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SubFrame-Based Slot Reservation Scheme for Minimizing Transmission Delay in Optical Slot Switching Network

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***Abstract*— We propose SubFrame-based slot reservation scheme for minimizing the transmission delay in optical slot switching (OSS) network. The computer simulation shows that our proposed scheme can reduce the transmission delay about 25% by using SubFrames.**

I. Introduction

Optical Slot Switching (OSS) [1] architecture is a new scheme for the efficient data transfer in optical network. In OSS network, all nodes are synchronized and share the fixed-length time-period named slot. Each slot carries multiple packets as shown in Figure 1 (c). To realize efficient data transfer, a source node reserves the next slot before data transfer. By reserving the next slot, a source node can transmit data without the effect of the present slot reservation. Now, although the problem of guard time between slots has been discussed ever before [2], the slot reservation in OSS network has not been discussed yet. In OSS network, a source node uses one fixed-length slot for transmitting any size of data. It causes no data transfer time within a slot. In this paper, we focus on this problem and study the reservation scheme which uses one or more slots variably to achive short transmission delay.

II. Slot reservation schemes

We assume that a node in OSS network uses two or more slots for transmitting large-size data which is beyond the slot-length. Fig. 1 shows three slot reservation schemes. Fig. 1 (a) shows MultiSlot Reservation (MSR). MSR uses one frame for data transfer and reserves slots continuously. In Fig. 1, a frame consists of 6 slots. Data transfer time of MSR is within a little time. Fig. 1 (b) shows MultiFrame Reservation (MFR). MFR uses one slot-number and reserves slots one by one per one frame periodically. Transmission delay of MFR is longer than that of MSR. However, the number of clients in one frame is larger than that of MSR. We consider the performances of MSR and MFR, and propose SubFrame-based slot Reservation (SFR). Fig. 1 (c) shows proposed SFR. SFR uses MSR and MFR variably according to the data size and the request occurrece time. SFR uses 2 SubFrames named SubFrame 1 and SubFrame 2. In Fig. 1 (c), a SubFrame consists of 3 slots. In SubFrame 1, SFR reserves slots by MSR. In SubFrame 2, SFR reserves slots by MFR.

III. Proposed Scheme

Fig. 1 shows an example of the three schemes. Fig. 1 (a) shows a MSR example. Client ① requests 4 slots at slot 5 of Frame 1. Client ① checks Frame 1. At slot 5, there remains only 2 vacant slots in Frame 1. So, Client ① checks Frame 2. In Frame 2, there remains 6 vacant slots. So, Client ① reserves slot 1 ∼ slot 4 of Frame 2. Client ② requests 4 slots at slot 1 of Frame 2. At slot 1, there remains only 2 slots in Frame 2. So, Client ② checks Frame 3. In Frame 3, there remains 6 vacant slots. So, Client ② reserves slot 1 ∼ slot 4 of Frame 3. Fig. 1 (b) shows a MFR example. Client ① requests 4 slots at slot 5 of Frame 1. Client ① checks slot 5 ∼ slot 6 in Frame 1 ∼ Frame 6 and slot 1 ∼ slot 4 in Frmae 2 ∼ Frame 7. Slot 5 of Frame 1 is the earliest availabe slot. So, Client ① reserves slot 5 of Frame 1 ∼ Frame 4. Client ⑤ requests 3 slots at slot 1 of Frame 3. Client ⑤ checks slot slot 1 ∼ slot 6 in Frame 3 ∼ Frame 8. Slot 2 of Fmrae 3 is the earliest available slot. So, Client ⑤ reserves slot 2 in Frame 3 ∼ Frame 5. Fig. 1 (c) shows a SFR example. Clinet ① requests 4 slots at slot 5 of Frame 1. Clinet ① checks SubFrame 2 of Frame 1. Slot 5 of Frame 1 is the earliest available slot. The data size is beyond the SubFrame-length. So, Clinet ① chooses MFR. So, Client ① reserves slot 5 in Frame 1 ∼ Frame 4. Client ② requests 4 slots at slot 1 of Frame 2. Client ② checks SubFrame 1 of Frame 2. There remains 3 vacant slots. The data size is beyond the number of vacant slots. So, Client ② reserves 3 slots in SubFrame 1 of Frame 2 and 1 slot in SubFrame 2 of Frame 2. Client ② checks SubFrame 2 of Frame 2. Slot 4 of Frame 2 is the earliest available slot. So, Client ② reserves slot 1 ∼ slot 4 of Frame 2. Client ③ requests 3 slots at slot 4 of Frame 2. Client ③ checks SubFrame 2 of Frmae 2. Slot 6 is the earliest available slot. The data size is not beyond the SubFrame-length. So, Client ③ checks SubFrame 1 of Frame 3. There remains 3

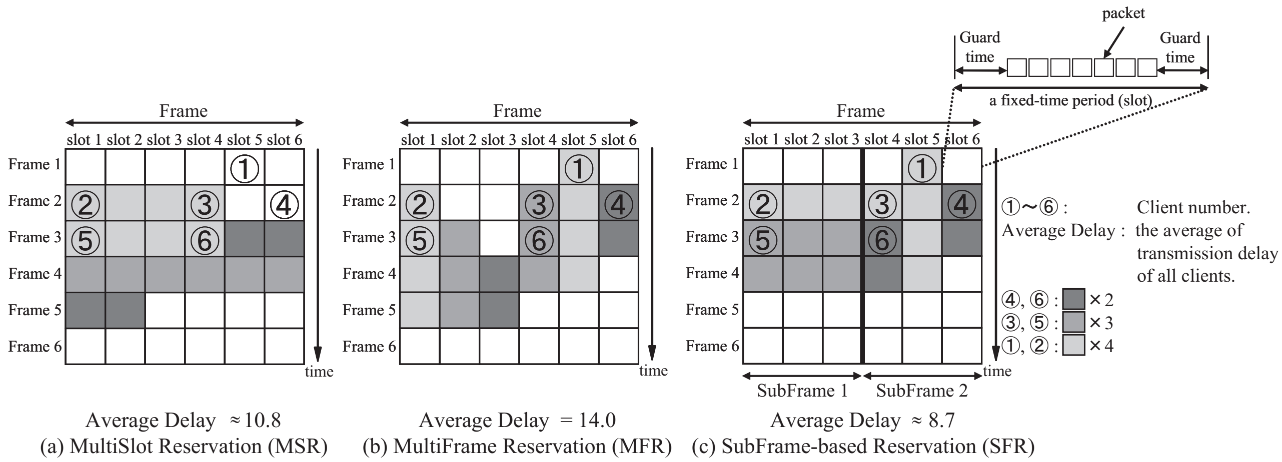

Fig. 1. An example of the three slot reservation schemes.

vacant slots in SubFrame 1 of Frame 3. The transmission delay of MSR is shorter than MFR. So, Client ③ reserves slot 1 ∼ slot 3 of Frame 3. Client ④ requests 2 slots at slot 6 of Frame 2. Client ④ checks SubFrame 2 of Frame 2. Slot 6 of Frame 2 is the earliest available slot. The data size is not beyond the SubFrame-length. So, Client ④ checks SubFrame 1 of Frame 3. There is no vacant slots in SubFrame 1 of Frame 3. So, Client ④ reserves slot 6 in Frame 2 ∼ Frame 3. Client ⑤ requests 3 slots at slot 1 of Frame 3. Client ⑤ checks SubFrame 1 of Frame 3. There is no vacant slots in SubFrame 1 of Frame 3. So, Client ⑤ checks SubFrame 2 of Frame 3. Slot 4 of Frame 3 is the earliest available slot. The data size is not beyond the SubFrame-length. So, Client ⑤ checks SubFrame 1 of Frame 4. There remains 3 vacant slots in SubFrame 1 of Frame 4. The transmission delay of MSR is shorter than MFR. So, Client ⑤ reserves slot 1 ∼ slot 3 of Frame 4. Client ⑥ requests 2 slots at slot 4 of Frame 3. Client ⑥ checks SubFrame 2 of Frame 3. Slot 4 of Frame 3 is the earliest available slot. The data size is not beyond the SubFrame-length. So, Client ⑥ checks SubFrame 1 of Frame 4. There is no vacant slots in SubFrame 1 of Frame 4. So, Client ⑥ reserves slot 4 in Frame 3 ∼ Frame 4. We can say that SFR can reduce the transmission delay.

IV. Performance Evaluation

We compare the transmission delay of MSR, MFR, and proposed SFR by the computer simulation. Frame-length is 20 slots. SubFrame-length is 10 slots. Access speed is 10 Gbps. The slot period is set to 10msec. The input traffic follows rectangular distribution (1 slot ∼ 16 slots). Figure. 2 shows the transmission delay of MSR, MFR, and SFR. We assume that the load is the request occurrence rate per slot and that the transmission delay is the time from request occurrence to the end of data transfer (When the load is 0.1, the average slot utilization is 0.8). When the load is low, MSR achieves the shortest transmission delay. It is because MSR reserves all slots continuously. When the load is over 0.12, SFR reduces the transmission delay

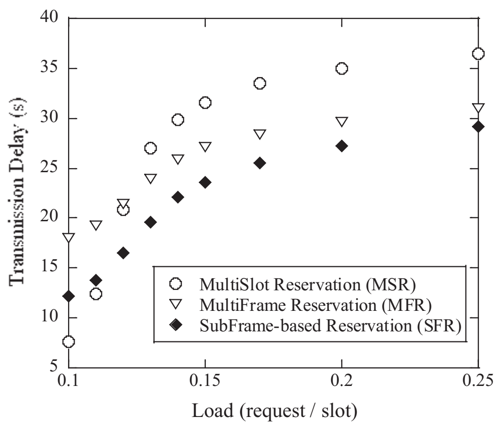

Fig. 2. The transmission delay versus the traffic load (request / slot) of MSR, MFR, and proposed SFR.

about 25% than MSR. It is because that SFR compare $Time_{MS}$ and $Time_{MF}$ and choose the earlier one, while MSR can't find continuously vacant slot. MFR reserves any size of data periodically and makes the transmission delay longer.

V. Conclusion

In this paper, we have proposed SubFrame-based slot reservation which minimizes the transmission delay by using MSR and MFR efficiently. The computer simulation showed that our proposed slot can reservation reduce the transmission delay about 25% by using SubFrames.

References

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[2] M. Hayashitani, T. Kasahara, D. Ishii, Y. Arakawa, S. Okamoto, N. Yamanaka, N. Takezawa, K. Nashimoto, "Design and Implementation of GMPLS-Based Optical Slot Switching Access-Distribution Network Using PLZT Ultra-High Speed Optical Switch," *Proc. OFC/NFOEC 2007*, Mar. 2007.