Chapter 1

Introduction

Emerging multimedia, high-speed data, and imaging applications are generating a demand for public networks to be able to multiplex and switch simultaneously a wide spectrum of data rates. These networks must be able to transport a large number of services such as low speed telemetry, telefax, low speed data, medium speed (Hi- Fi sound, video telephony), and very high speed (high quality video distribution, video library, video education).

These services are the target of B-ISDN. B-ISDN schemes are now being developed to provide various services, such as video, voice, and data to support these services effectively, various types of path connection, such as point-to-point, multipoint-to-point, and point-to-multipoint, need to be established in broadband networks. ATM is a key technique to realize B-ISDN because ATM can transfer broadband services at high speed, and various types of path connection can be established easily by using Virtual Paths (VP's)

The truth seems to be that ATM should be thought of as both big bits and small packets, and which description is more accurate depends on the context. For instance, at high bandwidth (a few 100 Mbps or faster), ATM cells look very much like bits. Each cell takes a negligible amount of time to send, and is too small for a sending or receiving computer to handle efficiently. But at low bandwidths (64 Kbps or slower), cells start to look big. A cell takes over 6 ms to transmit, a long time in a world where processors perform an instruction every few nanoseconds. The ATM concept results from the merging of two concepts: packet switching and Time Division Multiplexing (TDM). Each of these techniques has been modified in the following manner.

Related to packet switching, neither error control (on the data field) nor flow controls on the links inside the ATM network. Connection-oriented at the lowest level, all information is transferred in a virtual circuit assigned for the complete duration of the connection. Packets have a fixed and small length. Instead of allowing variable-length packets to be switched, only small fixed-length packets (called cells) are accepted by the network. This choice allows the use of very high speed switching nodes and puts no constraints on services, since large information entities will be segmented into cells. Limited functionality in the header of the cells. The primary functionality supported by the header of the ATM cells is the identification and characterization of the virtual circuit. In addition, some error detection and correction on the virtual circuit identifier are provided.

Related to TDM, the time-slotted operation is kept, but the time transparency is shifted to the network's edges. This means that no time relation is maintained inside the network. Time slots are no longer characterized by their relative position in a frame as in TDM. To identify a certain time, an additional field called a header is needed to contain a virtual circuit identifier. To keep overhead to a minimum, the header is 5-bytes and the cell information field is 48-bytes, giving a total cell size of 53-bytes.

It is also important to note that ATM is going to use the Synchronous Optical Network (SONET), which in Europe is called Synchronous Digital Hierarchy (SDH), which has defined speed in the multigigabit range. In such range bandwidth is not the limiting factor but latency due to the speed of light becomes the limiting factor. This has impact on congestion and flow control issues. In this case closed feedback control methods of flow control is too sluggish. Other methods should be sought like rate-based flow control in which the user is permitted to transmit at a maximum allowable rate. We have an ATM-based ring network as a subscriber network, because the ring architecture allows network resource sharing, it can realize a cost-effective network.

1.1 Objective of the Thesis

The first objective of this research is to evaluate the performance of the VP-Based ATM Ring network for supporting multimedia applications; in particular voice and video traffics. First we have studied the network performance carrying individual traffic. Then, we have dropped the previously mentioned premise of individual traffic and consider the case when two traffics are handled. Finally, the effect of including another traffic with the previous integrated two traffics. Our primary performance measure is the maximum number of sources that can be carried by the proposed network. The major performance measures are including:

I) The mean waiting time (MWT) for video, voice, and data cells;

II) The maximum buffer size (MBS) (queue length) for video, voice, and data cells;

III) The maximum number of video/voice sources that can be supported with the network while satisfying the real-time constraints of both video and voice; and

IV) The achievable throughput and utilization of each traffic.

Our study has confirmed that the VP-Based ATM Ring Network can effectively handle real-time synchronous transmission of video and voice. The control allowed method in [1] caused data traffic to suffer from very large latency and very low throughput. This is because, the control mechanism method gives high priority to video and voice traffics, however data traffic is only serve when there is no video and voice cells or the load of video and voice traffics is light.

Consequently, we have proposed a control mechanism method to guarantee fairness among traffics. Though the video and voice traffics remain having higher priority than data traffic. In the proposed control mechanism method, the number of cells to be picked up from each queue depending upon its offered loads for completing the transmission frame

In order to achieve the objectives of evaluating of the network's performance, we have implemented a computer simulation and used a check point analysis to check the proposed simulator, which has proved that the simulator is working properly. Although the real performance of a communication system is only clear in practical use, theoretical performance evaluations can be used to investigate its basic stability under different load conditions. Also, simulators are valuable tools in helping us understand how complex systems could operate and perform without need to build an actual physical model to test. We have built up our simulation model using the C programming language. The simulator itself is designed to be flexible, it can be easily changed to accommodate different experiments. Most of the changes can be made in the constants of the program header.

1.2 Literature Overview

The increasing number of customers requires network to access with high bandwidth and low delay over long distances. To satisfy these needs, several high-speed network techniques have been developed recently. ATM is superior compared to other networking technologies as it offers high bandwidth and is scalable in the sense that the bandwidth capacity of an ATM system is not fundamentally limited to the technology itself [2].

The history behind ATM including the ATM standards, the different parts of the ATM set of specifications, the network topologies, and the network management aspects of ATM are explained in [3, 4].

In 1987, ATM was selected by CCITT (now ITU-T) as the bearer service to support B-ISDN. In 1990, CCITT agreed on a set of 13 recommendations that specify the most important characteristics of ATM. In 1991, the ATM forum was established by Adaptive Corp, Cisco, Northern Telecom., and Sprint. This forum defines and develops ATM standards. ATM forum released the first ATM specification in 1992. In 1996, the forum approved the Anchorage Accord, which led to the convergence and interoperability of about 60 ATM specifications. Most ATM specification is now complete, said George Dobrowski, Chair of the ATM forum's Worldwide Technical Committee [5].

While it may be foreseen that ATM will drive the development of new networking interfaces, it will still be required to support the existing networking interfaces. It is necessary to define an ATM service, which emulates services of existing LANs on an ATM network without the need of any change in the ATM terminal equipment interface to the MAC layer. LAN Emulation is exactly designed to meet this requirement, more details in [6].

Since ATM doesn't provide media access control, it has been a concern that the throughput will be low if an ATM network experience congestion; in fact there is already practical evidence to this effect. Remanow and Floyed [7], investigated the throughput behavior of TCP over ATM for best-effort traffic when there is network congestion.

Originally, two feedback mechanisms were under consideration in the ATM forum: a rate-based scheme [8,9], and credit-based scheme [10,11]. An integrated approach to ATM flow control is described in [12].

The term Self-healing refers to the capability of the network to reconfigure itself around failures quickly and gracefully with the goal of approaching 100 % service availability an end-to-end basis. For more detail, see [13,14,15]. Shenghong and Zemin [16] present a new simple traffic model that can be realized arbitrary marginal distribution and its correlation may be not only long range dependence but also short-range dependence. As a result, compared with any existing traffic model, their proposed model is a more general traffic model.

P.S. Eom and etc. [17] investigate a Connection Admission Control (CAC) problem in a multimedia wireless ATM network that supports various multimedia applications based on micro/pico cellular architectures. They have presented a method that can decide the optimal CAC threshold values of their CAC scheme.

S.S. Petrovic [18], presented an adaptive closed loop congestion Control Scheme. He assumed two types of traffic share the ATM network resources. The first type consists of Variable Bit Rate (VBR) traffic, which is delay sensitive i.e. which has stringent delay requirements and is not subjected to any control, hence it is uncontrollable. The second type of traffic requires good loss performance, but agrees to have its bit rate controlled when necessary, thus accepting the possibility of longer mean delays during periods of high demand, i.e. cell loss is avoided at the expense of delay and hence is controllable. All delay insensitive, or best effort, or Available Bit Rate (ABR) traffic can join this group.

Gan and Mckenzie [19] investigated the traffic policing and bandwidth management strategies at the User Network Interface (UNI) of an ATM network. They assumed policing function, called the super leaky bucket (S-LB), it is based on the leaky bucket (LB), but handles three types of traffic differently according to their quality of service (QoS) requirement. Their simulations clearly demonstrate the advantages of the proposed strategy in providing improved levels of service for all types of traffic.

E. Yaprak and et al [20], proposed a shared buffer architecture associated with threshold based virtual partition among output ports. They investigated the system behavior under varying traffic patterns via simulation. Their study shows that the threshold based dynamic buffer allocation scheme ensures a fair share of the buffer space even under bursty loading conditions.

The few literatures mentioned, and many are not mentioned here have studied different cases of applications on ATM networks. Our goal is the integration of multimedia traffic such as video, voice, and data over a proposed VP-Based ATM Ring network. In our study we have considered that each station on the network can generate different types of traffic.

1.3 Organization of the Thesis

The thesis is organized into eight Chapters. The introduction and the outline of the thesis are presented in chapter one. In Chapter two, an overview of B-ISDN (Broadband-Integrated Services Digital Network) protocol reference model and its layers briefly explores what is the ATM network, the description of both the reference points and function groupings of ATM networks and the SONET/SDH specifications are included.

The multimedia traffic over ATM Network in more details, the traffic parameters, the ATM forum traffic categories, and the details of video, voice and data traffic assumptions are discussed and described in Chapter three. Chapter four outlines the characteristics of the system under consideration. The description of the VP-Based Ring architecture using VP concepts and ATM Ring Routing, the network operation and topology, the ADM node of VP-Based Ring network, the queue models and the previous control methods are included. Also, the proposed control mechanism method and the B-ISDN performance are explained. The simulation results when the proposed network is exclusive only one type of traffic are presented in Chapter five. Chapter six presents the simulation results for the proposed ADM/ATM network exclusive two different traffics such as video/data traffics and video/voice traffics. The performance measurements and characteristics for the service of multimedia traffic such as video, voice, and data over the ADM/ATM network is completely studied in Chapter seven. Finally, conclusion of the thesis and proposed future work are presented in Chapter eight.