

To Evaluate the Effect of Burst Length on the Performance of Optical Burst Switched Networks

Upkar Kaur¹, Nitika Chowdhary² and Jyoteesh Malhotra³

^{1,3}*ECE Dept, GNDU RC Jalandhar*

²*CSE Dept, GNDU RC Jalandhar*

upkar.kaur@yahoo.in, nitu.expert@gmail.com, jyoteesh@gmail.com

Abstract

Optical burst switching (OBS) has attracted interest of many from researchers to industries as a transport network architecture for the future optical Internet. OBS acts as a backbone to the Internet by providing long distance and large bandwidth links. In this work, we study the OBS networks in a very well-known network simulator tool “NCTUns” along-with the study of its performance evaluation. NCTUns is a high fidelity network simulator which can be used for simulating both wired and wireless networks. The simulation setup and evaluation results have been generated in NCTUns 6.0 running on Fedora 12 with kernel version 2.6.31.6.

Keywords: *Burst Segmentation, Minimum Burst Length, NCTUns, Optical Burst Switching.*

1. Introduction

Optical Burst Switching (OBS) has been proposed as an efficient and flexible switching paradigm for a highly dynamic future optical Internet. The primary idea in OBS is to accumulate IP packets into super-size packets called data bursts and to transmit these bursts following a burst header packet after some offset time [2]. OBS uses two channels, one for data transmission and the other for transmission of control information, known as data channel and control channel respectively. To initiate the transmission, source node sends the burst header packet (carrying the control information) first to reserve the resources along the data burst’s path. The burst header packet is electronically processed at each switch while the bursts are transmitted all optically.

National Chiao Tung University (NCTU) network simulator is one of the popular simulators being used for the Optical Burst Switched networks. Network simulation is a prime requisite to develop, test and analyze the various network protocols without the need of physical hardware, making it easy on the pocket and viable for almost any scale of network topology. NCTUns is used to carry out simulations of both the long-established circuit switching optical networks and the advanced optical burst switching networks.

The paper is organized as follows: Section II discusses the basic terminology used in the paper. Section III discusses the system setup of the network simulation tool NCTUns for OBS networks. Section IV discusses the results achieved after the performance evaluation of OBS network, and Section V concludes the paper providing an overview of the OBS extension in NCTUns.

2. Technical Background

Optical Burst Switching Network - Optical Burst Switching technology is a new switching paradigm for WDM optical networks. The OBS network strikes an ideal balance between packet switching and circuit switching. This network takes the incoming data packets and put them in basic units that are called as data bursts and then transport them to the core. In OBS, a control packet is sent first to set up a connection (by reserving an appropriate amount of bandwidth and configuring the switches along a path), followed by a burst of data [1].

Burst Header Packet (BHP) - In OBS, the data to be transmitted is assembled into bursts. Each burst has an associated control packet called burst header packet. BHP contains information regarding the burst such as, source and destination address, offset time, and the burst duration. BHPs are sent out of band. The BHP is transmitted ahead of data burst, while the burst is buffered at the source for an offset time.

Contention Resolution - Contention occurs when multiple data bursts are switched on the same wavelength are destined to go out through the same output port at the same time. That is a problem that generally occurs in packet switches. It is known as the external blocking.

Burst Segmentation - In burst segmentation, the entire burst is not dropped during contention, but the burst is broken into multiple segments, and the overlapping segments are dropped. Two approaches are followed for dropping burst segments when contention occurs between bursts. The first is to drop the tail of the first burst, and the second is to drop the head of the contending burst [3].

NCTUns - NCTUns is a high-fidelity and extensible network simulator and emulator capable of simulating various protocols used in both wired and wireless IP networks. The core technology of NCTUns is based on the novel kernel re-entering methodology invented by Prof. S.Y. Wang when he was at Harvard University. Due to this novel methodology along with discrete event methodology, NCTUns provides many unique advantages that cannot be easily achieved by traditional network simulators such as ns-2 and OPNET [4].

Minimum Burst Length (MBL) - MBL is a parameter under the 'Optical Burst Assembly' of the protocol module (OPT_OBWA) used in the protocol stack of an optical router. This field specifies the number of bytes of packets that are accumulated before a burst is sent [5].

3. Simulation Methodology

The network simulator is installed on the Windows platform using the Oracle VirtualBox. The simulations are carried out in NCTUns 6.0 on Fedora 12 with kernel version 2.6.31.6. To start with installation procedure, a virtual machine is created in the VirtualBox with name 'NCTUNS', type 'Linux' and version 'Fedora (32 bit)'. Next, RAM size of 700 MB is allocated for the virtual machine and a .vmdk file is used as a virtual hard drive. A virtual machine is created with aforesaid specifications. Start the virtual machine to begin with the installation of the network simulator. Login as root and make sure that the NCTUns setup folder is the root directory. Open the terminal and change the directory to root/NCTUNS6.0 and install the network simulator on the system by running the insall.sh file. The installation starts and a series of commands are automatically executed; enter yes whenever the prompt asks to enter a command. Finally NCTUNS6.0 is installed on the system. Set the environment variables to integrate the NCTUNS6.0 with fedora and reboot the guest system.

Before a user can start with the GUI program, user must ensure that the environment variables have been set. To do so open three terminal windows, become the root user in all the terminals and run the dispatcher, coordinator and nctunsclient program one in each terminal.

3.1. Operating Modes

The operations of generating a simulation case are grouped into four modes, discussed below.

i. The Draw Topology mode: This is the default mode in which NCTUns works when it is launched. This mode is used to create new topologies or modify the existing topologies. To analyze the performance of OBS network a topology is drawn as shown in Figure 1. Save the topology as a .tpl file.

ii. The Edit Property mode: IP addresses are automatically generated by the GUI program when the mode is changed to the Edit Property. Double click on the host (node 7); a host dialog box will open up. Enter 5 and 50 respectively in the start and stop time box. Enter the command `stcp -p 2000 1.0.4.2` in the command line. Figure 2 shows the host window where the command is entered to generate the network traffic. Open the node editor window, select MAC8023, next in log Packet Statistics, select Throughput of outgoing packets. Afterwards click on OK. Now, double click on host (node 9) and enter `rtcp -p 2000` in the command line and select Throughput of incoming packets in log Packet Statistics of MAC8023.

Double click on the host (node 10), a host dialog box will open up. Enter 0 and 70 respectively in the start and stop time box. Enter the command `stcp -p 3000 1.0.7.2` in the command line. Open the node editor window, select MAC8023, next in log Packet Statistics, select Throughput of outgoing packets. Then click on OK. Now, double click on host (node 12) and enter `rtcp -p 3000` in the command line and select Throughput of incoming packets in log Packet Statistics of MAC8023.

Double click on the host (node 11), a host dialog box will open up. Enter 0 and 100 respectively in the start and stop time box. Enter the command `stcp -p 4000 1.0.3.2` in the command line. Open the node editor window, select MAC8023, and next select Throughput of outgoing packets in log Packet Statistics. Then click on OK. Now, double click on host (node 8) and enter `rtcp -p 4000` in the command line and select Throughput of incoming packets in log Packet Statistics of MAC8023.

With the default values in the Queue length (50 packets) of FIFO module of host and Minimum Burst Length (16000 bytes) of OPT_OBWA module of router, run the simulation.

iii. The Run Simulation mode: The Run Simulation mode is selected to run the simulations. Configuration files are generated for the simulation and are stored in .sim folder of the filename. Next, select Run from the Simulation menu. The simulations will take some time and the progress can be checked on the time knot at the bottom of the screen. Lastly, the file transfers take place.

iv. The Play Back mode: This is the last operating mode of NCTUns. After the simulation is done, the GUI program receives the simulation result files from the simulation server and these files are stored in .results folder of the filename. This is used to re-play the transmission and reception of packets in an animated style [4,5]. Plot the graphs of Throughput of outgoing packets (node 7) and Throughput of incoming packets (node 9). These log files are stored in filename.results folder.

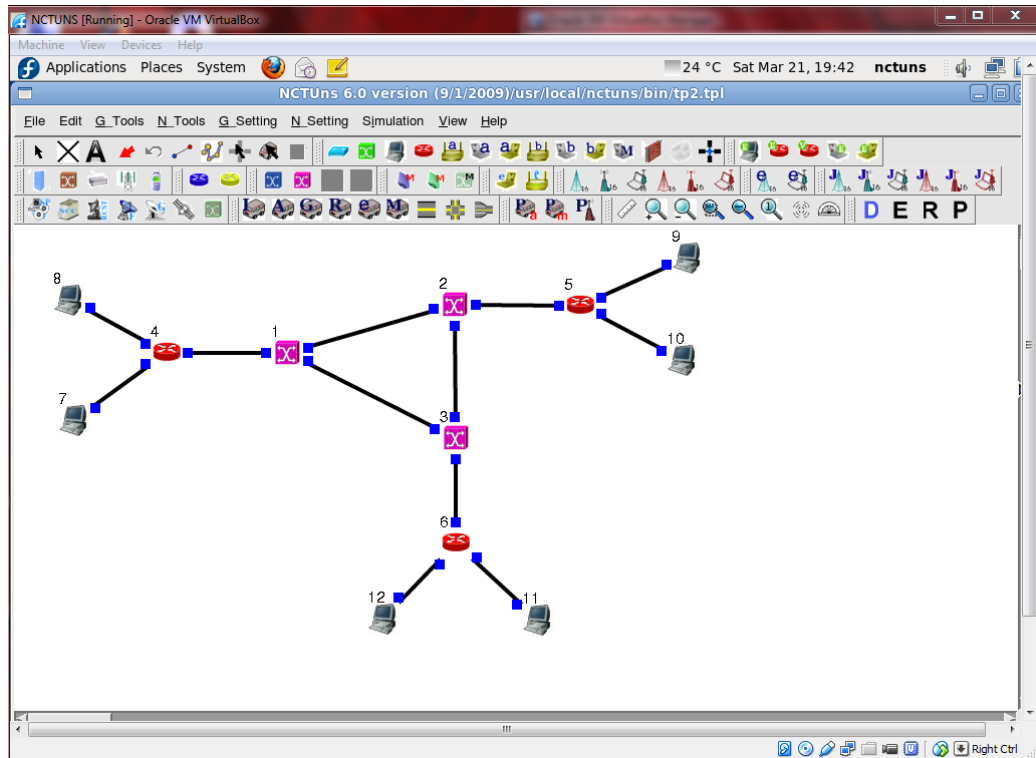


Figure 1. Topology of OBS Network in NCTUns



Figure 2. Traffic Generator Window

3.2. Simulation Parameters

The performance of the OBS network is evaluated by varying two parameters—minimum burst length and queue length. Select FIFO module of host (node 7 and node 9) and change the Queue length to 25 and 100 packets and plot the respective graphs. Next, plot the graphs by changing the Minimum Burst Length (MBL) of OPT_OBWA module of optical edge routers to 8000 and 32000 bytes.

Table 1. Simulation Parameters

Parameters	Value
Optical burst switches	3
Routers	3
Hosts	6
Optical links	12
Wavelength channels per optical link	3
Transport protocol	step, rtcp
Port number	2000, 3000, 4000
Minimum burst length (bytes)	8000, 16000 , 32000
Queue length (packets)	25, 50, 100

4. Results and Discussion

The graphs plotted using the log files after the simulation are shown in Figure 3 to Figure 8. Figure 3, 4 and 5 show the graphs plotted for edge router with minimum burst length of 8000, 16000 and 32000 bytes. Figure 6, 7 and 8 are graphs plotted for host having queue length of 25, 50 and 100 packets respectively.

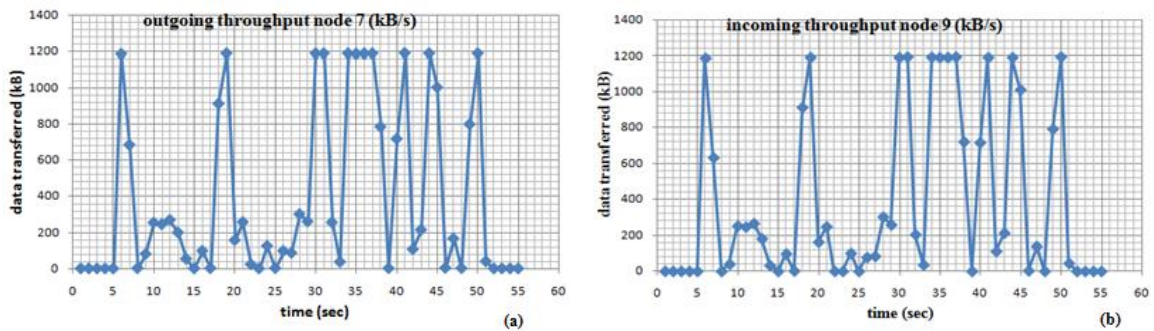


Figure 3. (a) Outgoing Throughput; (b) Incoming Throughput at MBL = 8000 Bytes

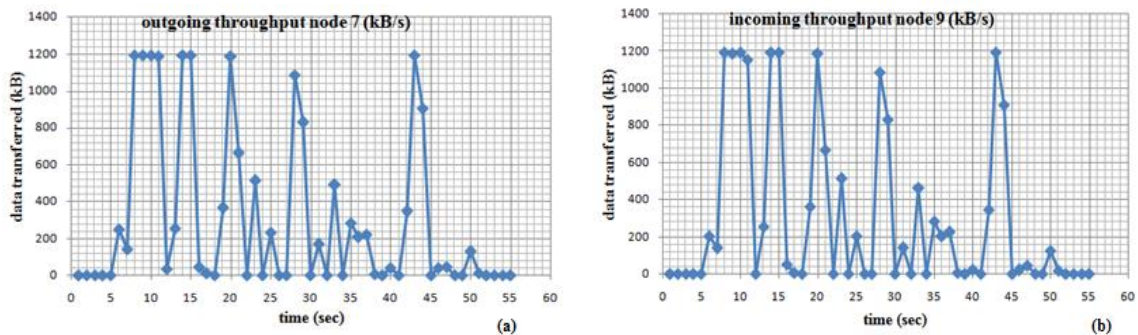


Figure 4. (a) Outgoing Throughput; (b) Incoming Throughput at MBL = 16000 Bytes (Default)

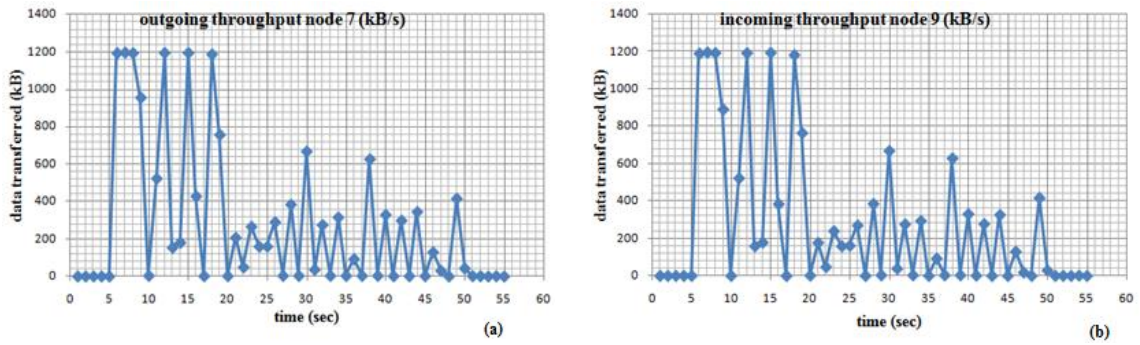


Figure 5. (a) Outgoing Throughput; (b) Incoming Throughput at MBL = 32000 Bytes

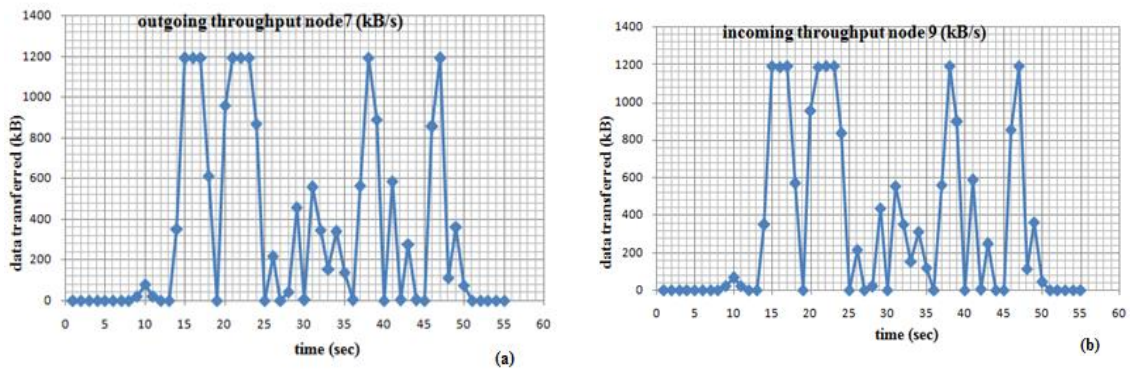


Figure 6. (a) Outgoing Throughput; (b) Incoming Throughput at Queue Length = 25 Packets

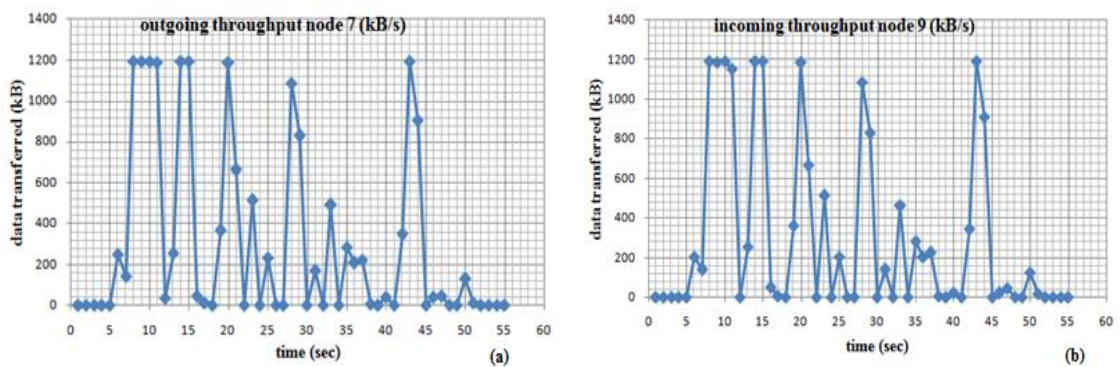


Figure 7. (a) Outgoing Throughput; (b) Incoming Throughput at Queue Length = 50 Packets (Default)

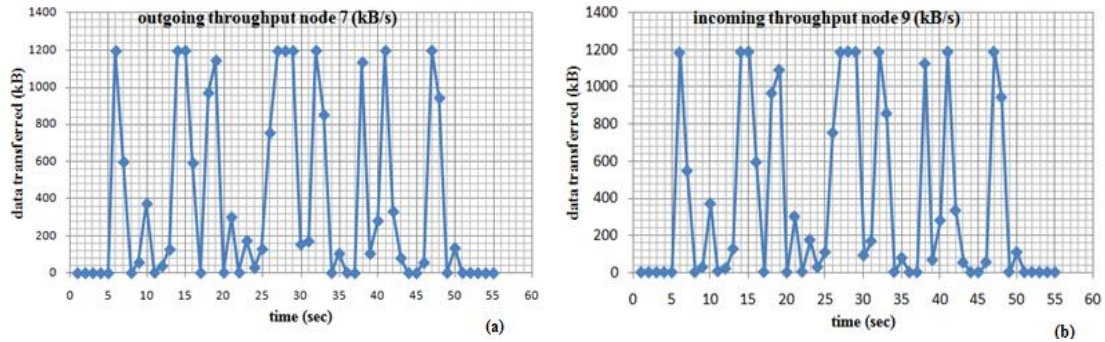


Figure 8. (a) Outgoing Throughput; (b) Incoming Throughput at Queue Length = 100 Packets

From the graphs, it is observed that with the increase in the minimum burst length the average throughput decreases and at the beginning of the transmission, throughput increases with increase in queue length. Table 2 summarizes the throughput obtained by changing the Minimum Burst Length and Table 3 summarizes the throughput obtained by changing the Queue Length.

Table 2. Throughput Achieved by Varying the Minimum Burst Length

Minimum Burst Length	Throughput of outgoing packets (node 7) in KB/s		Throughput of incoming packets (node 9) in KB/s	
	Max. Throughput	Average Throughput	Max. Throughput	Average Throughput
8000 bytes	1191.63	387.59	1191.63	380.91
16000 bytes	1191.63	306.39	1193.148	301.89
32000 bytes	1191.63	277.89	1191.63	272.28

Table 3. Throughput Achieved by Varying the Queue Length

Queue Length	Throughput of outgoing packets (node 7) in KB/s		Throughput of incoming packets (node 9) in KB/s	
	Max. Throughput	Average Throughput	Max. Throughput	Average Throughput
25 packets	1193.148	335.21	1191.63	330.07
50 packets	1191.63	306.39	1193.148	301.89
100 packets	1191.63	370.26	1191.63	363.52

5. Conclusion

Optical Burst Switching is an efficient switching technology that supports bursty data traffic. We have conducted a performance evaluation test of Optical Burst Switching network in this paper. The throughput obtained by changing the minimum burst length and queue length is plotted as graphs. It is observed that during the initial stage of the transmission, more throughput is achieved with the increase in the minimum burst length but the average throughput decreases with this increase.

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Authors



Upkar Kaur, (BTech), she is student of MTech in Electronics and Communication Department at Guru Nanak Dev University Regional Campus Jalandhar (INDIA). Her research area of interest is Optical Burst Switching.



Nitika Chowdhary, (BTech, MTech), she received the masters' degree in computer science and engineering, in 2013 and the bachelor's degree in information technology, in 2011 from Punjab Technical University, India. She is currently working as Assistant Professor in Computer Science and Engineering Department at Guru Nanak Dev University Regional Campus Jalandhar. Her research interests include security, distributed networks, and cloud computing.



Jyoteesh Malhotra, (BTech, MTech, PhD), he is involved in teaching and research in Electronics and Communication Department at Guru Nanak Dev University Regional Campus Jalandhar (INDIA). His research area of interest includes statistical modeling of Fading channels, Fading mitigation techniques in wireless communication, Optical Burst Switching and optimization of WBAN air interface. Dr. Malhotra has more than 100 research publication and authored two books. He is a life member of I.S.T.E and editorial board member of many international journal of repute.