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Labeled Burst Switching

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Abstract: In this study, Labeled Burst Switching (LBS) is proposed. At the ingress LBS switch, packets from different sources and to the same destination are aggregated into a burst and then labeled. The labeled burst is switched as a single packet inside the LBS network. Using LBS, the average delay time of a packet is enhanced compared with MPLS system.

Key words: MPLS, burst, packet aggregation

INTRODUCTION

Multiprotocol Label Switching (MPLS) (LeFaucheur, 1998; Viswanathan *et al*., 1998; Lawrence, 2001) has been proposed and considered to be one of the most promising prominent solutions for IP traffic.

The basic concept of MPLS is that packet switching is based on a fixed short length label instead of longest matching search (Qiao, 2000). Various approaches using MPLS have been proposed and most of them have been deployed in the backbone networks. In MPLS based network, once a packet has been classified as a new or existing Forward Equivalence Class (FEC) (Verma *et al*., 2000), a label is encapsulated in a layer-2 header along with the packet (Metz, 2001). Once a packet has been labeled, the rest of its journey through the network is based on label switching.

The traffic in the internet backbone network is bursty by nature due to the increasing deployment of new applications, such as multimedia and video applications, requiring more scalable resources and QoS solutions (Long *et al*., 2003).

In this study, we describe a framework for Labeled Burst Switching (LBS). The LBS is intended to address the issues of switching a burst in a LBS capable network.

THE INGRESS NODE

One of the main functions of a LBS edge node is to collect upper layer traffic, sort it based on destination address, aggregate it into variable size bursts and send it through one of its output links without waiting for resources reservation acknowledgment from intermediate nodes (Battestilli and Perros, 2003).

Burst assembly: The burst assembly algorithms are based on two parameters: a threshold time and maximum and minimum burst lengths. Theses two parameters are used to shape the size of the burst. This is a necessary mechanism to prevent some bursts from holding resources for long time causing high burst losses and end-to-end latency, while short bursts may give rise to too many header processing (Yang *et al*., 2004).

At the edge node, the following processes take place:

- First, arrived packets are queued according to their destination addresses.
- Then, packets to the same destination address are queued according to their Class of Service (CoS).
- After that, packets to the same destination address and belonging to the same CoS are aggregated to form a burst.
- Once a burst is formed (either its threshold time is expired or its maximum length is reached), it is send to the next node (Fig. 1).
- The generated burst consists of three parts (Fig. 2):

Burst Header (BH): Containing the necessary information for subsequent switching (label, burst length, Class of Service, number of hops, etc…)

Burst Data (BD): Containing the aggregated packets.

Burst Tail (BT): At the ingress node, the tail is identical to the header. However, in core nodes, the tail will update the information in the header if the burst is not fully switched after sending the header.

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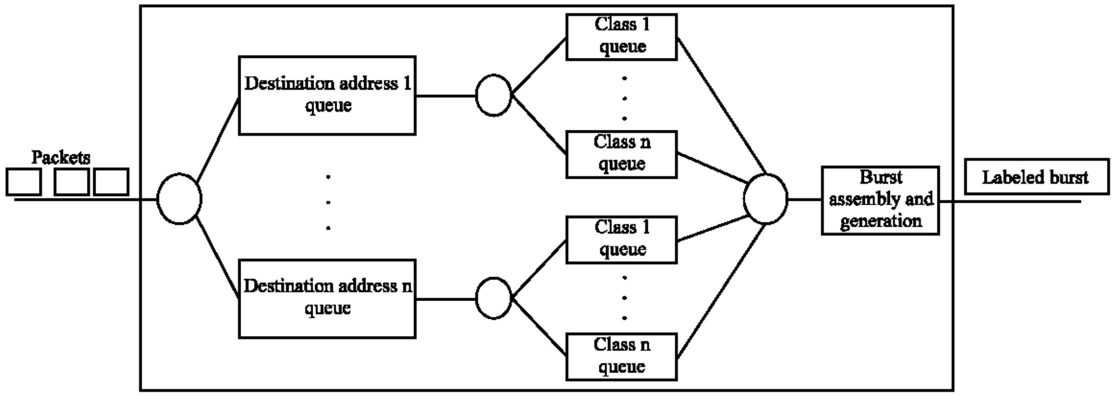

Fig. 1: LBS ingress node architecture

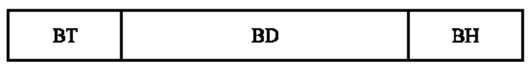

Fig. 2: Labeled burst

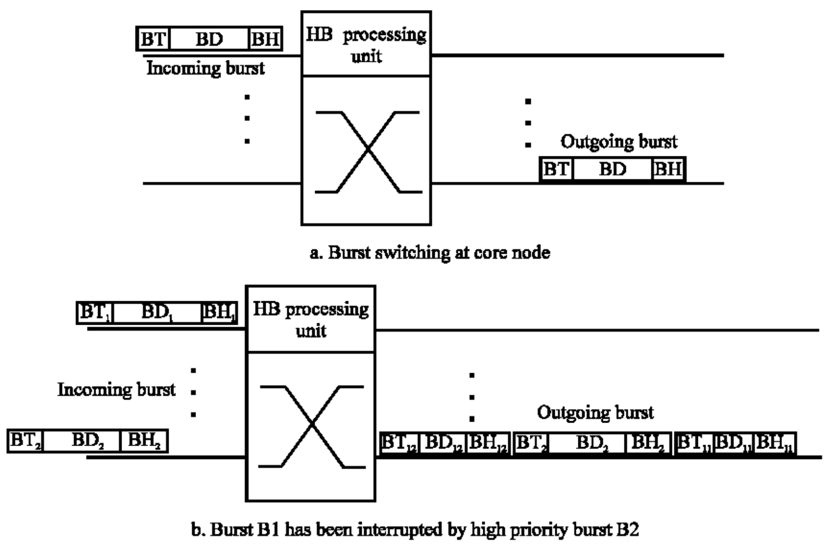

Fig. 3: Burst scheduling at intermediate/core LBS nodes

THE CORE NODE

The main functions of an LBS switch is to schedule the incoming burst, resolving any contention between bursts attempting to use the same resources simultaneously and ensure the network survivability in case of any link or node failure.

Burst scheduling: At the core/intermediate nodes, once the burst is received, it is queued and its header is proceeded to extract the routing information needed by the switch. If the resources are available (the output link and the outgoing label), then the BH is updated by replacing the incoming label with the outgoing label and the switch fabric starts switching the burst (if the burst is long enough, its BH may start going out before the whole burst is received). Once the BT is received, it indicates the end of the burst. If the burst is interrupted by higher priority traffic before the total switching of the BD, a new BT is generated to reflect the new burst size and the remaining part of the burst is sent either after a delay or sent to a different output link (Fig. 3).

Contention resolution: Using one way reservation in LBS, the ingress node sends out bursts without waiting for the acknowledgments. This implies that intermediate nodes

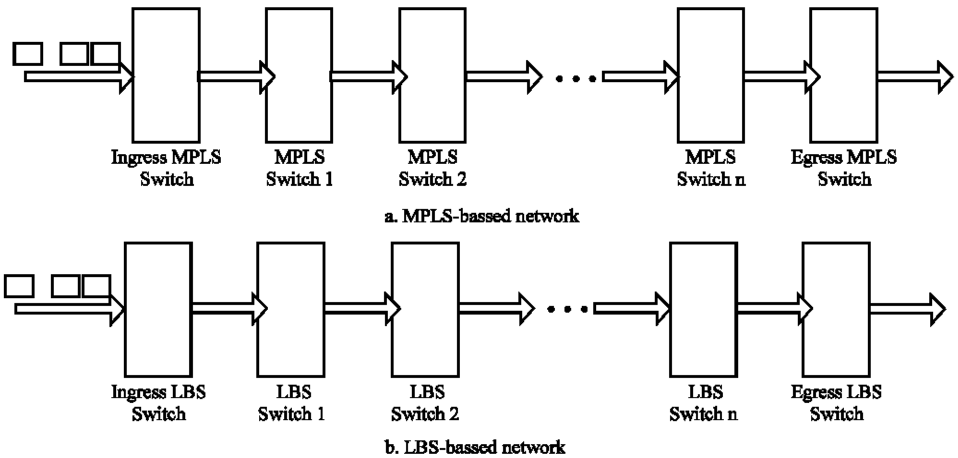

Fig. 4: Performance analysis of MPLS and LBS networks

are able to resolve any contention among bursts. If more than one burst are contending to use the same output link, the burst with the highest CoS is granted the link. The other contending burst can be delayed or sent to another output link. If a low priority burst is interrupted by a high priority burst during the switching phase, the switch will continue switching the current packet of the low priority burst, generating a new tail to reflect the new burst information and send it together with the burst. Then, the high priority burst is switched completely (unless interrupted by a higher priority burst). After that, the switch generates a new header for the remaining part of the low priority burst and this latter is either switched to a different output link or delayed until the completion of the switching of the high priority burst and then switched to the same output link (Fig. 3).

RESULTS AND DISCUSSION

To illustrate the advantages of the LBS over an MPLS system, we analyze the packet delay incurred in networks shown in Fig. 4. We adopt the following notations:

T_S: The header processing and switching time
T_L: The labeling time (in the Ingress node)
T_A: The average burst assembly time
T_D: The average burst disassembly time
N : Average number of packets in a burst
H : The number of intermediate hops

Using MPLS, packets are labeled one after the other at the ingress switch and then sent to the next switch. At each subsequent switch, the header of each individual packet is processed, the switch fabric is configured and

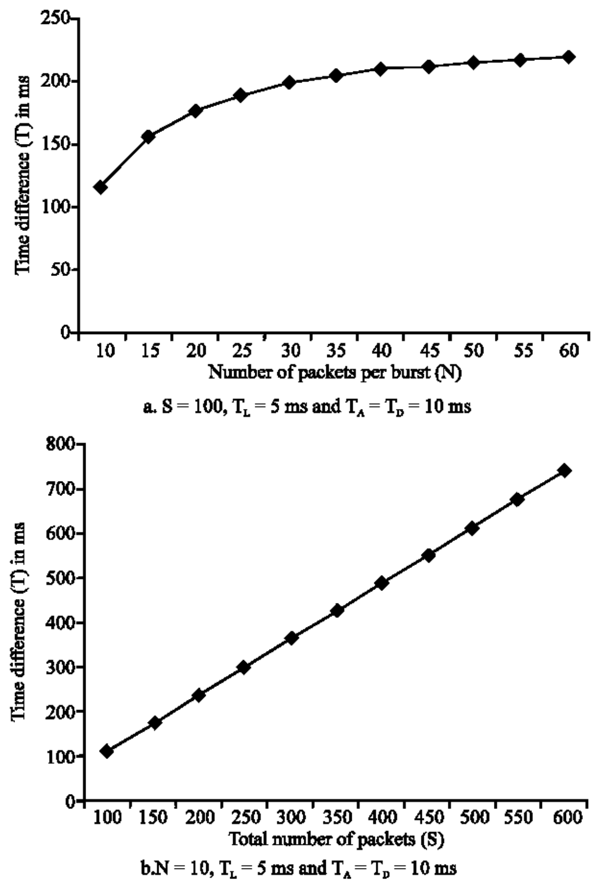

Fig. 5: Average packets delay

the packet is sent to the corresponding output port. However, using LBS, the packets are first gathered and assembled to form a burst at the ingress LBS switch. At subsequent switches, the packets belonging to the same burst are treated as a single labeled packet. Assuming that the header processing and switching time is less than the labeling time and the packets are switched at the core nodes without being queued. For stream of S packets, the average time required for each of the S packets to reach the egress node is given by:

$$T_{MPLS} = \frac{(S+1)}{2} \cdot T_L + H \cdot T_S \quad (1)$$

$$T_{LBS} = \frac{(S+N)}{2N} \cdot (T_A + T_L + T_D) + H \cdot T_S \quad (2)$$

The difference between the two delays is given by:

$$T = T_{MPLS} - T_{LBS} = \frac{S+1}{2} \cdot T_L - \frac{S+N}{2N}\left(T_A + T_L + T_D\right) \quad (3)$$

Figure 5 shows the difference in packets delay T for different values of N, S, T_L, T_A and T_D.

CONCLUSION

In this study, we have proposed a framework for a Labeled Burst Switching (LBS) system. We have presented the architecture of the ingress switch and the different functions of the core switches. Finally, we have compared the average delay time for packets using both MPLS and LBS systems.

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