Chapter 13

A SURVEY OF SURVIVABILITY TECHNIQUES FOR OPTICAL WDM NETWORKS

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Abstract
In an optical wavelength division multiplexed (WDM) network, link or node failures may result in huge amounts of lost data, due to the enormous fiber throughput. This requires that optical WDM network be designed to be resilient to failures. Thus, survivability can be defined as the ability to respond gracefully to such failures. This chapter presents a comprehensive survey of various mechanisms proposed to achieve survivability. The survey considers different topologies, different failure models, implementation issues, signaling issues and quality-of-protection issues.

Keywords: Survivable Optical WDM Networks, Protection and Restoration, Single and dual-link failures, Node failures, Channel failures, Implementation, GMPLS-based Signaling, Quality of Protection.

13.1 Introduction

Optical fiber based networks, characterized by a bandwidth of over 50 terabits per second (Tb/s), have emerged as the transmission medium of choice for high speed communication due to their capacity, reliability, cost and scalability. Recent advances in optical technology and in particular wavelength division multiplexing (WDM), a multiplexing technique that partitions the bandwidth provided by an optic fiber into individual multi-gigabit channels, have been identified as enabling technologies that will allow us to fully and effectively utilize the fiber capacity [1, 2]. Current optical technology demonstrations have shown a feasibility of 160 channels, each operating at 10 gigabits per second (Gb/s), and future networks are expected to operate at 40 Gb/s per channel or higher.
The advent of wavelength-routing enabled the design of wide area networks and the concept of all-optical lightpaths from source to destination [3]. Figure 13.1 shows a typical optical WDM wavelength routed network. The network consists of optical routing nodes called wavelength selective or wavelength interchanging cross-connects [4]) interconnected by fiber links (uni-directional or bi-directional). The connection between the source and the destination node is realized by a lightpath, an end-to-end optical path. The procedure of setting up a lightpath between any source-destination pair involves choosing an appropriate route and assigning the required wavelength(s) on the route selected. This problem is referred to as the Routing-and-Wavelength Assignment (RWA) problem. The network lightpaths can be established in two ways. They can be established in a static manner, where the set of lightpaths are determined before network operation begins. Alternatively, the lightpaths can be established in a dynamic manner, where the lightpaths are established on a demand basis, where lightpaths enter and leave the network based on some arrival process.