BCSM SWITCH FOR B-ISDN
A NEW HIGH-PERFORMANCE SWITCHING ELEMENT*

Wang Binqiang  Fan Changxin
(Information Science Institute, Xidian University, Xi'an 710071)

Abstract This paper proposes a new high-performance switching element with the new shared-memory queuing policy, which is called blocked-cell shared-memory (BCSM) queuing. As the name means, instead of buffering all cells through them, the BCSM switching elements only buffer the blocked cells at their input ports. Theoretic analysis results under the uniform traffic model prove that BCSM switching elements have better performance than shared-memory switching elements.

Key words ATM; Switching elements; Queuing

I. Introduction

One of the main tasks for ATM switching elements is to route the input cells to the correct output ports according to their routing tags. Because the arrival of input cells and their destination output ports are random, two or more cells may compete for one output port at the same time slot. Under the circumstances, a collision occurs. Then all but one of the competing cells are blocked and only one cell is routed to the output port. The treatment methods for the blocked cells can be classified into the loss system and waiting system[1,2]: the loss system discards the blocked cells and the waiting system buffers the blocked cells to wait for being switched at the following time slots. The method in this paper belongs to the waiting system.

The key to the waiting system is where buffering queues are located. Different buffering queues location corresponds to different queuing policies. In ATM switching elements there are three kinds of basic queuing policies—input, output and shared-memory queuing. Input queuing switching elements have the advantage of the same cell transmission rate in the interior as that at input ports, but its drawback is that there exists the head of line (HOL) blocking, which extremely limits the switching element throughput (the limit is 0.586 theoretically[3]) and also affects the other performances such as mean cell delay and cell loss probability. In order to improve the performances of input queuing switching elements, many methods have been suggested, representatives of which are windowing[4], input smoothing[5], speeding-up[6], and grouped input queuing[7]. The most interesting method is the speeding-up, which introduces the speed-up factor. When the speed-up factor equals N, the input queuing switching element becomes the output queuing switching element. It has been proved[6] that the performances of any improved input queuing switching elements are impossible to be better than the performance of output queuing switching elements. How-

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ever, for the output queuing switching elements, the cell transmission rate in the interior must be \( N \) times the rate at the input ports (assumed that the size of switching elements is \( N \times N \)). Because each output port has an independent buffer queue for the output queuing policy, the total buffer volume can not be used efficiently\(^8\). To improve the usage factor, shared-memory queuing policy is commonly selected.

Among three kinds of basic queuing policies, the shared-memory queuing policy has the best performance. But it has the disadvantage of complicated control mechanism and high access speed for the shared-memory\[^9\]. In another aspect, its cell transmission delay and required buffer volume for a given cell loss probability remain unsatisfactory. All of these results from that the shared-memory switching elements must buffer all cells passing through them. In this paper, a new shared-memory queuing policy is conceptually proposed, which is called blocked-cells shared-memory queuing (BCSM). As the name means, instead of buffering all cells through it, the BCSM switching element only buffers the blocked cells at its input ports. The theoretic analysis results under the uniform traffic pattern prove that BCSM switching elements have better performance than shared-memory switching elements. Of course, BCSM switching elements need more complicated input control circuits than the traditional shared-memory switching elements. However, it will be seen that the required shared-memory access speed for BCSM can be greatly reduced compared to that for the traditional shared-memory queuing.

II. BCSM Switching Elements

A BCSM switching element is shown in Fig.1. It consists of an input arbitrator, an output arbitrator, an internally non-blocking switching element and a blocked-cells shared-memory (BCSM) queuing. Internally non-blocking switching elements may be a cross-bar switching element without any buffering queues. All the buffering queues for the BCSM switching element concentrate in a BCSM shared-memory. When there is no cell contention in a given time slot, all the cells at the input ports can be switched to the destination output ports through the internally non-blocking switching element and no buffer is needed. Once the contention takes place, the winning cells can be directly routed to the correct output ports, but the blocked cells have to enter the BCSM to wait for switching in the following slots.

The input arbitrator mainly makes contention arbitration according to the predetermined arbitration rules. Instead of discarding the blocked cells in loss systems, here the input arbitrator sends the blocked cells to the BCSM to wait for being switched in the