Comparison of Single-Line Rate for Dedicated Protection on WDM Optical Network Topologies

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***Abstract*—Wavelength division multiplexing (WDM) divides the huge bandwidth available on a fiber into several non-overlapping wavelength channels and enables data transmission over these channels simultaneously. Failure of the optical fiber causes loss of huge amount of data which can interrupt communication. There are several approaches to ensure network survivability. In survivability, we consider dedicated protection in this paper in which backup paths are configured at the time of establishing connections. If a primary path is failed, the traffic is rerouted through backup path with a short recovery time. In this paper, we investigate the performance by calculating the spectrum efficiency variation for dedicated protection in WDM networks. Spectrum efficiency is calculated by dividing the total traffic bit rate by the total spectrum used. In this paper, we carry out the investigation with detailed simulation experiments on different single-line rate (SLR) scenarios such as 100 Gbps, 400 Gbps, and 1Tbps. In addition, this paper focuses on four standard network topologies which consist of different number of links to identify how the spectrum efficiency varies for each network. Our findings are as follows. (1) Spectrum efficiency for each SLR are almost similar and comparable in all the network topologies. (2) Unlike network topology with low number of links, the spectrum efficiency for network topology with high number of links are higher, therefore, the spectrum efficiency increases when the number of links are increased. (3) The spectrum efficiency is lower when the number of primary links are higher even though in all the network topologies.**

Keywords*—*wavelength division multiplexing; dedicated protection; single-line rate; spectrum efficiency.

I. Introduction

Optical networking with wavelength division multiplexing (WDM) has been considered to be a promising solution for handling the explosive growth of Internet traffic [1]. Furthermore, it is very likely that this trend will continue due to the massively increasing number and use of internet services such as Video on Demand (VoD), high definition Internet Protocol (IP) TV, cloud computing and grid applications requiring high amount of data rate. The ever increasing demand for bandwidth is posing new challenges for transport network providers. A viable solution to meet this challenge is to use optical networks based on WDM technology. WDM is a method of data transmission in which it divides the vast transmission bandwidth available on a fiber into several non-overlapping wavelength channels and enables data transmission over these channels simultaneously [2]. WDM is similar to frequency division multiplexing (FDM). However, instead of taking place at radio frequencies (RF), WDM is done in the electromagnetic spectrum. In this technique the optical signals with different wavelengths are combined, transmitted together, and separated again. It uses a multiplexer at the transmitter to join the several signals together, and a demultiplexer at the receiver to split them apart. It is mostly used for optical fiber communications to transmit data in several channels with slightly different wavelengths. This technique enables bidirectional communications over one strand of fiber, as well as multiplication of capacity. In this way, the transmission capacities of optical fiber links can be increased strongly. Therefore, the efficiency will be increased. WDM systems expand the capacity of the network without laying more fiber. WDM technique has mainly been used in optical backbone networks. To meet these high data rate demands, modulation formats installing higher number of bits per symbol into 50 GHz fixed grid spaces as standardized by International Telecommunication Union (ITU) along the bandwidth spectrum were brought in [3, 4]. For instance, 100 Gbps-based transmission systems have been fit into 50 GHz fixed grid space and commercialized [5]. Theoretically, a single fiber is capable to support over 1000 optical channels or wavelengths at a few Gbps in speed [6]. We have focused on survivability particularly traditional dedicated protection approach in WDM optical networks that received much attention in the research community. We realized more opportunities for further research in these areas.

Failure of the optical fiber in terms of fiber cut causes loss of huge amount of data which can interrupt communication

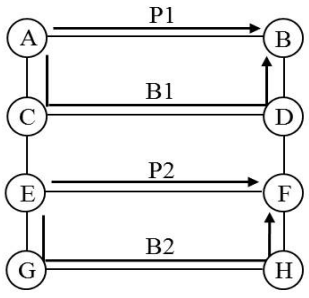

Fig. 1: A scenario of traditional dedicated protection.

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