A mixed-length and time threshold burst assembly algorithm based on traffic	Thuật toán lập burst ngưỡng thời gian và chiều dài hỗn hợp dựa trên dự đoán

prediction in OBS network

Abstract: In Optical burst switching (OBS) network, some traffic adds extra offset time (thời gian dịch trễ, thời gian trễ, thời gian bù) to ensure transmission quality, which leads to a high delay. In order to solve this problem, a mixed-threshold burst assembly algorithm based on traffic prediction is proposed. This algorithm assembles and sends BDP in advance by predicting the burst length, which reduces BDP end-to-end delay. The simulation results show that, in terms of delay, the number of packet transmission and link utilization, the performance of the proposed algorithm has been improved significantly with respect to that of the traditional mixed-threshold burst assembly algorithm.

1. Introduction

Optical burst switching [1-2] (OBS) is a simple and flexible switching method for the future network. Due to the combination of electricity processing virtue and light transmission advantage, OBS is regarded as a promising switching scheme to optical network. Compared with the circuit switching (OCS), a data burst in OBS has a smaller switching granularity, which leads to a higher bandwidth utilization rate and more flexibility. Compared with optical packet switching (OPS), OBS is easier to be carried out.

In the existing QoS supported OBS schemes [3-4], there is an extra offset

lưu lượng trong mạng OBS

Tóm tắt: Trong mạng Chuyển Mạch Chùm Quang (OBS), một số lưu lượng thêm vào thời gian offset phụ để đảm bảo chất lượng truyền tải, dẫn đến độ trễ cao. Để giải quyết vấn đề này, chúng tôi đề xuất giải thuật lập burst ngưỡng hỗn hợp dự trên dự đoán lưu lượng. Thuật toán này lập và gửi BDP trước bằng cách dự đoán độ dài burst, làm giảm độ trễ đầu cuối BDP. Từ kết quả mô phỏng chúng ta thấy, xét theo độ trễ, số lượng gói tin truyền tải và khả năng tận dụng liên kết, hiệu năng của thuật toán mới đề xuất cải thiện đáng kể so với thuật toán lập burst ngưỡng hỗn hợp truyền thống.

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time in some traffic, such as high priority traffic. That increases the high priority traffic's chances of reserve success and reduces its blocking rate. This scheme indeed reduces the high priority traffic blocking rate, but it also increases the high priority traffic end-to-end delay. After the burst has been assembled by the high priority traffic, it must wait not only a basic offset time but an extra offset time as well. However, there is a strict requirement in end-to-end delay for the high priority traffic, thus, there must be a contradiction between the end-to-end delay and the blocking rate for the high priority traffic caused by setting up an extra offset time [5-6].

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In order to solve this problem, this paper proposes an assembly algorithm that guarantees low blocking rate and the end-to-end delay of high priority traffic simultaneously. This assembly algorithm adopts traffic prediction mechanism, the difference with MTBA is that MTBA-TP assembles and sends BDP in advance by predicting the burst length. Therefore, it can reduce the end-to-end delay of high priority traffic.

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The rest of this paper is organized as follows. We first discuss the ingress node model and optical burst assembly mechanism for OBS network. The third section introduces the classical OBS network resources reservation mechanism. The fourth and the fifth sections introduce the proposed assembly algorithm and the simulation

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results analysis. Finally, concluding remarks are made in Section 6.

2. The ingress node model and burst assembly mechanism in OBS network

OBS network mainly includes the ingress nodes and core nodes [7]. In Ingress node, which is an adaptation layer between the electric customer network and the OBS network, a variety of customer traffic (IP packets) assembles into a huge data burst. Then this data burst is sent into the OBS core network and transmitted. In the core node, the data switch and transmit in the form of burst in the optical domain. Burst assembly is completed at the ingress node of the OBS network, as shown in Fig.1 [8], ingress node mainly includes classifiers, multiple assembly queues, a first in first out (FIFO) scheduler and so on. After IP packets arrive at the OBS network ingress node, the classifiers classify the IP packet according to the destination address (corresponding to the outlet ingress node of OBS network) and QoS level, then fed it into the corresponding assembly queue and cache it. We assume there are N egress nodes in OBS network, then, N ingress nodes is needed for assembly queue to cache IP packets. Similarly, if the traffic can be classified as M levels according to QoS, thus each assembly queue divides the traffic into M sub-queue to store different QoS level of traffic respectively. After that, assembly queue assembles BDP by some assembly mechanism. Finally, the burst is scheduled by FIFO scheduler and sent

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into the OBS core network to transmit. After passing through OBS core network, BDP is split into the original IP packet at the egress node.

The traditional burst assembly algorithm mainly includes time threshold, length threshold and mixed-threshold assembly algorithms [9]. However, these algorithms cannot utilize the offset time efficiently because the data burst must wait for an offset time to transmit until it is assembled and formed. In an offset time, the new arriving IP packet can generate the next burst packet but can not assemble in the current burst. This would result in the packet wait in the offset time, especially when extra offset time is set for the high priority traffics. The high priority traffics not only need to wait more than one basic offset time but need another extra offset time which increases the end-to-end delay of the high priority traffics [10-11]. The algorithm proposed in this paper is to solve this problem by sending BCP in advance and adding a mechanism of traffic prediction to reduce the end-to-end delay of high priority traffics.

Figure 1. The general model of OBS with assembly queue

3. Resource Reservation Protocol

Fig.2 is the process of a data burst using the Just-Enough-Time (JET) protocol [12] to reserve the resource. A data burst is assembled in the edge router, the BCP is sent out and the offset time is started up simultaneously. BCP contains some of the information of the

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data burst, and the BCP reserves the resource for the coming burst through the information. The data burst was sent out when the offset time's up, and it can transmit in the core node through the resource which was reserved by the previous BCP.

Figure 2. JET protocol in OBS

4. Mixed-threshold burst assembly algorithm based on traffic prediction

In order to solve the contradiction between the high priority traffic's blocking rate and end-to-end delay, this paper aims to reduce the end-to-end delay as much as possible without reducing the high priority traffic blocking rate. We add the minimum length threshold and minimum time threshold into the proposed algorithm based on mixed-threshold burst assembly algorithm. It generates a BCP when the assembly queue length threshold or time threshold reaches the pre-set minimum threshold, and then initializes the offset time and extra offset time, the new IP packets continue to assemble into the current BDP. Since BCP contains information of BDP length, we adopt a traffic prediction mechanism to predict the number of the IP packets arrive within the combination of the offset time and the extra offset time. The traffic prediction mechanism is as follows:

A1 is assumed to be the average IP packets arrival rate when the current BDP is being generated, A2 represents the average IP packets arrival rate when the previous BDP is being generated,

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parameter A is the observation time, toffset means the offset time, let texoffset represents extra offset time.

In an observation time, average increment for the IP packet arrival rate is:

(1)

According to (1), we can obtain the average IP packets arrival rate A in an offset time and an extra offset time.

(2)

According to (2), it can be concluded that the number of arrival IP packets in the combination of an offset time and an extra offset time:

(3)

According to the above equations, the number of arrival IP packets in a combination of offset time and a extra offset time is completely decided by A1, A2, toffset and texoffset, but it has nothing to do with A. Finally, the information of BDP length recorded by BCP contains the set minimum length threshold (or the length of BDP in a minimum time threshold) and the BDP length predicted by traffic prediction mechanism.

5. Performance Simulation and Analysis

In this section, simulation results are presented to evaluate the performance of MTBA-TP compared with the MTBA [13]. We choose OPNET11.5 [14] as the simulation software. The simulation parameters setting is as follows: time threshold and length threshold are 0.0005s and 250Kbytes in

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MTBA respectively. The minimum time threshold is 0.0003s and the minimum length threshold is 150Kbytes in MTBA-TP, offset time is 0.0002s, the extra offset time is 0.0003s. We consider traffic to be an independent Poisson process.

Fig. 3 shows IP packets transmission number by MTBA-TP and MTBA respectively. Since MTBA- TP assembles burst in the combination of offset time and extra offset time, there is a great improvement in packets transmission number, which is mainly decided by offset time and extra offset time.

Traffic load

Figure 4. Link utilization rate VS. Traffic load

As can be seen from Fig. 4, MTBA-TP gains a better link utilization compared with MTBA. This is because by using the proposed algorithm it can transmit more packets during the same period compared with MTBA.

In order to contrast the end-to-end delay, in this simulation, we set offset time as 0.0002s, and change the extra offset time from 0.0001s to 0.0003s, the traffic load is 0.5s.

Extra offset time

Figure 5. End-to-end Delay VS. Extra offset time

Fig. 5 shows the simulation results of the end-to-end delay versus the extra offset time. MTBA- TP sends BCP at the moment when time or BDP length reaches the minimum threshold value, thus it reduces the burst assembly time,

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accelerates the packets transmission and reduces packet waiting time. As a result, end-to-end delay gains a great improvement. 6. Conclusions In this paper, a mixed-threshold burst assembly algorithm based on traffic prediction is proposed to decrease the end-to-end delay. Simulation results show that, compared with the traditional mixed- threshold burst assembly algorithm, the proposed algorithm not only improves the number of packets transmission and link utilization rate but also greatly decreases the end-to-end delay. • Integrate BASTP into intelligent model. Due to the mechanism of pretransmission BCP based on prediction, there is a long offset time between the time of sending BCP and of sending DB. So we can make use of the long offset time to build intelligent model, like paper [15] propose C3-OBS network. The longer the offset time, the better performance the intelligent model can have. Consequently, using BASTP, the intelligent model schemes will be more attractive.	[redacted] [redacted]