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Pre-Deflection Routing with Control Packet Signal Scheme in Optical Burst Switch Networks

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***Abstract*—**Optical Burst Switching (OBS) is a promising technology for the future generation Internet. Control architecture and Contention resolution are the main issues faced by the Optical Burst Switching networks. In this paper we are only taking care of the Contention problem and to overcome this issue we propose Pre-Deflection Routing with Control Packet Signal Scheme for Contention Resolution in Optical Burst Switch Networks. In this paper Pre-deflection routing approach has been proposed in which routing is carried out in two ways, Shortest Path First (SPF) and Least Hop First (LHF) Routing to forward the clusters and canoes respectively. Hereafter Burst Offset Time Control Algorithm has been proposed where a forward control packet (FCP) collects the congestion price and contention price along its paths. Thereafter a reverse-direction control packet (RCP) sent by destination node which delivers the information of FCP to the source node, and source node uses this information to revise its offset time and burst length.

***Keywords*—**Contention Resolution, FCP, OBS, Offset Time, PST, RCP.

I. Introduction

OPTICAL Burst Switching has been proposed as a future of high speed switching technology to transport dynamic burst traffic. Optical burst switching (OBS) is a viable solution for providing terabit switching in the near future because of its easy implementation high bandwidth utilization, and flexibility [1], [2]. Optical burst switching (OBS) [3], [4] is an optical networking paradigm that combines the best intrinsic worth of both the circuit switching and packet switching technologies. In an OBS network, firstly small packets are assembled into large bursts at network ingress or source node and disassembled back into packets at network egress or destination node. When a burst is ready for transmission, the ingress node sends a header packet toward the egress node on a dedicated control channel to reserve resources at intermediate nodes along the path.

The data burst follows after an offset time without waiting for an acknowledgement. The physical separation data bursts and their header packets help to provide flexible electronic processing of headers at core nodes and end-to-end transparent all-optical paths for transporting data bursts [5].

Unlike conventional IP network which buffer its data packet while processing the corresponding header and configuring its switching path, OBS can eliminate the need for buffers for the data bursts. OBS also has advantages in switching efficiency, low setup time for bursty IP traffic and in optical hardware feasibility [6].

In OBS the Control Architecture and the Contention Resolution scheme are two important issues. The control architecture, defines how an edge node will inform the network about an impending burst and the kind of information about the burst that the source gives to the network. JIT (Just in Time) [7], [8], JET (Just Enough Time) [9], [10], and TSL SP (Time-Space Label Switching Protocol) [11], are three of the many signaling schemes proposed for OBS networks. In Optical reservation is a one way process in which a burst starts its transmission without waiting for the reservation acknowledgment and if two or more bursts intend to take the same output port at the same time and on the same wavelength then contention will take place that causes blocking of data bursts, therefore proper contention resolution schemes are needed to be implement [12].

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II. OBS Net Work Architecture

A. Issues of OBS Network

1. An important issue related to one-way reservation in general, and OBS in particular (since there is no optical buffer), is how to deal with contention and reduce burst dropping [13].
2. Another important issue related to OBS using a non-zero offset time is the end-to-end latency encountered by each burst.
3. Certain performance related issues need to be addressed like scheduling, burst aggregation, contention resolution and Quality of services [14].
4. The main design issues include how to interpret the conveyed information and how to react to the current network state.
5. How to provide QoS for users in the optical network [15].
6. Hardware complexity, high cost devices are also various issues.

B. Contention Resolution Schemes in OBS

The presently used contention resolution schemes can be classified into five domains, but they have some inherent problems as well. Table I shows the detail of these schemes.

TABLE I
DIFFERENT CONTENTION RESOLUTION SCHEMES FOR OBS NETWORK

Domain	Example	Problems
Space	Deflection Routing	It makes setting the time lag between a burst header packet and the corresponding data burst.
Wavelength	Wavelength Conversion	Wavelength converters are expensive and complex devices.
Time	Fiber Delay Line (FDL)	It will increase data latency and also introduce complexity for the network.
Burst	Segmentation	It is not easy to carry out in the physical layer.
Control	Shortest-Drop, Look Ahead Policy	It increases the complexity of implementation too much.

III. PARTIAL PRE-DEFLECTION CONTENTION RESOLUTION SCHEME

We propose a new scheme to deal with the contention problem in OBS networks by pre-deflecting part of the payload at the edge node. In this scheme traffic payload is divided into two categories, cluster and canoe.

Cluster: It is a consecutive traffic payload consisting of identical attribute data packets.

Canoe: The remainder traffic payload, which is relatively discrete and independent.

This separation of traffic payload is done by Payload Segregator Threshold criterion [16].

A. Payload Segregator Threshold (PST) Criterion

The function of payload segregator is to categorize the burst assembled by Dual Time Threshold (DTT) assembly algorithm into the cluster and canoe. The criterion of classification is PST, which is an integer value close to the mean value of burst length l. If the length of a burst is lower than PST, the burst is classified to the class of canoe; otherwise it belongs to the class of cluster. Let p denote the probability that ST Timer does not interrupt when a new data packet arrives, x denote the inter-arrival time between the new data packet and the anterior one close to it, suppose x is under independent and identical Pareto distribution, E(l) is the mean value of burst length l . So according to the mechanism of ST Timer, the burst length l obeys geometric distribution.

So, E(*l*) is determined by the Hurst parameter H, when we set the value of ST to be E.

$$P = \text{Prob}\ (X < ST) = F\ (ST) \tag{1}$$

$$\text{Prob}\ (l = k) = p^{k-1}\ (1-p) \tag{2}$$

where k = 1, 2, 3, 4…….∞

$$E\ (l) = \sum_{l=1}^{\infty} l.p^{(l-1)}.(1-p) = \frac{1}{1-p} \tag{3}$$

So E (*l*) is only determined by the Hurst parameter H when we set the value of ST to be E.

$$E\ (l) = \frac{1}{1-F(E)} = \frac{1}{(1-1/\propto)^2} = \frac{1}{\{1-1/(3-2H)\}^{2-2H}} \tag{4}$$

We use the integer value close to E(l) as the value of PST, as shown in Table II. The load of canoe and load of cluster in the self-similar traffic are:

$$Canoe\_load = \frac{\sum_{l=1}^{PST} l.p^{(l-1)}.(1-P)}{E(l)} \tag{5}$$

$$Cluster\_load = (1 - Canoe\_load) \tag{6}$$

TABLE II
PROB (X ≥ E), E (L), PST, CLUSTER LOAD UNDER DIFFERENT DEGREE OF SELF SIMILAR TRAFFIC

α	H	Prob (x ≥ E)	E(l)	PST	Cluster_load
1.2	0.9	0.1165	8.6	9	0.6519
1.4	0.8	0.1731	5.3	6	0.6517
1.6	0.7	0.2082	4.8	5	0.6352
1.8	0.6	0.2323	4.3	5	0.6701
2.0	0.5	0.2500	4.0	4	0.6328

So the load of cluster is around 66%, i.e. 2/3 of the traffic load, under Self-Similar traffic.

Our scheme includes two steps:

We separate the traffic payload at the edge nodes into clusters and canoes before they are transmitted through the core nodes.

The clusters and canoes will transfer through the core nodes to their destination by the different paths, even though they have the same source address and destination address.

B. Burst Offset Time Control Algorithm

In this approach we propose an algorithm which is known as joint flow and burst offset time control algorithm in order to achieving zero burst loss and maximize network utility. Here the source node assembles multiple IP packets destined to the destination node into a burst. Before this burst is sent to the destination node, a forward control packet (FCP) is sent to reserve the resource for this burst which collects the congestion and contention price along its route, and a reverse-direction control packet (RCP) sent by destination node delivers this information to the source node, consequently source node update its burst length and offset time.

IV. RESULT AND DISCUSSION

A. Simulation Setup

In this section, we examine the performance of our Partial Pre-Deflection Routing with Control Signal Scheme with an extensive simulation study based upon the ns-2 network simulator [17]. We use the OBS network simulator (n-OBS) patch in ns-2, to simulate our network. The simulation settings are given in the following Table III:

TABLE III
SIMULATION SETUP OF THE MODEL

Topology	Mesh
Total no. of Nodes	14
Edge Nodes	7
Core Nodes	7
Maximum channels per link	10
Number of control channels per link	2
Number of data channels per link	8
Total channel Bandwidth	100Mb
Link Delay	1ms
Maximum burst size	40Kb
Traffic Type	SSIM
Packet Size	512 bytes
Load	5 to 10Mb

In this simulation, a CBR traffic model is used, in which 5 traffic flows are setup between two edge routers. In all the simulation, the results of our proposed PPDRCS algorithm are compared with the PPDR method.

B. Performance Matrices

Burst Received: It is the number of optical bursts received at the edge receiver.

Delivery Ratio: It is the ratio between the number of bursts received and the numbers of bursts send.

Delay: It is the average end to end delay between the sender and the receiver.

Based On Load

In our experiment we vary the load value as 5Mb to 10Mb.

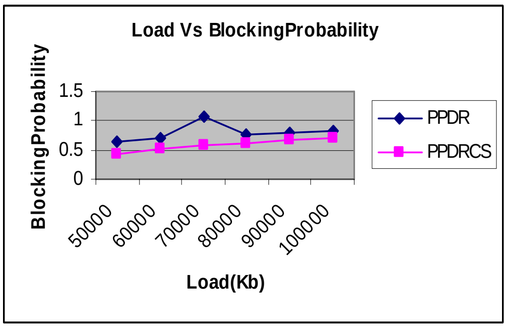

Fig. 1 Load Vs Blocking probability

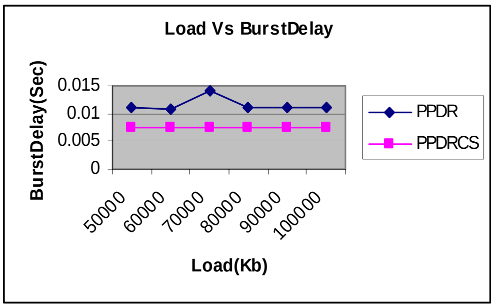

Fig. 2 Load Vs Burst Delay

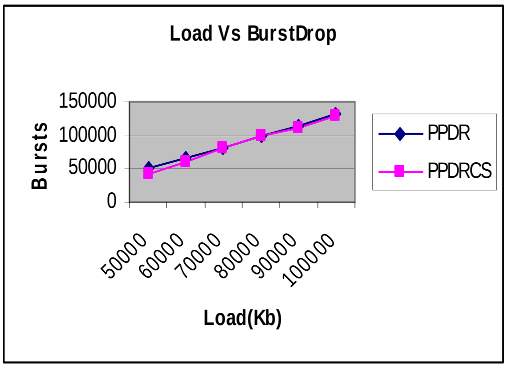

Fig. 3 Load Vs Burst Drop

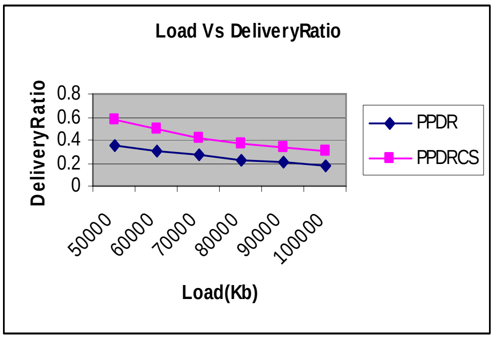

Fig. 4 Load Vs Delivery Ratio

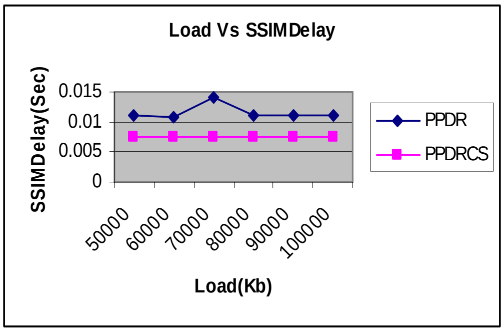

Fig. 5 Load Vs SSIM Delay

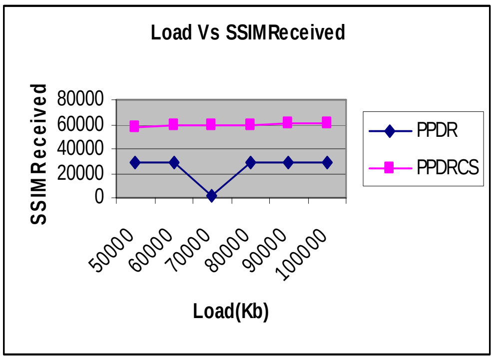

Fig. 6 Load Vs SSIM Received

From Fig. 1, we can see that the blocking probability of our proposed PPDRCS is less than the existing PPDR protocol.

From Fig. 2, we can see that the Burst drop of our proposed PPDRCS is less than the existing PPDR protocol.

From Fig. 3, we can see that the Burst delay of our proposed PPDRCS is less than the existing PPDR protocol.

From Fig. 4, we can see that the delivery ratio of our proposed PPDRCS is higher than the existing PPDR protocol.

From Fig. 5, we can see that the SSIM Delay of our proposed PPDRCS is less than the existing PPDR protocol.

From Fig. 6, we can see that the SSIM Received ratio of our proposed PPDRCS is higher than the existing PPDR protocol.

V. Conclusion

In this we propose Partial Pre-Deflection Routing with Control Signal Scheme for Contention Resolution in Optical Burst Switch Networks. In this approach Partial Pre-deflection routing approach has been proposed which routing is carried out in two ways Shortest Path First (SPF) routing and Least Hop First Hop First (LHF) routing. The Shortest Path First (SPF) Routing is used by the canoes and LHF routing is used to forward the clusters. And a Burst Offset Time Control Algorithm has been proposed where a forward control packet (FCP) collects the congestion price and contention price along its paths, and a reverse-direction control packet (RCP) sent by destination node delivers this information to the source node. The source node uses this information to update its burst length and offset time.

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