Performance Evaluation of Different High Speed LANs Connected by Optical Cross Connect and Couplers in Optical Networks

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Abstract- This paper presents an analysis of optical cross connect and couplers of high speed LAN in optical networks. In addition, simulation results of this paper compare the performance of high speed LAN with respect to the utilization of both optical cross connect and coupler. The delay and collisions occur in both networks have been examined. We have observed the performance and effect of both networks in case of sending and receiving frames. If the frame size is constant 1500 bytes then the Traffic Received, Delay and Collision is high. But if we reduce the frame size from 1500 to 256 bytes, the performance is improved. The performance metrics used in this work are: Delay, Traffic Sink, Traffic Source, Collision and Packet Size. The simulation results show a good approximation of data traffic observed in the optical network.

Keywords: Local Area Network (LAN), Frame, Delay, Collision, OXC (optical cross connect), Coupler

1. Introduction

In optical networks the number of hosts and the size of network in a LAN are limited. Optical cross connect are used to enable communication between coupler [1].Optical cross connect (OXC) connects LAN segments, use a table of MAC addresses to determine the segment on which a frame needs to be transmitted, and reduce traffic. OXCs are data link layer devices that let multiple physical LAN segments be interconnected into single larger networks. Instant access to the full bandwidth is received by each host. Collision is avoided in full duplex OXCs, because only one device is connected to each OXC port [2]. Increasing the number of packets in the network also increases the length of the queues at each router. Longer queues, in turn, mean packets are delayed longer in the network, and, hence, the traffic received is dropped. At the same time too conservative approach leads to the drop again as it does not allow enough packets to being sent to keep the links busy [3].

The core job of an OXC is to take frames arrive on a port and forward them to the correct destination. The key problem with which the OXC must deal is the finite bandwidth of its outputs [4]. If frames arrive at an OXC destined for a certain output and their arrival rate is higher than the capacity of that output, then the OXC queues the frames until the contention is reduced. If it lasts for a long time, then the OXC discards frames due to its limited buffer space. If it discards frames too frequently, we say that the OXC is congested. Segments of a LAN are commonly connected by coupler. When a coupler receives a frame, it floods that on all of its ports except at which it is arrived.
Minh Huynh et al. [8] presented that ethernet has been the indisputable technology of choice for the local area networks (LANs) for more than 30 years. Its popularity is due to its versatility, plug-n-play feature, and low cost. It has transformed from a CSMA/CD technology providing low throughput to a full-duplex link increasing the throughput 1000-folds. Despite these improvements, Ethernet is still restricted to local area networks, and is not ready to become a carrier-grade technology for wider areas. However, there are efforts to assist the transformation of Ethernet from the mainstream LAN technology to the possible adoption for metropolitan area networks (MANs). This paper introduced the movement from basic Ethernet to the carrier grade Ethernet for MANs. The paper describes the underlying technology, offered services, the state-of-the-art, and the comparison between various technologies.
N. Ghani et al. [9] studied the performance of various topology overlay schemes for multi-point

Ethernet LAN services, including star, bus, and minimum spanning tree. A comprehensive tiered survivability approach for provisioning these overlays is also detailed using both pre-fault protection and post-fault restoration algorithms. The overall findings show the lowest blocking and/or highest carried load with more advanced minimum spanning tree overlays, particularly when combined with load-balancing routing of sub-connections (i.e., active resource usage state). Finally, the use of post-fault restoration is particularly beneficial and is shown to yield very high recovery rates even with generally lower levels of pre-fault protection reservation. Building upon this work, future efforts will focus on more elaborate shared protection strategies as well as optimization formulations.

The purpose of this paper is to measure the performance of delay and throughput in optical environment. The simulations have been done in OPNET. It provides a comprehensive development environment for the specification, simulation and performance analysis of communication networks [5], [6]. Many factors such as a heavy load in the network that generates higher traffic, may contribute to the congestion of network interface [7]. Therefore, this paper is significant to be managed in order to predict and measure of data transfers in optical environment.

The remaining paper is structured as: In section 2, the simulation scenarios of the two networks have been described. Section 3 shows the OPNET simulation and the performance of both networks in case of sending and receiving packets. In section 5, conclusion is given.

2. Simulation Setup

In figure 1, a network with 24 nodes and a coupler that supports 24 optical connections is established. In figure 2, the network is modified with two 16 port coupler and an optical cross connect (OXC).

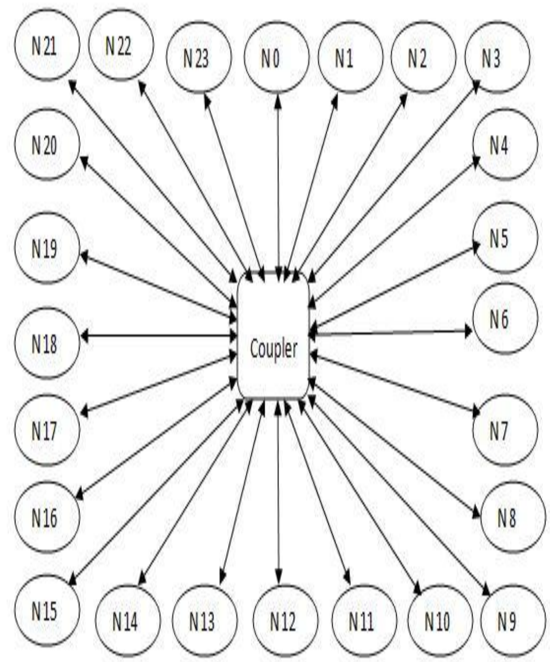

Fig 1: Coupler's network with 24 nodes

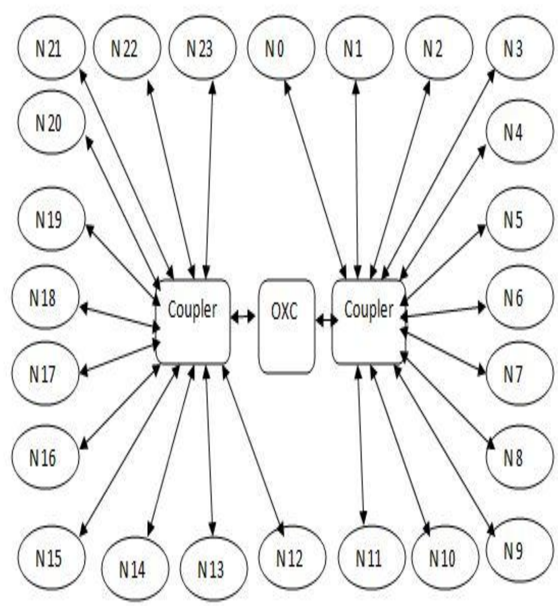

Fig 2: OXC's network with 24 nodes

4. OPNET Simulation of Different LANs

As it is mentioned above that the main focus of this paper is to examine different LANs' performance in optical network. Using OPNET simulator, the two optical LANs were simulated.

4.1 Applications Parameters

OPNET allows choosing different parameters for optical networks [10], e.g. Delay (sec), Traffic Sink, Traffic Source, Collision Count and Packet Size etc. The Delay (sec) shows the end to end delay of all frames received by all nodes. Traffic Sink illustrates the traffic received across all stations. Traffic Source examines the traffic sent across the connected nodes. Collision Count is the total number of encountered collisions during frame transmission.

4.2. Simulation Results

In this section, two scenarios were tested. In the first scenario the frame size was kept 1500 bytes and tested the delay and collision. In the second scenario, the frame size was tested that was reduced from 1500 to 256 bytes. Figure 3 and 5 show the received and sent traffic of the stations with a constant frame size of 1500 bytes respectively. The received and sent traffic with 256 byte frame sizes are shown in figure 4 and 6 respectively. The delay in case of 1500 byte frame size is shown in figure 7. Figure 8 describes the delay when frame size is 256 bytes. The average collision is given in figures 9 and 10.

4.3. Performance Evaluation

We compare our result in which the packet size was kept 1500 bytes. Figure 3 shows the traffic received with a constant frame size of 1500 bytes, but as it is decreased from 1500 to 256 bytes in figure 4, it is clear that the throughput (received traffic) is far better. While the traffic sent in both cases is almost identical (figure 5 and 6). In our result (figure 8); the delay, compared to figure 7 has also decreased considerably.

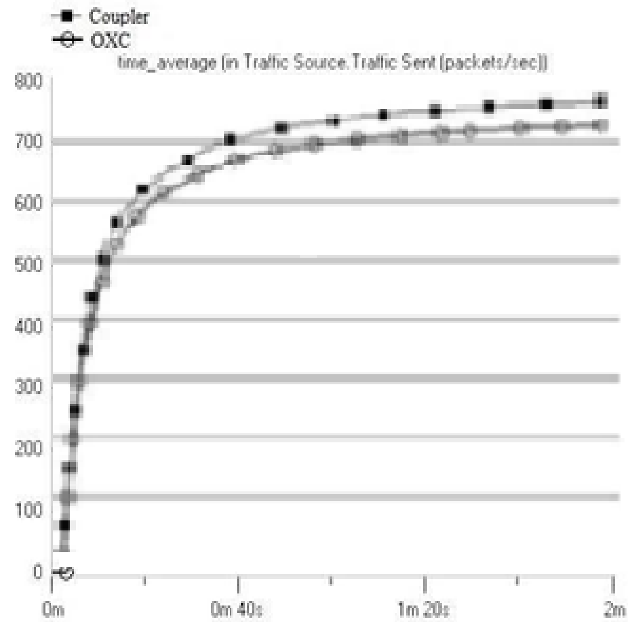

Fig 3**:** Received traffic when frame size is 1500 bytes

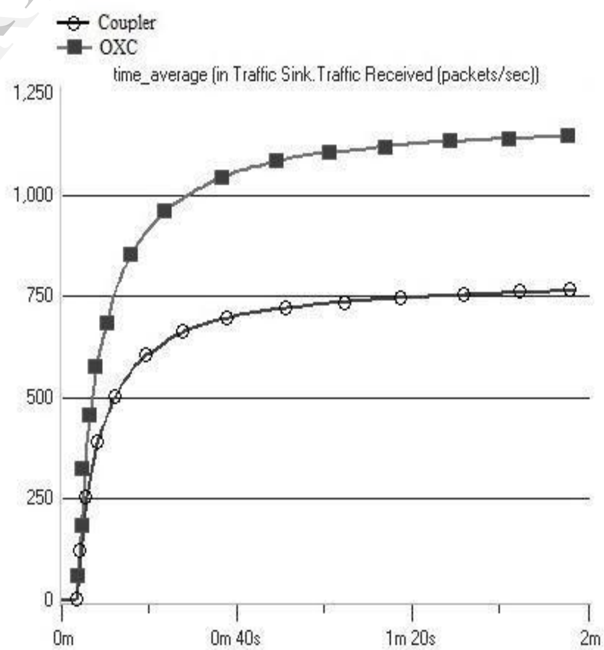

Fig 4**:** Received Traffic when Frame size is 256 bytes

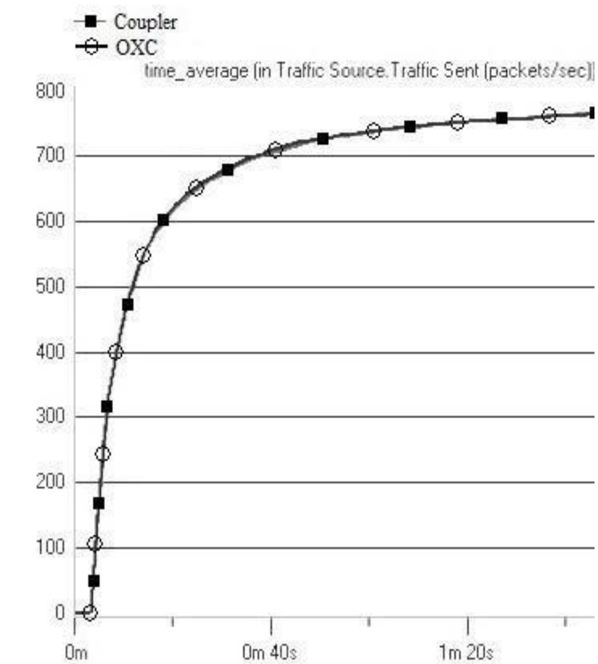

Fig 5**:** Sent traffic While Frame size is 1500 bytes

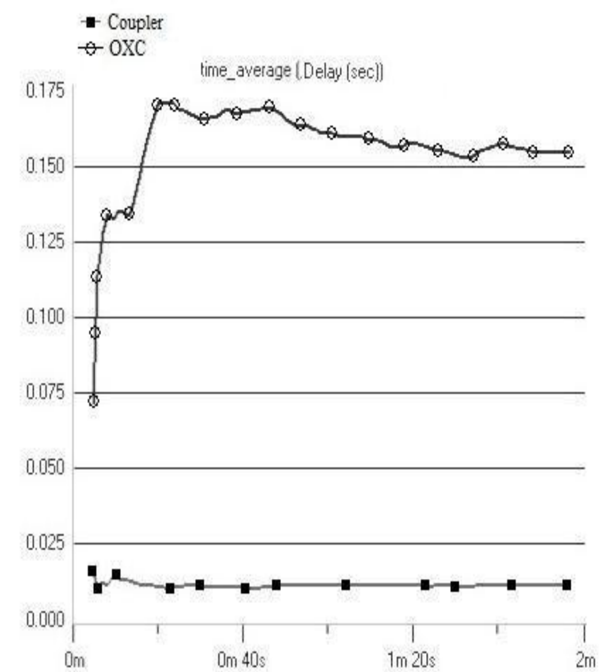

Fig 7**:** Average Delay in case of 1500 byte frame size

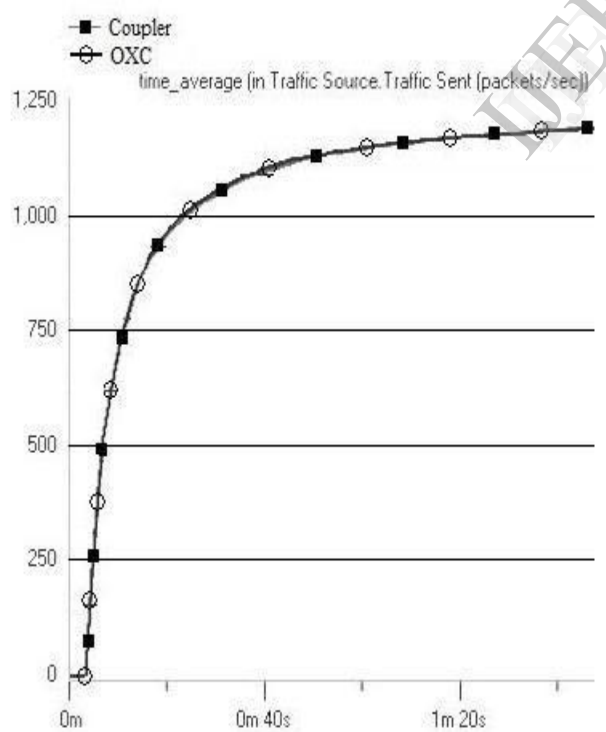

Fig 6**:** Sent Traffic While Frame size is 256 bytes

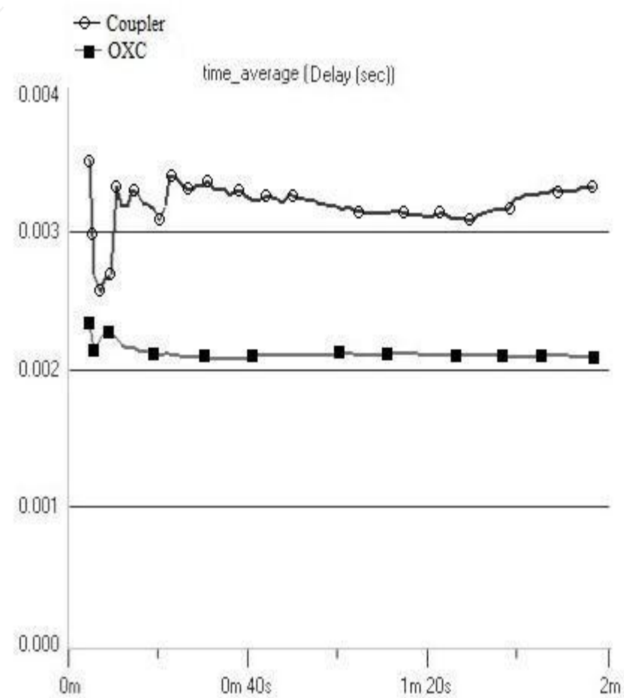

Fig 8**:** Average Delay in case of 256 byte frame size

4.4. Collision's Analysis

The use of an OXC makes it possible to reduce the collisions on the network. In optical network, the collision is increased as the network is loaded, and this causes retransmissions and increases in load that produce even more collisions. The resulting network overload slows traffic considerably. But decreasing the size of the frame can differently reduce the collision. The result is shown in figure 10 in which the value in case of OXC network is almost 30. While the collision's value in figure 9, in which the frame size was kept 1500 bytes is near to 1000.

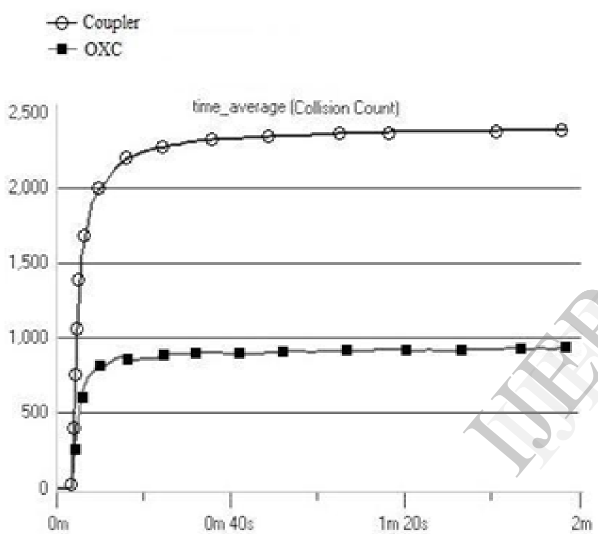

Fig 9**:** Average Collision when Frame size is 1500 bytes

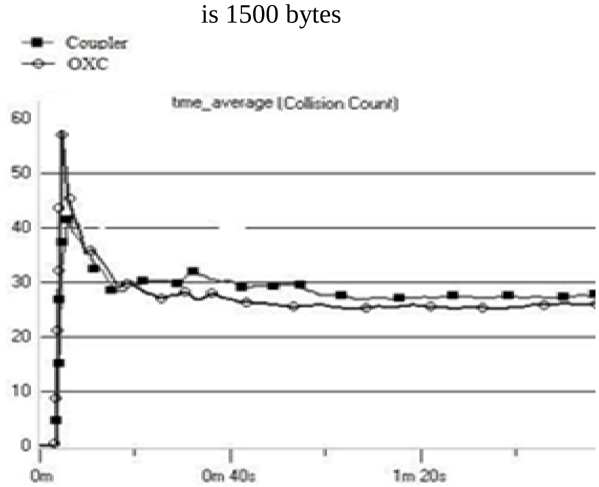

Fig 10**:** Average Collision when frame size is 256 bytes

5. Conclusion

In this paper two optical networks have been observed using OPNET: one with a coupler and the other with two couplers and an optical cross connect in optical networks. In both networks the delay and collisions have been inspected. We have compared the performance and effect of both networks in case of sending and receiving frames delay, traffic sink, traffic source; collision and frame size are the performance parameters. The throughput is improved and collision is decreased as the constant 1500 byte frame size is reduced to 256 bytes. The compared simulation results show a good approximation of data traffic analyzed in the optical networks.

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