBPS and EONs. Particularly, we illustrate that, our switch architectures avoid the specific problems/issues mentioned above. Therefore, our switch architectures support using resources more efficiently and reducing blocking of requests.**

Keywords—elastic optical networks; survivability; optical switch architectures

I. Introduction

Optical networking with wavelength division multiplexing (WDM) has been considered to be a promising solution for handling the explosive growth of the Internet traffic [1]. WDM divides the vast transmission bandwidth available on a fiber into several non-overlapping wavelength channels and enables data transmission over the channels simultaneously. Typically, as specified by the International Telecommunication Union (ITU), 50 GHz or 100 GHz fixed grid spectrum spacing has been used for these channels in WDM. Recently, elastic optical (or flexgrid) networks (EONs) have received much attention for using the frequency spectrum more efficiently [2]. In EONs, fine granular frequency slots (12.5 GHz) or flexible grids are used for provisioning lightpaths instead of the conventional fixed grid spacing [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. To support EONs, two optical switch architectures have been proposed in the literature [6, 7]: gridless multi-granular and broadcast and select architectures which are shown in Fig. 1(a) and Fig. 1(b) respectively. In these architectures, components such as gridless/flexible/ bandwidth-variable wavelength selective switches (gridless/flex/BV WSSs) and bandwidth variable transceivers (BVTs) or gridless add/drop ports are primarily used to support EONs. In the gridless multi-granular architecture (shown in Fig. 1(a)), the gridless WSS is configured to select (switch) particular frequency slots. These frequency slots are then directed via the optical switch to the necessary output link. (In this architecture, a limited number of splitters are used for multicasting). Gridless add or drop ports are used to transmit or receive optical signals based on flexgrid. In the broadcast and select architecture, optical signals are broadcast (by splitters) to BV-WSSs attached to output links. Necessary frequency slots are then selected (switched) to the required output link by BV-WSSs.

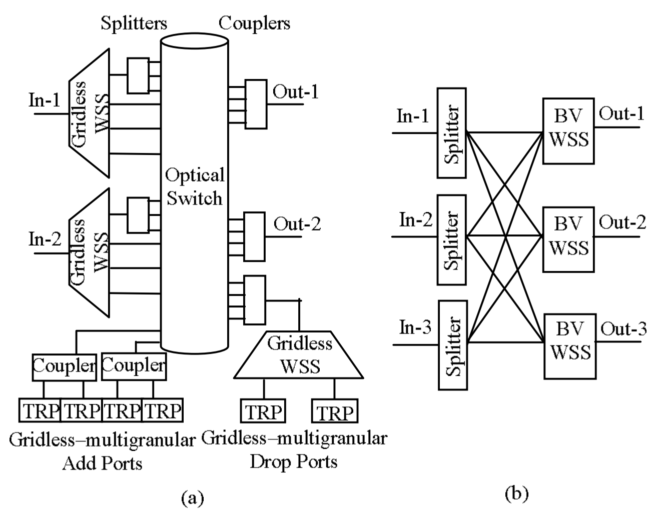

Fig. 1. Switch architectures for EONs (a) using gridless multi-granularity (b) using broadcast and select.

978-1-4799-4598-6/14/$31.00 ©2014 IEEE