CHAPTER I
INTRODUCTION

This chapter gives an introductory description of the project background, objective, and scope of the project. This chapter also includes an outline of the project contents before it is ended with a summary.

1.1 Background

Higher bandwidth is expected to support future applications. An Asynchronous Transfer Mode (ATM) network is a broadband high-speed network for supporting various integrated multimedia services. ATM is compatible with currently deployed physical networks because it is not based on a specific type of physical transport. ATM can be transported over twisted pair, coaxial and fibre optics.

ATM has grown out of the need for a worldwide standard to allow interoperability of information, regardless of the "end-system" or type of information. With ATM, the goal is one international standard. ATM is an emerging technology being driven by international consensus and it is evolving into a standard technology for local, backbone and wide area services. This uniformity is intended to simplify network management by using the same technology for all levels of the network. The information systems and telecommunications industries are focusing and standardising on ATM [5].

Historically, there has been different methods used for the transmission of information among users on a Local Area Network (LAN) and on the Wide Area Network (WAN). This situation has added to the complexity of networking as the c`lonnectivity expands from the LAN to metropolitan, nationwide, and finally worldwide connectivity. ATM is a method of communication, which can be used as the basis for both LAN and WAN technologies. As ATM continues to be deployed, the line between local and wide networks will blur to form a seamless network based on one standard ATM.

ATM provides a single network for all traffic types - data, voice, and video. Basically, different networks are used to carry data, voice, and video information because they have different characteristics. For instance, data traffic tends to be "bursty". Voice and video, on the other hand, tend to be very sensitive to, when and in what order the information arrives. But with ATM, it is potentially capable of supporting all classes of traffic (e.g. data, voice, and video) in one transmission and switching fabric technology.

ATM networks are connection-oriented. This is similar to the telephone networks where a virtual circuit (VC) is setup from calling party to the called party. The VC allows the network to guarantee the Quality of Service (QoS) by limiting the number of virtual circuit connections [5].

ATM cells are transmitted through virtual path connections (VPC) and virtual circuit connections (VCC). A VPC consists of a set of VCCs, while a VCC is a concatenation of several VPCs. ATM consists of 5 Class of Services (CoS) that have different characteristics and requirements. These five CoS are constant bit rate (CBR), real-time variable bit rate (rt-VBR), non-real-time variable bit rate (nrt-VBR), available bit rate (ABR) and unspecified bit rate (UBR). CBR and rt-VBR are for delay sensitive services and the other three are for delay insensitive services.

It is certainly impossible to accept all connection requests. Therefore, the network needs to determine whether to accept a connection request on a call-by-call basis. This decision process is often referred to as Connection Acceptance Control [1] or Connection Admission Control (CAC) [1]. Usage parameter control (UPC) will enforce the contract between the user and the ATM network to guarantee the agreed QoS. A user must declare key service requirements at the connection setup stage.

Under a well-designed connection acceptance control policy, the cell-level CoS can be guaranteed and the resource (bandwidth) usage could be highly efficient. However, call request processing can still be a significant load to network traffic, if the bandwidth allocation procedure has to be performed at each call connection. Allocation of bandwidth to each VCC is handled by CAC. CAC judges whether a VC connection can be accepted while still meeting the QoS objective of each previously established VCC.

Congestion is a state in which performance of networks degrades due to saturation of network resources such as communication links, processors time and memory buffers. Fair bandwidth re-allocation can avoid network congestion and increase the utilisation of bandwidth. The results of network congestion include waste of resources and possible network collapse in the extreme case.

Dynamic bandwidth allocation is becoming one of the crucial issues in design and research in computer network. This is due to the continuous increasing demand of intensive applications that require more bandwidth while retaining higher quality. Dynamic bandwidth allocation utilises the current network state information in the optimal bandwidth distribution. The state information may be gathered through prediction using past data or measurement on current state. Agility and flexibility of dynamic bandwidth allocation has the advantage that it can adapt to the state changes of the network.

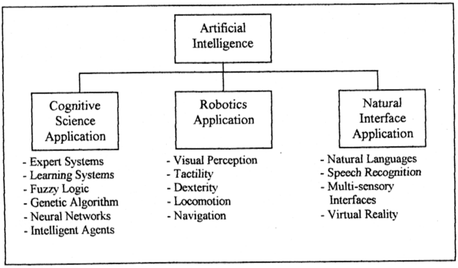

Figure 1.1 The major application areas of AI.

Artificial Intelligence (AI) could play an important role in bandwidth re-allocation and traffic prediction. AI is a field of science and technology based on disciplines such as computer science, biology, psychology, linguistics, mathematics and engineering [1] (refer Figure 1.1). The goal of AI is to develop computers that can think, as well as see, hear, walk, talk and feel. A major thrust of AI is the development of computer functions normally associated with

human intelligence, such as reasoning, learning, problem solving and prediction. AI applications can be grouped under three major areas, which are cognitive science (Fuzzy Logic), robotics (visual perception) and natural interfaces (speech recognition).
The expression Neural Networks come from the similarities with the neurons in the human brain. Of course, Neural Networks are much simpler in architecture. However, like the brain, the interconnected processors in a Neural Network operate in parallel and interact dynamically with each other. Neurons and the interconnection synapses constitute the key elements for neural information processing. Neural Network can be trained by processing sample problems and their solutions. As Neural Networks start to recognise patterns, they can begin to program themselves to solve such problems on their own. In this research, Neural Network is constructed as a predictor to predict the next incoming traffic.

Fuzzy theory was presented by Zadeh in 1965 and has been applied in various areas such as management, industrial control, medical diagnosis and decision-making. Fuzzy Logic can process data that are incomplete or ambiguous, that is, fuzzy data. Thus, we can solve the unstructured problems with incomplete knowledge by developing approximation inferences. Fuzzy Logic is a simple, rule-based approach to solve control or interpretation problem instead of using mathematical system. Fuzzy Logic requires some numerical parameters to operate, but the exact values of these numbers are usually not critical.

AI developers are constructing products that integrate several AI technologies into a single hybrid AI system. For example, an integrated Neural Network and Fuzzy Logic (or Neural-Fuzzy) might detect trends (pattern) or hidden relationships and let the Fuzzy Logics to make decision with the imprecise data. Neural-Fuzzy systems are designed to offset each other's strengths and weaknesses.

In the training of the Neural Network, three series of faked (or artificial) traffics of ATM network operation must be generated. These traffics are similar to the real network traffic operation. There are 2 random variables, Poisson and Exponential, which are very important in the traffic generation. The random variables are a mapping from the set of all possible events under consideration to the real numbers. That is, the random variables associate with a real number for each event. This concept is sometimes expressed in terms of an experiment with many possible outcomes; the random variables assign a value to each such outcome. The random variables are continuous, if they take on an infinite number of distinct values. In contrast the random variables are discrete, if they take on a finite number of distinct values [4].

1.2 Objective

The main objective of this project is to investigate the performance of ATM network after implementing the dynamic bandwidth allocation algorithm. The effectiveness of the different bandwidth re-allocation methods will be measured. Strengths and weaknesses of dynamic bandwidth allocation schemes will be discussed.

The following are the objectives of this project:

- Improve the bandwidth utilisation compared to static bandwidth allocation
- Comparing different types of bandwidth re-allocation method
- Reduce cell loss (dropping)
- Reduce buffer requirement
- Reduce admission overflow rate

1.3 Scope

A generic dynamic bandwidth allocation algorithm that is capable to support heterogeneous traffic in ATM network will be implemented. However, only the ABR traffic will be simulated. The proposed dynamic bandwidth allocation algorithm should be able to maintain the guaranteed QoS, re-allocate bandwidth to achieve high bandwidth utilisation, low buffer occupancy and low buffer overflow (packets dropped). The next arriving traffic is predicted by using the Neural Network. Based on the simple if-then rules stored in the Fuzzy Logic knowledge based system, the Fuzzy Logic will decide the amount of bandwidth is to be re-allocated.

1.4 Disposition

CHAPTER II reviews the literature and describes some important basic concepts about ATM, Neural Networks, Fuzzy Logic, admission control, ATM congestion control, dynamic bandwidth allocation schemes, bandwidth fairness, and buffer occupancies.

CHAPTER III discusses the algorithm used, traffic generating, and construction of Neural-Fuzzy.

CHAPTER IV concerns with implementation of the algorithm. The algorithm is simulated by using MATLAB. The results of the simulation are analysed and discussed.

CHAPTER V is the conclusions and problems raised during the implementation of the research and future study of this project.

1.5 Chapter Summary

ATM has grown out of the need for a worldwide standard to allow interoperability of information, regardless of the end-system or type of information. ATM – the multi-service networks have far more flexibility than the data-only network. Dynamic bandwidth allocation will improve bandwidth utilisation at the low network management cost. The next chapter concentrates on the background information of the project.