12th Optoelectronics and Communications Conference/16th International Conference on Integrated Optics and Optical Fiber Communication (OECC/IOOC2007)
Technical Digest, July 2007, Pacifico Yokohama

13P-6

Network Performance of the Multi-Protocol Optical Switch Routing Algorithm using Multimedia Packet Traffic

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Abstract

In this paper, authors compared the performance of the MPOS [1] routing algorithm against conventional packet schemes. The MPOS routing segregates the different types of multimedia traffic into dedicated classes/priorities and assigns a light path for each of them. Improved traffic performance has been observed by the MPOS technique at high traffic load.

1 Introduction

All-optical networks using Wavelength Division Multiplexing (WDM) and wavelength routing offers an excellent bandwidth capacity for real-time multimedia traffic such as IPTV, Voice over IP (VoIP) and also the conventional Internet Data. Furthermore, with the current efforts to automate and expedite dynamic wavelength and bandwidth provisioning over the optical layer, trends are leading towards more intelligent optical networks with more efficient routing algorithms. The concept of a single routing algorithm that suits all types of traffic may not apply to multimedia applications which require a dedicated routing algorithm that suits its individual needs.

2 Theory and Concept

Alternatively to applying a single routing algorithm to cater for all types of multimedia traffic, the MPOS routing techniques applies a 'divide and route' approach. Sets or clusters of wavelengths and optical switching planes are assigned to cater for each of the three main traffic types (i.e. Video, Voice and Data). The MPOS routing technique is similar to the conventional Priority/Class Routing algorithms [3] which priorities the incoming traffic and store them in individual queues depending on the packet's priority. The switch later will retrieve the packet from the queue and route them through the switching plane and out towards the output port. When contention occurs, the packets with the highest priority will be routed first while the rest will be queued awaiting available slots. During high traffic load where the switch is unable to handle all the packets, packets with the lowest priority will be dropped to ease congestion. Although such priority routing scheme increases the chances of higher priority packets to be delivered, low priority packets suffers from high packet loss. Thus an 'unfair' scenario occurs.

Figure 1: MPOS Routing Algorithm

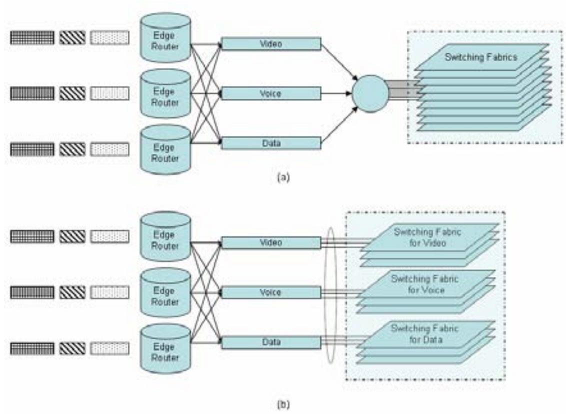

Figure 2: (a) Conventional and (b) MPOS Priority Routing

In the MPOS routing scheme, incoming packets are also prioritized and put into their individual queues according to their priorities, similar to the conventional method. But instead of having each switching plane routing packets from all priority classes, each of them will only route packets from a single priority class. Therefore the MPOS routing technique avoids contention among priority classes. Contention will only occurs among packets with the same priority thus reducing high packet loss for a specific traffic type.

3 Simulation Results

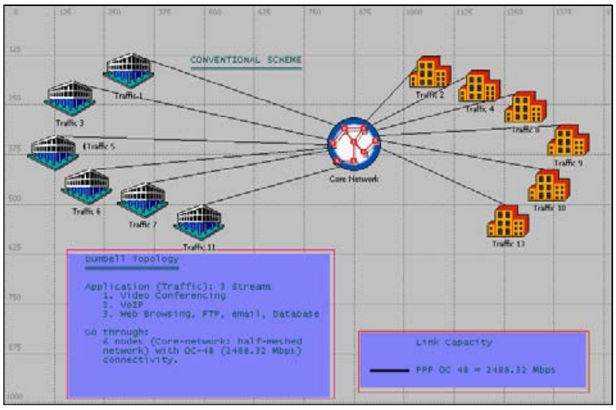

Figure 3: Simulation Setup using OPNET Modeler

The objective of this simulation setup (Figure 3) is to investigate the performance differentiation between the MPOS method versus the conventional by use of scheduling at the router interface. Two scenarios are simulated using OPNET, which are the conventional method and the MPOS method in a 6 node mesh network. The multimedia traffics used in this case study are video conferencing, voice over IP (VoIP) and data traffic (web browsing, FTP, e-mail and database). For both conventional and MPOS methods, web browsing, FTP, e-mail and database uses exponential inter-arrival time and each is set with constant transaction/packet/file size. Traffics are set to best efforts except for video streaming traffic. From the simulated results, the average packet jitter and the average packet delay variation are collected for both scenarios. In packet jitter, if two consecutive packets leave the source node with time stamps t1 & t2 and are played back at the destination node at time t3 & t4, then:

$$\text{Jitter} = (t4 - t3) - (t2 - t1)$$

Negative jitter indicates that the time difference between the packets at the destination node was less than that at the source node. On the other hand, packet delay variation is the variance among end to end delays for packets received by each node. End to end delay for a voice packet is measured from the time it is created to the time it is received. As the network utilization increases from 0% to 100% (occurs at 2m) packet jitter occurs in the conventional approach but not in the MPOS. Packet delay also increases with network utilization for the conventional approach but not the MPOS. Therefore, both the Packet Jitter and Packet Delay Variation results show that the MPOS approach has an improved performance over the conventional method when the network utilization reaches 100% (approximately at 2m). This is due to the dedicated link for each type of traffic thus avoiding contention between different classes.

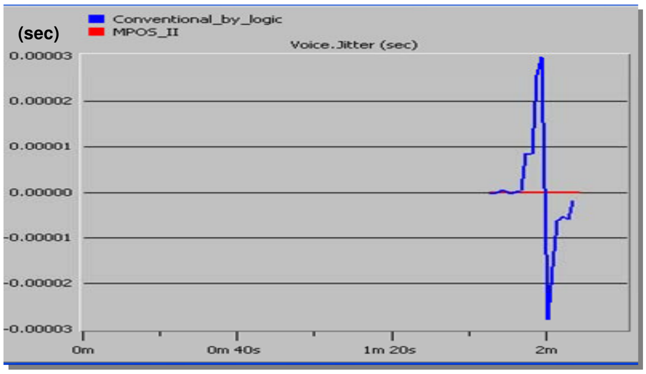

Figure 4: Packet Jitter for MPOS vs Conventional

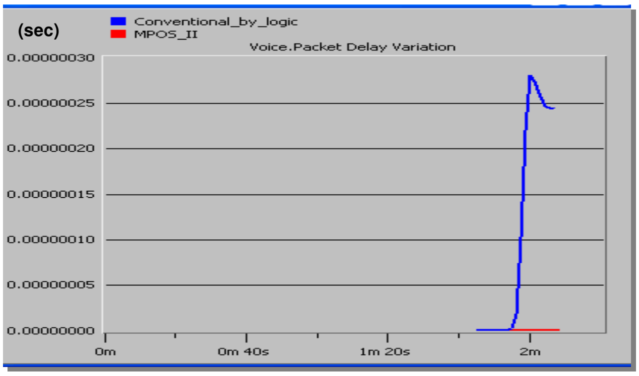

Figure 5: Packet Delay Variation for MPOS vs Conventional

4 Conclusion

In this paper we have shown a novel routing method which has an improved performance over the conventional IP routing with multimedia traffic. At high network utilization, the MPOS routing method was able to maintain the end-to-end delay variation and also avoided packet jitter.

5 References

1. Bernard H.L. Lee, et al, 'Performance Simulation of Multi Protocol Optical Switch (MPOS) with Multicasting Capable Transponders for Optical GRID Networks,' IEEE NUSOD 2006, S'pore 2006
2. Shun Yao, et al, 'A comparison study between slotted and unslotted all-optical packet-switched network with priority based routing,' OFC2001, pp TuK2-1 – TuK2-3