Multicasting over OBS WDM Networks

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***Abstract*—In this study, we present a new protocol structure for multicasting on OBS networks. We investigate the performance on Just Enough Time (JET) and Just In Time (JIT) between multicast and unicast traffic. We examine behaviors of data and control planes of the network. We also study how to add and remove a client or a node from a constructed multicast tree. The results show that our proposed multicast protocol structure produces low multicast traffic join request drop rates.**

Keywords-OBS; multicast; JIT; JET; WDM network.

I. INTRODUCTION

The number of Internet users continuously increases. Internet traffic growth rates exponentially ascend; therefore, there is a great bandwidth demand emerges in backbone networks. The main reason of the growing number of Internet users is the recent advances in networking. These advances are for instance, video conferencing, distributed games, HDTV, interactive distance learning and many more multimedia real time applications. These are multi destination communication-based, most popular network applications. The bandwidth need of these multicast applications may be met by optical networks and dividing fiber into numerous channels with WDM technology. In multicasting, the messages and data are transmitted from one or more sources to a set of destinations in a multicast group of a WDM network over a multicast tree. To construct a tree, a route should be decided from source to all of the related destinations, a wavelength should be assigned to the links and also QoS should be provided. In WDM networks, for multicast trees, delay and cost are the most important QoS factors for network efficiency. In optical networks, Optical Burst Switching (OBS) is a good solution for data transmission since OBS combines the advantages of Optical Packet Switching (OPS) and Optical Circuit Switching (OCS). The first generation of optical networks was based on OCS. The most important detail of the switching in OCS is the construction of a lightpath between the source and destination before data transmission. By the way, OPS is presented as a good alternative for OCS since OPS is more efficient for dynamic and bursty traffic transmissions. However, today OBS seems as the best solution for data transmission since OBS evolves the performance of WDM on optical networks with bursty traffic [1], [2].

In this paper, we study a multicasting protocol for OBS networks. In the network, communication of clients and the source is performed by join-request messages. We concentrate on how to avoid gathering of traffic crowd in definite parts of the network by using thresholds at intermediate switches with minimum join-request message loss rates. Most of the multicasting protocols depend on a source initiated structure. This type of structures produces excessive message round trip times because of using acknowledgement messages. In our study, a leaf initiated structure is considered. In the protocol, a join-request message notifies the source about the request, composes the path and informs the switches without producing extreme message round-trip times. In this protocol, the main aim is to achieve the routing and bandwidth allocation of the network by using less number of messages and message round-trip times.

The rest of the paper is organized as follows. In Section II, a brief overview of all optical networks, OBS and multicasting is presented. In Section III, the proposed protocol structure is introduced and the numerical results are given. Finally, the paper is concluded in Section IV.

II. MULTICASTING AND OBS

All optical networks with WDM transmissions include many optical cross connects (OXCs). These OXCs connect client networks over lightpaths or light trees. An optical signal arrives at an OXC over an input fiber wavelength. Then it is switched to the same wavelength over an output fiber. However, the arriving signal can be switched to a different wavelength over the output fiber by the help of the converters. Optical switching has many advantages like protocol transparency and less power consumption rates [4].

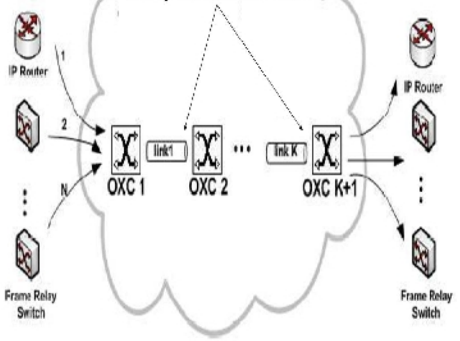

Figure 1.   OBS network structure [7].

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OBS is presented as a solution for great bandwidth demand on Internet traffic. The network structure with OXCs is presented in Fig. 1. The data packets are assembled into bursts at the ingress node and transmitted by fiber optics on the network in optical form. In the network, to arrange the reservations for the coming burst, a control packet is sent before the burst. Furthermore, in OBS networks there is a definite time period between the control packet and the burst which is called as offset. Separated data and control channels are the most remarkable specialty of OBS networks. Data is transmitted in optical form with optical switching but control packets are transmitted in electronic form with electronic switching in OBS networks [3], [6].

Other than OBS, another solution for increasing bandwidth demand is multicasting. There are many multicast applications in the literature according to the multipoint destinations. Document distribution and on demand video distributions are one to many type applications, which are sent from only one source to many destinations. Many to one applications are sent from more than one sources to a destination like group polling and resource discovery. In many to many, there are more than one sources and many destinations as in multimedia conferencing and distributed simulations [5].

III. THE MULTICAST OPTICAL NETWORK DESIGN

We consider an optical WDM network with 14 node NSFNET topology. The constructed network model is composed of a source, an ingress switch, intermediate switches, edge switches and clients. The nodes of the networks are connected to each other by fiber links that carry two wavelengths with 10 Gb/s capacity. In the network, all of the nodes are multicast capable. In our study there is a source and multiple destinations as clients. These clients access the backbone network by edge switches. The multicast sessions have different amount of multicast traffic and different number of destinations. As distinct from the source initiated multicast tree structures, we consider to construct leaf initiated multicast trees for each of the multicast sessions.

The multicast session begins with the video context announcement with broadcasting to the clients then the join requests are considered. If a client is interested in one of the video contexts' video then it sends a join request to the connected edge switch. The edge switch sends this request to the closest intermediate switch. The intermediate switch controls both its timetable and threshold. If the threshold value of the intermediate switch is not exceeding the predetermined value, then the timetable is checked if the intermediate switch will be available during the video transmission time. If both of the conditions are ensured, join request is accepted and transmitted to the next node but if one of the conditions are not ensured, the join request is rejected. Then the edge node sends a re_join_request message to another closest intermediate switch. If none of the intermediate switches accepts the join request, in that case the join request is dropped. The threshold control takes place at the intermediate switches, which are directly connected with edge switches for preventing potential traffic collisions. Besides, the clients whose join requests are accepted have to send their keep alive messages on specific time intervals to the source to notify that they are still alive and when the video transmission starts, the bursts are sent from source to the related clients.

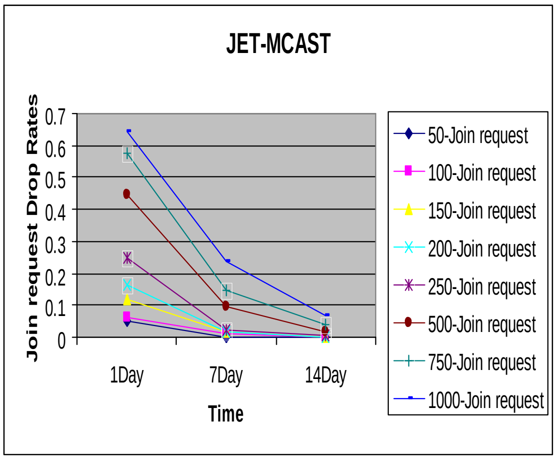

Figure 2. The multicasting on JET reservation protocol.

The main function of our protocol is multicasting the bursts; for comparison, we also designed a unicast data traffic. Fig. 2 and Fig. 3 present the results of our simulation.

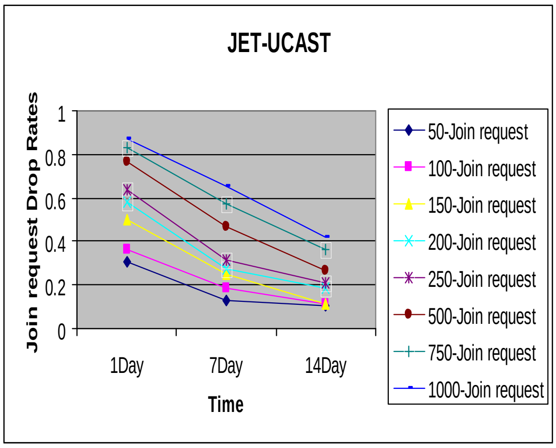

Figure 3. The unicasting on JET reservation protocol.

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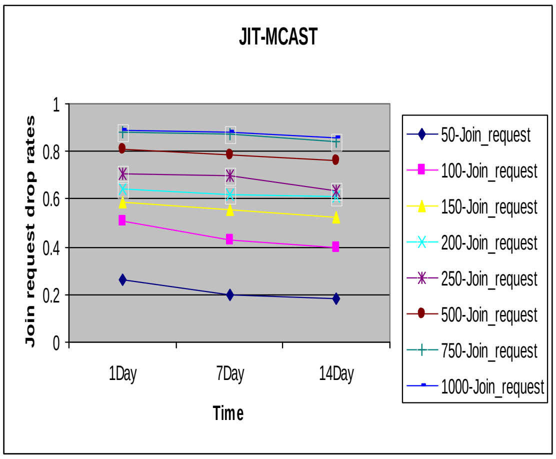

Figure 4. The multicasting on JIT reservation protocol

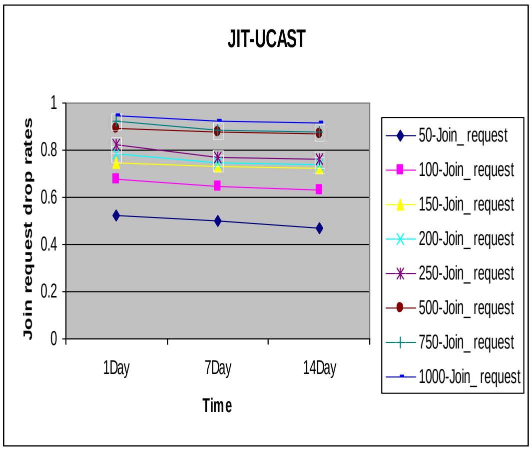

Figure 5. The unicasting on JIT reservation protocol.

The join request drop rates in JET with multicast gives better results. The drop rates change according to the time periods and they decrease as the time periods increase.

Fig. 4 and Fig. 5 show the join request drop rates in JIT reservation protocol. As the time period increases from one day to fourteen days according to the increasing number of join requests, the join request drop rates change with respect to the variable traffic.

IV. Conclusion

In this paper, a promising protocol structure for multicasting is presented. We considered the drop rates of join requests according to definite time periods. We investigated the protocol performance on JET and JIT with multicasting and unicasting. Our performance results show that multicasting provides better drop rates than unicasting in both of the reservation protocols. Furthermore, when we compare the simulation results, the protocol structure gives best values on JET with the least drop rates.

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