

Chapter 1

Introduction

In order to provide high speed multimedia network communication services such as voice, data and real-time video transmissions, the demand for B-ISDN (Broadband Integrated Services Digital Network) has been recently increased. A basis for packet transmission in B-ISDN, Asynchronous Transfer Mode (ATM)[1] has been introduced. ATM is a high-speed connection-oriented packet-switching technique with minimal functionality in the network which differs from the conventional packet switching in many aspects. High-level protocol functions such as error control are performed on an end-to-end basis, not such as link-by-link basis in ATM.

In ATM, the multiplexing of transmission capacity into short fixed length transmission slots called *cells* has been adopted as a flexible and efficient transmission standard. The ATM cell consists of a 48 bytes information payload and a 5 bytes header[1]. The cell requires a mere total of 3 μ s for transmission on a 155.12 Mb/s ATM link. Each cell header contains an n -bit binary address of the requested output port.

These cells are entered and distributed to their destinations, respectively, by an ATM switch[2]-[5]. An ATM switch of size N can be regarded as a box with N input ports and N output ports. It routes cells arriving at its input ports in a time-slotted fashion to their desired output ports (destined by their headers). Since all input lines are synchronized and the minimum slot size is equal to the transmission time of a single cell, input and output lines are assumed to operate at the same speed. This construction simplifies the design of switches, and reduces delay and jitter especially for delay-sensitive services such as voice and video processing.

Many ATM switches are constructed by self-routing networks[6]-[10] such as banyan networks[11]-[15]. A cell is routed at each switching element in the banyan network by its destination address. When two cells select the same route in a switching element at the same time, one of them is blocked its way and eliminated from the switching element. This cell blocking problem gives a huge damage to ATM network performance.

To solve this problem, many improved networks are proposed. For example, dilated banyan networks[16] duplicate links in their switching elements to reduce the occurrence of cell blocking. Re-routing networks[17] and tandem networks[18]-[20] construct special links to save and reroute blocked cells. However these networks need more switch size, which is closely concerned with network cost, or increase delay of the networks.

This thesis proposes two kinds of solutions for the above problems. One is a hybrid dilated banyan network[21, 22], and the other is a bypass method[23]-[25]. From these solutions, three sorts of networks are introduced, and their throughputs are analyzed. From the comparison with other networks, it is concluded that the proposal networks improve their throughput and give a flexible choice for network construction to network designers.

The rest of this thesis is organized as follows. Chapter 2 introduces banyan networks and 2-dilated banyan networks. Chapter 3 proposes hybrid dilated banyan networks which are hybrid of the original and the 2-dilated banyan networks. They are analyzed their throughput, and compared with other ordinary networks. Chapter 4 provides a bypass method to the original and the 2-dilated banyan networks. The bypass is a link between neighbored switching elements to transmit blocked cells from a lower switching element to the upper one. Although the bypass method reduces a cell loss rate, it increases delay of the network. To improve this problem, one-bypass-connection method also proposed. Chapter 5 introduces the bypass method to hybrid dilated banyan network and their throughput has been analyzed. Chapter 6 concludes and discusses about the performance of each network.