Chapter 11
Distributed Quality of Service Based Provisioning Framework for Survivable Optical Networks

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ABSTRACT
This chapter provides new distributed frameworks to support Quality of Service (QoS) differentiation. These frameworks provide differentiated protection services to meet customers’ availability requirements effectively. We describe the availability-analysis for connections with different protection schemes. Through this analysis, we show how connection availability is affected by resource sharing. Based on the availability analysis, the proposed framework provisions each connection in which an appropriate level of protection is provided according to its predefined availability requirement. We consider the networks without wavelength conversion capability as well as dynamic traffic environment. In these distributed frameworks we propose several distributed schemes to provision and manage connections cost-effectively while satisfying the existing and new connections availability requirements.

INTRODUCTION
All-optical networks are potential candidates for future wide-area backbone networks. Such networks provide high throughput of the order of terabits per second. They display low error rates, and are characterized by minimum delay. Due to those features, they can satisfy the emerging applications such as supercomputer visualization, medical imaging, and distributed CPU interconnect. Optical network provides a large number of wavelengths per fiber; and present technology allows transmission rates of up to 10 Gbps per channel. The optical network consists
of wavelength cross-connects (OXC) interconnected by point-to-point fiber links in an arbitrary mesh topology. In these networks, a connection is referred to as a lightpath, which is established between any two nodes by allocating the same wavelength on all links along the chosen route. The requirement that the same wavelength must be used on all the links along the chosen route is known as wavelength continuity constraint.

Compared to a ring network, a WDM mesh network can provide a wide variety of protection schemes. The trend in the development of optical networks has recently started moving towards a multiservice platform. In such scenario, considering the requirements of different applications/end users, it is essential to provide services with different Qualities. Consequently, systematic methodology to efficiently select a cost-effective protection scheme for each connection while satisfying its quality-of-service (QoS) requirements is highly desired. Usually, QoS can be measured in many different ways: service availability, service reliability, restoration time, service restorability, etc… Service availability is one of the key concerns of customers and it is usually defined in a Service-Level Agreement (SLA). The SLA is a contract between the network operator and a customer. The violation of SLA may entail penalties to be paid by the network operator. Thus, a cost-effective, QoS-aware, connection-provisioning scheme is very desirable such that, for each customer’s service request, a proper protection scheme (dedicated, shared, or unprotected) is designed to guarantee the SLA-defined QoS requirement and to reduce overall network cost.

In this Chapter, We first describe the availability analysis for connections with different protection schemes (i.e., unprotected, dedicated protected, or shared protected). Through this analysis we show how connection availability is affected by resource sharing. Based on the availability analysis, we then develop a distributed provisioning framework in which an appropriate level of protection is provided to each connection according to its predefined availability requirement. We consider networks without wavelength-conversion capability and consider dynamic lightpath provisioning, where a set of traffic demands is not known in advance. We assume that each connection requires the full capacity of a wavelength channel. The network operator needs to provision each connection with minimal network resources while still meeting the connections availability requirements. Our distributed framework includes approaches to control and manage the network resources and lightpath connections in fully distributed fashion, which improves scalability and reduces control overhead.

The chapter will be organized as follows. Section 2 presents the background of the QoS Requirements in Survivable optical Networks. Section 3 presents the availability analysis for connections with different protection schemes in survivable networks. Section 4 presents a distributed controlled availability-aware provisioning framework in which an appropriate level of protection is provided to each connection according to the customer’s predefined availability requirement. Section 5 presents distributed controlled schemes to keep track the availabilities of the existing connections while provisioning new connections. The performance evaluation for the framework will be presented in section 6. Finally, section 7 concludes this chapter and gives some directions for future research.

QUALITY OF SERVICE IN OPTICAL NETWORKS

A WDM mesh network may provide different services for customers. The QoS requirements for these services can be different because of their diverse needs of the customers; banking services, on-line trading, and military applications demand high QoS levels, while IP best-effort packet-