

Chapter 8.18

All-Optical Internet: Next-Generation Network Infrastructure for E-Service Applications

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ABSTRACT

To exploit the unprecedented opportunities offered by the E-Service Applications, businesses and users alike would need a highly-available, reliable, and efficient telecommunication infrastructure. This chapter provides an insight into building the next-generation network infrastructure, that is, the All-Optical Internet. It also reveals the factors driving the convergence of the Internet Protocol (IP) and the Wavelength-Division Multiplexing (WDM) technology. The chapter discusses the

dominant optical networks architectures in an attempt to show the evolution towards the ultimate all-optical packet-switching network. A special focus is given to the Optical Burst Switching (OBS) as a new emerging switching paradigm and a highly promising technology. OBS network architecture, burst assembly, signaling and reservation protocols, QoS support, and contention resolution techniques are presented. Furthermore, realistic suggestions and strategies to efficiently deploy OBS are given.

INTRODUCTION

The Internet is a technology with many properties that has the potential to influence, and even transform established ways of conducting business, especially Electronic Services, while at the same time creating entirely new industries and businesses. The Internet has a profound impact on the competitive landscape, since it is affecting the way that firms' activities are coordinated, how commerce is conducted, how business communities are created, and how communications are defined and performed.

As we are moving towards the Web-dependent era, the 99 percent or even the 99.99 percent network reliability would be inadequate for the mission-critical applications that have genuine requirements that exceed the typical application needs.

The e-service applications are typically reliant on IP data networks that construct the Internet, which has become a ubiquitous success. Furthermore, the capacity of optical fibers is doubling annually toward a terabit per second per fiber, providing strong incentives to exploit the huge bandwidth of fiber-optic networks, which has increased considerably with the introduction of Wavelength-Division Multiplexing (WDM) technology.

The rapid advancement of optical technologies and the growing effort to enhance the Internet Protocol (IP) makes it possible to move from the current network architecture to an all-optical Internet, where the network traffic is optically transmitted, buffered, amplified, and switched through high performance Internet switches and routers directly connected using WDM optical links.

ALL-OPTICAL INTERNET

The Internet is an interconnection of computer networks that are a combination of hardware

and software, controlled by a set of protocols to transmit and communicate data. The Internet uses the TCP/IP protocol suite, where the Transmission Control Protocol (TCP) is a connection-oriented end-to-end protocol. TCP is used to create logical connections between various applications running on different hosts, prior to executing protocols that exchange information. TCP relies on the Internet Protocol (IP) to route the packets (data units that are routed between an origin and a destination) through the network. Therefore, the Internet is simply a massive network of networks.

Depending on the deployed physical technology, three network generations can be distinguished. The first-generation networks are based on copper wire or radio; subsequently, the copper wire (around 10 gigabits per second) was replaced by a more sophisticated transmission medium, the optical fiber, which offers an immense bandwidth (theoretically, 50 terabits per second), low error rate, high reliability, availability, and maintainability. Additionally, optical fibers feature many other advantages, for example, lightweight and small space requirements, resistance to corrosive materials, less signal attenuation, and high immunity to tapping. Having optical fiber as the transmission medium in the second-generation networks enhanced the network performance and throughput; however, this improvement was restricted by the so-called Electronic Bottleneck. Electronic bottleneck phenomenon is caused by the limited processing speed of electronic components (a few gigabits per second) deployed in switches/routers, multiplexers, and end-nodes in the network. As the electronic processing speed is at its peak, the solution is to transfer the switching and routing functions from the electronic domain to the optical domain. Therefore, the third-generation networks will be designed as all-optical networks, where the data are transmitted all-optically through the network from source to destination.

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