Resource Efficiency for Dedicated Protection in WDM Optical Networks

Suthaharan, S., Samarakkody, D. and Perera, W.A.S.C.

Department of Physical Science, Vavuniya Campus of the University of Jaffna

Email: s.shelton4@yahoo.com, dhanushadlr@gmail.com, anneshehari@gmail.com

Abstract

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 wavelength division multiplexing (WDM) technology. WDM divides the huge transmission bandwidth available on a fiber into several non-overlapping wavelength channels and enables data transmission over these channels simultaneously. 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. Failure of the optical fiber in terms of fiber-cut causes loss of huge amount of data which can interrupt communication services. There are several approaches to ensure mesh fiber network survivability. In survivability, the path through which transmission is actively realized is called working path or primary path whereas the path reserved for recovery is called backup path or secondary path. In this paper we consider traditional dedicated protection method in which backup paths are configured at the time of establishing connections primary paths. If a primary path is brought down by a failure, it is guaranteed that there will be available resources to recover from the failure, assuming the backup resources have not failed also. Therefore, 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 traditional dedicated protection in WDM optical networks. To evaluate the pattern for the spectrum efficiency we use various network topologies where the number of fiber links in each network is different. Spectrum efficiency is the optimized use of spectrum or bandwidth so that the maximum amount of data can be transmitted with the fewest transmission errors. Spectrum efficiency is calculated by dividing the total traffic bit rate by the total spectrum used in the particular network. The total traffic bit rate can be calculated by multiplying the data rate by the number of connections (lightpaths). The total spectrum would be the multiplication of the frequency used for a single wavelength and the total number of wavelengths (bandwidth slots) used in the network. 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 optical network topologies which consist of different number of fiber links to identify how the spectrum efficiency deviates for each network. To evaluate the performance, we considered 21-link NFSNET, 30-link Deutsche network, 35-link Spanish network, and 43-link US network as specimens. In our simulation study, spectrum efficiency for each networks are plotted in separate graphs and compared with each other. Our findings are as follows. (1) Spectrum efficiency for each SLR is almost similar and comparable in all the network topologies. (2) Unlike network topology with low number of fiber links, the spectrum efficiency for network topology with high number of fiber links are higher, therefore, the spectrum efficiency increases when the number of links are increased.

Keywords: *wavelength division multiplexing, dedicated protection, single line rate, spectrum efficiency.*