Design of Reservation Mechanism Based on the Slotted Ring Network

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Abstract

The traditional slotted ring network is one of the high speed networks, however its transmission delay in heavy network load is too long. In this paper we propose a reservation mechanism to improve this drawback for network. The mechanism is particularly useful in the heavy network load to get the lower delay for high priority packet transmission. Here we compare it with traditional slotted ring network by using simulations, and their results show that this mechanism provides the lower delay when the traffic load of network is heavy.

Keyword : Slotted ring, source removal policy, destination removal policy, reservation, real-time

1. Introduction

With the development of multimedia technique, there are more and more applications strongly ask their requirements of bandwidth-intensive and delay-sensitive[5]. The most of existing networks cannot provide these requirements. To achieve this objective, many papers in the high speed network are recently proposed The slotted ring network is one of high speed networks, however its transmission delay in heavy network load is too long. In this paper we propose a mechanism to improve this drawback.

The slotted ring network separates the network bit-length into a constant number of fixed-length continuous slots, and these slots will repetitively circulate around the ring in one direction [2]. If any station on the ring has data to transmit, it must occupy an empty slot first; then set the flag to FULL and place the packet into the slot[3]. While this transmission is finished, the flag must be set back to EMPTY to release the slot. In generally, there are two kinds of slot removal policy. The first is *source removal policy*, and the other is *destination removal policy*. We will describe them in detail in the behind section. In this paper, we adopt the destination removal policy.

It is difficult to observe an empty slot in the slotted ring network as the network load is heavy. In this paper, we will propose a reservation mechanism based on this network. This mechanism can make stations more easy to reserve slots, so stations can get the available slot in the next cycle and the lower delay for the high priority data transmission. Therefore, the slotted ring network with reservation mechanism is useful to satisfy the requirement of real-time system.

The rest of this paper is organized as follows: Section 2 reviews the architecture and the protocol of the traditional slotted ring network. Section 3 describes the operations of reservation mechanism. Section 4 gives the simulated results, and compares these to understand the improvement of reservation mechanism. Section 5 concludes with a discussion of related work.

2.The Tradition Slotted Ring Network

Fig. 1 shows the architecture of the slotted ring network. The bit-length of slotted ring network will be separated into a constant number of fixed-length continuous slots, and these slots circulate around the ring in the one direction[2]. The long data have to be broken into small packets in order that they can fit into the slots. A flag in the slot header is used to signal the status of slots. If any station on the ring have packet to transmit, it has to wait until it observes an empty slot, set the flag to FULL, then place the packet into the slot[3]. There are two kinds of slot removal policy: The first is source removal policy. When the slot returns back the source station , the station will set the flag to EMPTY, then passed it to the next station. This policy has the automatic acknowledgment function. Besides, the slots have already circled the ring once, so it is easy to carry out the broadcast mechanism too. The another is the destination removal policy. While the slot arrives the destination station, the station will set the flag to EMPTY, and pass it to the next station. This slot can be used after the receiver removes the packet on it. Therefore, the slotted ring with the destination removal policy can increase the utilization of network bandwidth.

There are some characteristics of the slotted ring network with destination removal policy: (1) Fairness; The network bandwidth could be equally shared by all stations. Any station on the ring can transmit its packet only by observing the empty slot, and the non-empty slot will be released after arriving the destination. So all stations on the ring can share the bandwidth equally. (2) High utilization of bandwidth; Stations can transmit their packet only when they observe an empty slot, hence the data collision is free on this network protocol.

When the network load is more and more heavy, the empty slot will be more and more few. This will increase the packet delay. Fig. 2 presents the relation between the packet arrival rate and the packet delay. When the network load is light, it yet satisfies the requirement of real-time system. However, the packet delay in heavy network load will become too large and difficult to fit for real-time system. So we propose a reservation mechanism for the slotted ring network to solve this problem. This mechanism will reserve slots for the high priority data.

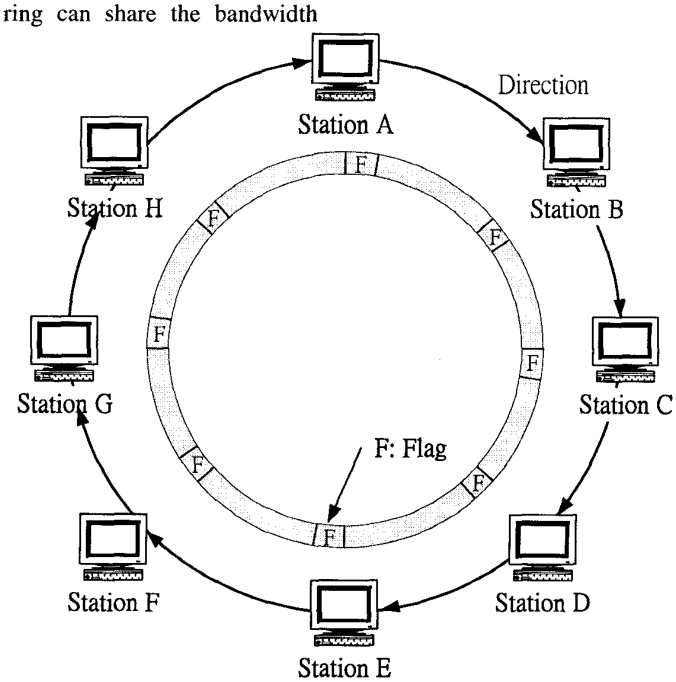

Fig. 1 Slotted Ring Network Architecture

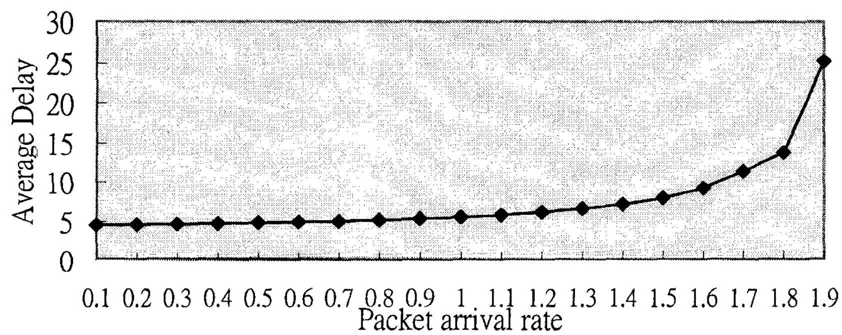

Fig. 2 Average Packet Delay for Slotted Ring Network

3. The Reservation Mechanism

In this paper we propose a reservation mechanism for the slotted ring network. This mechanism is used to reserve slots for stations to transmit the real time data. In the slotted ring network with the mechanism, every station has two data queues. One is called *common queue* and the another is called *reservation queue*. The common queue is used to store the general data, and the reservation queue is used to store the high priority data. In order to satisfy the reservation mechanism, it is necessary for slots to record the reserved status of slot and who reserves the slot by stations. A new packet format is defined and is shown as Fig. 3.

The station operations are described as follows. When any station on the ring has packets to transmit, it must get a slot on the ring first. If this slot's A/U bit is 0 and reservation bit is 0, the station can place its any type packet and set the A/U bit to 1 simultaneously. If the slot's A/U bit is 0 and the reservation bit is 1, it can only be used when its destination address is before the address of reservation node. Because this kind of slot has already been reserved by other station which address is recorded in the RA field.

If the slot's A/U bit is 1 and reservation bit is 1, the station can use the reservation mechanism to reserve this slot for its high priority packet. The operation of reservation is described as following. While the station detects a slot whose reservation bit is 0, it can set that reservation bit to 1 and place its address into the RA field of the slot. When the reserved slot arrives its destination, its data will be removed by the destination station and passed to the next station. This slot can be reused by other stations before it return to the reservation station. While the slot arrives at the reservation station again, the station can use it to transmit its high priority packet. The reservation bit will be set to 0 by the station simultaneously.

For the reservation station, the reservation station maybe observes another available slot before its reserved slot arrives. At this time, if the station has more packets to transmit, it can use the slot to place its high priority packets on it. Afterward it places its next high priority packet into the reserved slot as the reserved slot comes back. No high priority packet for the reserved slot is not permitted because it will cause the waste of the network bandwidth. In order to avoid this problem, the station must hold the number of high priority packets greater equal than the number of its reserved slot.

How to make sure that the packet was received correctly? Since the destination removal policy is adopted in this paper, the automatic acknowledgment mechanism should be supplied by the higher level software. It is not necessary to discuss the mechanism here.

S	A/U	R	RA	DA	SA	D	C	E
1	1	1	8	8	8	92	8	1

Key:
S = Start bit
A/U = Available/unavailable bit : A = 1
U = 0
R = Reservation bit : Reserved = 1
Not reserved = 0
RA = Reservation address
DA = Destination address
SA = Source address
D = Data Field
C = Control field
E = End bit

Fig. 3 Packet format for the slotted ring network with reservation mechanism

4. Simulation Result

The packet delay is the spent time for transmitting a packet in the system, i.e., it is the time between the packet was sent by the source station and the packet is received at the destination station [4]. A simulation model was made according to the descriptions in the previous section. There are 8 nodes in the simulation system, and their packet arrival distribution is Poisson distribution. The average transmission distance of a packet equal to one half of ring cycle, so the maximum throughput is 2. Nodes are equally separated with a propagation delay of 1 slot between neighboring nodes. The simulation results are shown as Figure 4 -7.

Figure 4, 5, 6, 7 show the average packet delay for the proportion of priority packet in total packets is 20%, 40%, 60%, and 80%. These figures show that the average packet delay for common packet is grown as the proportion of priority packet increases. The average packet delay for priority packets is grown very slowly and has lower value in heavy network load.

5. Conclusion

In the traditional slotted ring network, the packet delay will grow quickly in heavy network load. In order to improve this problem we propose a reservation mechanism on it in this paper. This mechanism permits station to reserve slots, and reduce the packet delay of the high priority packets. The simulation results show the delay of priority packets is little higher than that of common packets in the light network load. However, the delay of priority packet is much lower than that of common packets in the heavy network load.

Reference

[1] Barghi, Hamid; Cronenwet, William T.; Bredeson, Jon G. "Real-Time Study of a High-Performance Protocol for Local / Metropolitan ring networks," Conference on Local Computer Networks Proceedings of the 19th Conference on Local Computer Networks Oct 2-5 1994.

[2] Werner Bux, "Local-Area Subnetworks: A Performance Comparison," IEEE Transactions on Communications, Vol. COM-29, No. 10, October 1981, PP. 1465-1473.

[3] LAXMI N. BHUYAN, DIPAK GHOSAL, QING YANG, "Approximate Analysis of Single and Multiple Ring Networks", IEEE Transactions on Computers, Vol. 38, No. 7, July 1989, PP. 1027-1040.

[4] Eric W. M. W., Andrea F. and Imrich C., "Performance Evaluation of CROWNs: WDM Multi-Ring Topologies", ICC'95, pp. 1296-1301.

[5] Hasan, Cam, "LAN-ATM Internetworking over a Priority-Based Slotted Ring Network", CLCPDN'97, PP. 54-63.

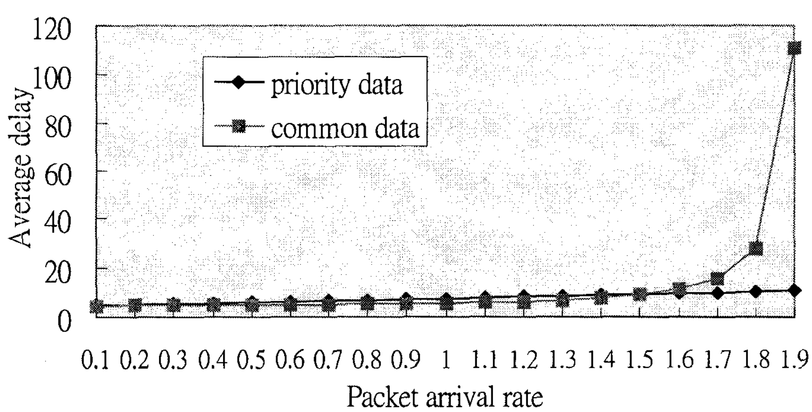

Fig. 4 Priority is 20%, Common data is 80%

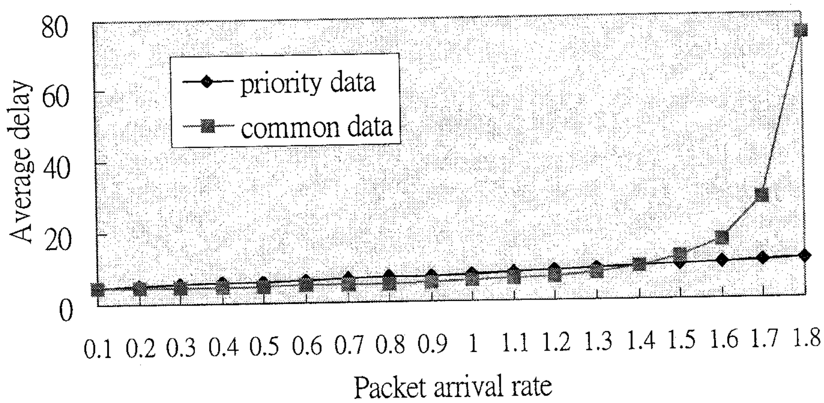

Fig. 5 Priority is 40%, Common data is 60%

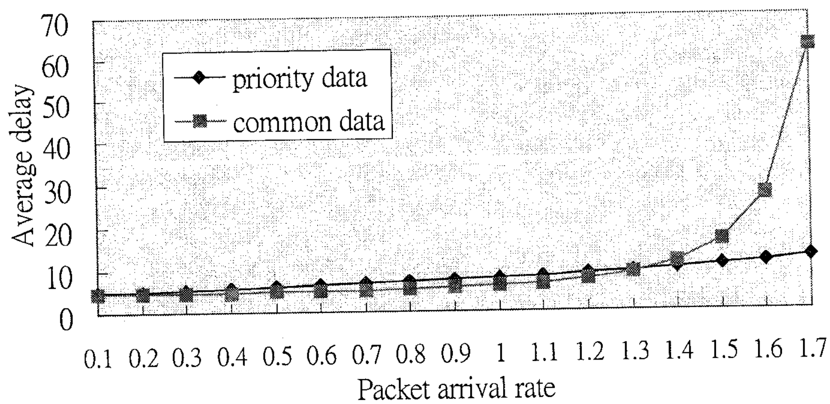

Fig. 6 Priority is 60%, Common data is 40%

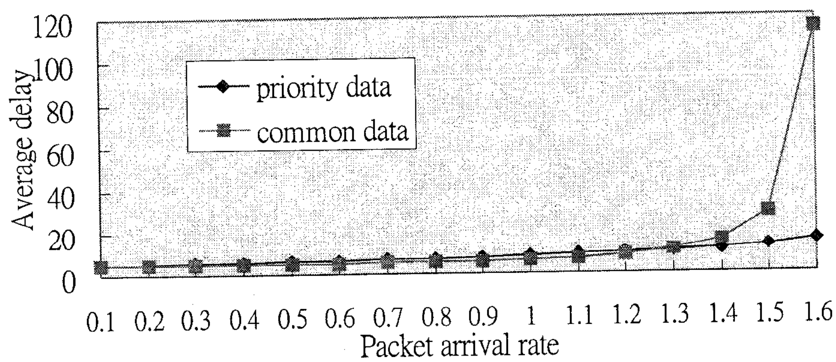

Fig. 7 Priority is 80%, Common data is 20%