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Combined probabilistic deflection and retransmission scheme for loss minimization in OBS networks

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ABSTRACT

Optical burst switching (OBS) is an appropriate optical switching technology for optical internet considering the bandwidth requirements and technological constraints. However, burst loss remains to be the critical issue in the bufferless OBS network. Many contention resolution schemes were proposed in the literature to address this issue. Deflection routing is regarded as an attractive method for contention resolution in OBS networks. To further reduce the loss, hybrid schemes combining deflection and retransmission were proposed. In this paper, a new hybrid scheme combining the limited retransmission and deflection namely combined probabilistic deflection and retransmission (CPDR) is proposed to achieve loss minimization, overcoming the adverse effects of pure deflection and pure retransmission. The proposed protocol is found to provide 25 percent to 60 percent reduction in burst loss with respect to other similar protocols at higher load conditions. An analytical model is also developed to estimate the burst loss probability of the proposed protocol and the predicted results are found to be in good agreement with simulation based results.

1. Introduction

Optical burst switching (OBS) [1] is a switching technology that has the potential to support the ever increasing bandwidth demand of the internet backbone. It efficiently utilizes the bandwidth provided by dense wavelength division multiplexing (DWDM), and also avoids the requirement for optical buffers in carrying bursty loads. In an OBS network, multiple internet protocol (IP) packets are assembled into a data burst and switched through the network all-optically. A burst header packet (BHP) consisting of information required to reserve resources for the data burst is transmitted ahead of the data burst in an out-of-band control channel and processed electronically at the intermediate nodes [1]. The BHP is separated from its data burst by an offset time that allows the BHP to be processed before the arrival of the burst at the intermediate nodes. This avoids the burst being buffered at the intermediate nodes. In Just-Enough-Time (JET) reservation protocol, one-way signaling is used. No acknowledgment is sent by the core or destination nodes. This one-way signaling and bufferless nature of the network leads to significant burst loss due to contention, even at moderate traffic loads.

Many contention resolution schemes were proposed and studied in literature including fiber delay line buffering, wavelength conversion, segmentation, and deflection [2]. Deflection routing is found to be an attractive solution to resolve contention in OBS networks because it does not need additional hardware and it can be implemented without optical buffers [3]. However, as the load increases, uncontrolled deflection routing could lead to performance degradation and network instability [4]. None of the contention resolution schemes can completely eliminate the burst loss and hence retransmission is necessary [5] to

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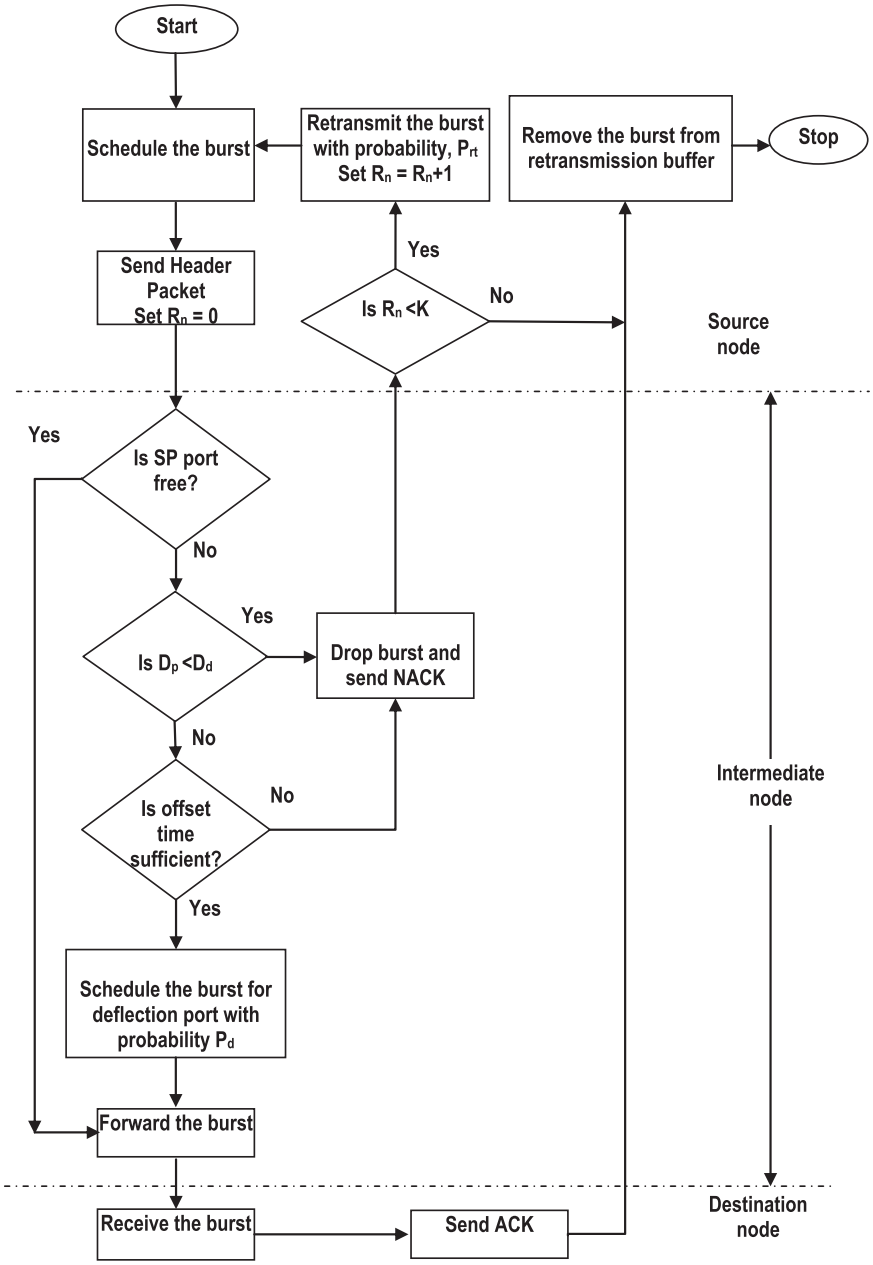

Fig. 1. Flowchart of CPDR scheme.

further reduce the loss. In large scale OBS networks, achieving lossless transmission through retransmission is not feasible even under low load, due to the large propagation delay. To address this issue, hybrid schemes combining deflection and retransmission were reported in literature to achieve smaller end-to-end delay and burst loss ratio compared to pure deflection routing (PDR) and pure retransmission (PRT) [6,7]. The hybrid deflection and retransmission (HDR) scheme transmits the data bursts first using deflection routing and if the deflection routing fails, applies burst retransmission. The HDR performs better than both PDR and PRT up to certain load. At very high load, the performance degrades and becomes worse than pure deflection and pure retransmission. To avoid this degradation, a hop count based constraint is used for limiting deflection in the case of limited hybrid deflection and retransmission (LHDR). This limitation is found to improve the burst loss as well as delay performance at higher load conditions. An adaptive hybrid scheme combining deflection and retransmission namely adaptive HDR (AHDR) was reported in [8,9]. In this scheme, the contending burst is deflected or retransmitted based on an adaptive threshold function and if deflection is done, the alternate route is chosen based on the load condition of the network. The performance of this protocol had been compared with LHDR and higher throughput had been reported in the case of AHDR even under high load. The