Optik 122 (2011) 616–619

Contents lists available at ScienceDirect

Optik

journal homepage: www.elsevier.de/ijleo

Analysis of burst/packet assembly techniques in high-speed optical switching network

Amit Kumar Garg

School of Electronics and Communication Engg, Shri Mata Vaishno Devi University (J&K), India

ARTICLE INFO

Article history:
Received 25 September 2009
Accepted 30 March 2010

Keywords:
Optical Burst Switching
OBS Network
Burst assembly
Burst dropping
Segmentation of burst

ABSTRACT

In the Optical Burst Switching (OBS) Network, the burst assembly technique is one of the challenging issues in the implementation of the system. It has the influence on the burst characteristic, which gives an impact on the network performance. Burst assembly is the process of assembling incoming data from the higher layer into bursts at the ingress edge node of the OBS network. The burst assembly mechanism must then place these packets into bursts based on some assembly policy. In this paper, the OBS system performance has been observed in simulated 12-node network based on Just-Enough-Time (JET) reservation protocol with various burst assembly techniques under the standard drop policy (DP) and the segmentation policy for contention resolution. The simulation results show that the performance of the proposed Adaptive-Threshold with Fixed Maximum Time Limitation (ATH-FMTL) burst assembly scheme is better than conventional burst assembly schemes in terms of loss probability and average assembly delay. Also, the proposed scheme avoids a sudden increase in the burst size and makes the burst sent out smoother as compared to conventional schemes.

1. Introduction

Photonic networks using Optical Burst Switching (OBS) has emerged as an attractive choice for building the next generation photonic Internet. In burst switched photonic networks, the transmission links carry multiple WDM channels, which can be dynamically assigned to user data bursts. One channel on each link is reserved for control information. This separation of control and data simplifies the data path implementation, facilitating greater use of optical switching technologies. OBS combines the advantages of both circuit and packet switching (as shown in Table 1) and ensures efficient bandwidth and resource utilization.

An OBS network consists of core nodes and end-devices interconnected by WDM fibers as shown in Fig. 1. In OBS networks, the transmission links carry multiple WDM channels, which can be dynamically assigned to user data bursts. One channel on each link is reserved for control information. This separation of control and data simplifies the data path implementation, facilitating greater use of optical switching technologies. At the edge of the network, a Setup control packet is sent on the control channel to announce an upcoming burst. The control packet is then followed by a burst of data after a short delay. At the intermediate node, the Setup control packet is electronically processed, while the data channels are switched through transparently with no examination or interpretation of the data.

Since OBS is based on statistical multiplexing, burst contentions may arise at the nodes, and thus resulting packet loss. Therefore, in order to make statistical multiplexing more efficient and also to reduce packet loss probability due to burst contentions, excessive variation in burst size, in this paper, an efficient burst assembly scheme named as Adaptive-Threshold with Fixed Maximum Time Limitation Burst Assembly (ATH-FMTL) has been proposed, which uses optimal burst length threshold and fixed maximum time limitation as the condition for burst generation. The burst length thresholds are increased or decreased in case the burst queue size, at the time of burst generation, is larger than upper threshold or smaller than lower threshold, respectively. The performance of proposed scheme is compared under the standard drop policy (DP) and the segmentation policy (SDP) for packet loss probability.

The rest of the paper is organized as follows. In Section 2 a short state-of-the art in literature regarding conventional burst assembly methods such as timer-based and threshold-based have been described. It is seen that by calculating the optimum threshold value, calculating the minimum burst length and using a time-out value based on the packet's delay tolerance, minimum packet loss can be obtained, while satisfying the delay requirement. The current burst assembly mechanisms lack flexibility to actual network traffic and increases assembly overhead and delay. Thus, in Section 3 an efficient burst/packet assembly technique (ATH-FMTL) has been proposed to achieve the equilibrium between the incoming

E-mail address: garg_amit03@yahoo.co.in.

0030-4026/$ – see front matter © 2010 Elsevier GmbH. All rights reserved.
doi:10.1016/j.ijleo.2010.03.025

Table 1
Comparison of optical switching paradigms.

Optical switching (paradigm)	Bandwidth utilization	Latency (set-up)	Optical buffer	Traffic adaptively
Circuit	Low	High	Not required	Low
Packet/cell	High	Low	Required	High
Burst	High	Low	Not required	High

packets to the transmission of the bursts. Achieving an equilibrium implies that the rate of arrival packets at the ingress node corresponds to the rate at which the bursts are formed and transmitted. Section 4 provides the brief methodology to verify the feasibility of the proposed scheme. In Section 5 simulation results has been presented along with the performance comparison of the proposed scheme (ATH-FMTL) with conventional schemes. Finally, concluding remarks are made in Section 6.

2. Burst assembly

Burst assembly is the process of assembling incoming data from the higher layer into bursts at the ingress edge node of the OBS network. As packets arrive from the higher layer, they are stored in electronic buffers according to their destination and class. The burst assembly mechanism must then place these packets into bursts based on some assembly policy. The most common burst assembly techniques are *timer-based* and *threshold-based* [1]. In *timer-based* burst assembly approaches, a burst is created and sent into the optical network at periodic time intervals. In *threshold-based* burst assembly approaches, a limit is placed on the maximum number of packets contained in each burst. Using both time-out and threshold together provides the best of both schemes and burst generation is more flexible than having only one of the above. By calculating the optimum threshold value, calculating the minimum burst length and using a time-out value based on the packet's delay tolerance, it is ensured that minimum loss can be obtained, while satisfying the delay requirement.

2.1. Data burst generation

The OBS network structure components can be considered separately as two groups; the edge nodes and the core nodes. The edge node at the ingress side receives the IP packets from outside network and then assembles those IP packets into the bursts based on their destination and class of service. After that the edge node will forward the control packet and data burst with the policy according to the reservation protocol. For the edge node at the egress side, it does the function of de-framing and de-assembling the data burst into multiple IP packets in a rather simple manner. It also handles the burst reordering and retransmission request if required. The core nodes have to perform the function of routing burst scheduling, contention resolution and protection and restoration mechanism. Burst assembly process is done at the edge node of the OBS network. It is the process that assembles several IP packets into a burst grouping by their destinations and priorities. The assembly buffer threshold and time threshold are two influences

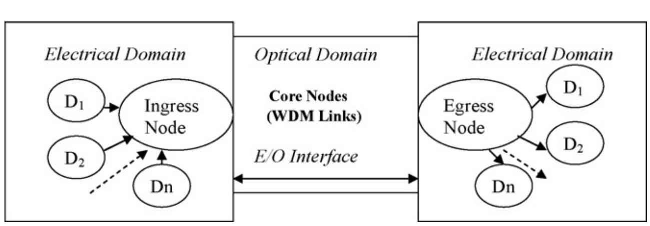

Fig. 1. An OBS network (electrical domain using aggregate traffic and the optical domain using OBS).

that make the effect to the burst generation. The assembly buffer threshold is used to limit the maximum size of the burst, while the assembly time threshold is used to limit the maximum assembly waiting time of the burst generation. The conventional burst assembly schemes are described as follows.

2.1.1. Threshold-based without time limitation (TH)

This threshold-based assembly scheme uses the fixed burst size decision value. It does not include the maximum assembly delay time limitation, thus it does not guarantee for the maximum assembly delay time. The burst will be transmitted when its length reaches the threshold value [2,3]. In case of constant packet size, the generated bursts will have the fixed size value. While packet size varies, the generated bursts will have a varied burst size value.

2.1.2. Timers-based with minimum burst length (TM)

The author in [4] proposed the timer-counter-based burst assembly method. This method uses the concept of maximum waiting time and minimum burst length. The burst will be generated as soon as the assembly waiting time reaches the maximum time limitation. The size of the bursts must be equal to or bigger than a given minimum burst size. If the waiting time is reached while the burst size is still smaller than the minimum burst size, the burst will be padded to the minimum burst size and transmitted into the network.

2.1.3. Fixed length threshold-based with time limitation (FL)

A fixed length threshold-based assembly method uses both fixed threshold and time-out interval for constant burst size and limited delay time of the assembly function [5,6]. The timer starts to count as soon as the first packet arrives at an assembly queue. The burst consisting of IP packets in the assembly queue is sent out whenever the time-out occurs or the number of packets in assembly queue reaches the threshold value. The additional technique, called padding, is used to make the generated burst size equal to the designed fixed value.

3. Proposed assembly scheme (ATH-FMTL)

The current burst assembly mechanisms lack flexibility to actual network traffic and increases assembly overhead and delay. The existing limit factors bring pressure to bear on core network and make the network performance deteriorate. Assembly time is inversely proportional to the offset time, that is, the longer the assembly time, the less time will be available for setting an offset at the burst queue. The aim of the proposed scheme is to achieve equilibrium between the incoming packets to the transmission of the bursts. Achieving an equilibrium implies that the rate of arrival packets at the ingress node corresponds to the rate at which the bursts are formed and transmitted. In order to alleviate an excessive variation in burst size, a novel burst assembly scheme named as Adaptive-Threshold with Fixed Maximum Time Limitation Burst Assembly (ATH-FMTL) has been proposed, which uses optimal burst length threshold and fixed maximum time limitation as the condition for burst generation. The burst length thresholds are increased or decreased in case the burst queue size, at the time of burst generation, is larger than upper threshold or smaller than lower threshold, respectively. The performance of proposed