Optical Burst Switch as a New Switching Paradigm for High-Speed Internet

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INTRODUCTION

The concept of burst switching was initially proposed in the context of voice communications by Haselton (1983) and Amstutz (1983, 1989) in the early 1980s. More recently, in the late 1990s, optical burst switching (OBS) has been proposed as a new switching paradigm for the so-called optical Internet, in order to overcome the technical limitations of optical packet switching, namely the lack of optical random access memory (optical RAM) and to the problems with synchronization (Baldine, Rouskas, Perros, & Stevenson, 2002; Chen, Qiao, & Yu, 2004; Qiao & Yoo, 1999; Turner, 1999; Yoo & Qiao, 1997; Xu, Perros, & Rouskas, 2001). OBS is a technical compromise between wavelength routing and optical packet switching, since it does not require optical buffering or packet-level processing as in optical packet switching, and it is more efficient than circuit switching if the traffic volume does not require a full wavelength channel. According to Dolzer, Gauger, Späth, and Bodamer (2001), OBS has the following characteristics:

- **Granularity**—the transmission unit size (burst) of OBS is between the optical circuit switching and optical packet switching;
- **Separation between control and data**—control information (header) and data are transmitted on a different wavelengths (or channels) with some time interval;
- **Allocation of resources**—resources are allocated using mainly one-way reservation schemes. A source node does not need to wait for the acknowledge message from destination node to start transmitting the burst;
- **Variable burst length**—the burst size is variable;
- **No optical buffering**—burst switching does not require optical buffering at the intermediate nodes (without any delay).

In OBS networks, IP packets (datagrams) are assembled into very large size packets called data bursts. These bursts are transmitted after a burst header packet (also called by setup message or control packet), with a delay of some offset time in a given data channel. The burst offset is the interval of time, at the source node, between the processing of the first bit of the setup message and the transmission of the first bit of the data burst. Each control packet contains routing and scheduling information and is processed in core routers at the electronic level, before the arrival of the corresponding data burst (Baldine et al., 2002; Qiao & Yoo, 1999; Verma, Chaskar, & Ravikanth, 2000; White, Zukerman, & Vu, 2002). The transmission of control packets forms a control network that controls the routing of data bursts in the optical network (Xiong, Vandenhoute, & Cankaya, 2000). Details about OBS network architecture are given in the next section.

OBS NETWORK ARCHITECTURE

An OBS network is an all-optical network where core nodes, composed by optical cross connects (OXC), plus signaling engines, transport data from/to edge nodes (IP routers), being the nodes interconnected by bidirectional links, as shown in Figure 1. This figure also shows an example of an OBS connection, where input packets come from the source edge node A to the destination edge node B. The source edge node is referred to as the ingress node, and the destination edge node is referred to as the egress node. The ingress node of the network collects the upper layer traffic, sorts and schedules it into electronic input buffers based on each class of packets and destination address. These packets are aggregated into bursts and are stored in the output buffer, where electronic RAM is cheap and abundant (Chen et al., 2004). After the burst assembly process, the control packet is created and immediately sent towards the destination to set-up a connection for its corresponding burst. After the offset time, bursts are all-optically transmitted over OBS core nodes without any storage at the intermediate nodes within the core, until the egress node. At the egress node, after the reception of a burst, the burst is disassembly into IP packets and provides these IP packets to the upper layer. These IP packets are forwarded electronically to destination users (Kan, Balt, Michel, & Verchere, 2002; Vokkarane, Haridoss, & Jue, 2002; Vokkarane & Jue, 2003).

Recently, a new multilayered architecture for supporting optical burst switching (OBS) in an optical core network was defined by Farahmand, Vokkarane, Jue, Rodrigues, and Freire (in press). This article discusses the layered architecture of IP-over-OBS, describing each layer of the OBS layered architecture, separating them into a data plane and a control plane.

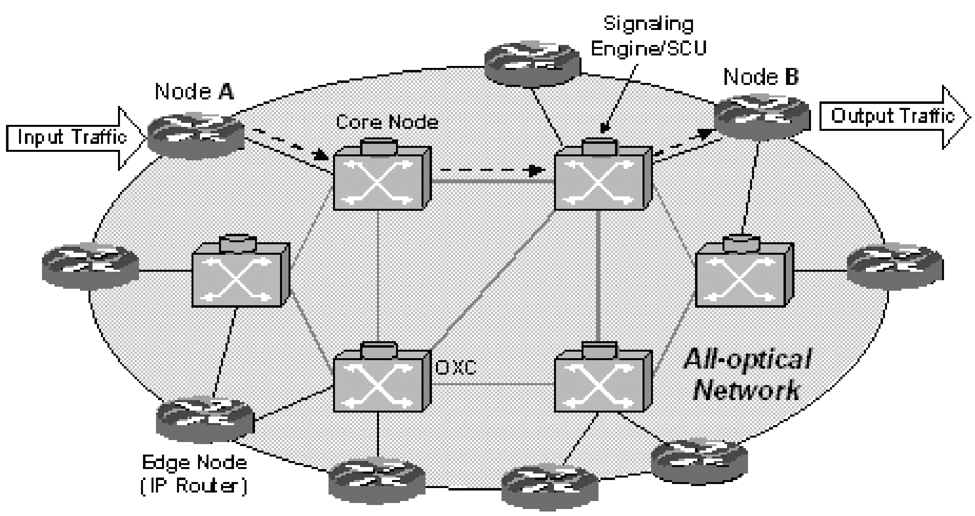
OBS EDGE NODES

The OBS edge node works like an interface between the common IP router and the OBS backbone (Kan et al., 2002; Xu, Perros, & Rouskas, 2003). An OBS edge node needs to perform the following operations:

- Assemblies IP packets into data bursts based on some assembly policy;
- Generates and schedules the control packet for each burst;
- Converts the traffic destined to the OBS network from the electronic domain to the optical domain and multiplexes it into thewavelength domain;
- Demultiplexes the incoming wavelength channels and performes optical-to-electronic conversion of the incoming traffic;
- Disassembles and forwards IP packets to client IP routers.

The architecture of the edge node includes three modules (Vokkarane & Jue, 2003): routing module,

Figure 1. Schematic representation of an IP over OBS network



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