CHAPTER V

DISCUSSIONS AND CONCLUSIONS

This project investigates the performance of ATM network after implementing the dynamic bandwidth allocation algorithm. Three types of re-allocation methods and a conventional static allocation were studied. The comparison between these methods was conducted. The effect and impact on ABR service in the ATM network were analysed.

This chapter encompasses three parts of the research:

1. Summary of the research.
2. Conclusion of the research.
3. Suggestions for further enhancement.

5.1 Summary

This study examines the Neural-Fuzzy for the Dynamic Bandwidth Allocation. Table 5.1 summarises all the captured results. A method with high bandwidth utilisation, low buffer utilisation, and low rate of packets dropped is the best method for Dynamic Bandwidth Allocation. In this case, the Average Re-allocation met two of the requirements, so it is taken as the best method relative to the other methods. From the captured results:

- The Average Re-allocation gives the best result. Although it does not has the highest bandwidth utilisation, it has the lowest buffer utilisation and a zero packets dropped.
- The Static Allocation performs well with a high bandwidth capacity and a large amount of buffer. In contrast, its performance will drop (high buffer utilisation and high number of packets dropped) when the capacity of bandwidth and the amount of buffer are reducing.
- The Maximum Re-allocation shows a good performance on the bandwidth utilisation and the number of packets dropped, but this method shows a higher buffer utilisation.
- The Minimum Re-allocation shows the worst performance in the buffer utilisation and the packets dropped rate, but it shows the best result in the bandwidth utilisation. This method

caused long queues in the buffer, and the packets dropped rate is also unacceptable (>10%).

Table 5.1 Summaries of Results

	Static	Average	Maximum	Minimum
Bandwidth Utilisation	%	%	%	%
Connection 1	16.45	44.74	74.55	99.32
Connection 2	35.05	89.66	87.48	98.48
Connection 3	70.43	87.90	87.61	95.00
Buffer Utilisation				
Connection 1	0.00	0.05	26.29	82.83
Connection 2	8.05	3.50	45.26	78.73
Connection 3	30.27	0.04	40.72	78.16
Packets Dropped	%(number of packets)	%(number of packets)	%(number of packets)	%(number of packets)
Connection 1	0.00(0)	0.00(0)	1.17(31)	43.22(1146)
Connection 2	8.15(308)	0.00(0)	8.16(282)	50.72(1914)
Connection 3	33.38(1503)	0.00(0)	30.51(1374)	60.37(2718)

Applications nowadays like video conferencing are large-bandwidth consumers. Bandwidth is used to transfer simple text and graphic data as well as high quality audio and high-resolution video. Thus, bandwidth is an invaluable network resource. An unutilised bandwidth (allocated but unused) in the under-loading connection is a waste of the network resource. A low buffer utilisation means a low latency in the process of packets transfer. Low latency of the packets transfer is an important issue for the tightly time constrained application. Packets drop is undesirable. 10% or more of the packets dropped is unacceptable. A packets maybe considered as a lost packets by the receiver (or sender) if the transmission time is too long. In this case, the sender may retransmit the packets and is congested the network.

5.2 Conclusion

In this research, a proposed model of Neural-Fuzzy system for the dynamic bandwidth allocation is simulated using the MATLAB software. Dynamic Bandwidth Allocation can dramatically improve the bandwidth utilisation, and reduce the buffer utilisation and the number of packets dropped (presented in Table 5.1). Anyway, this depends on which re-allocation method is being implemented. Some of the re-allocation method may decrease the performance of ABR service class.

Artificial Intelligence (Neural-Fuzzy) plays a vital role in dynamic bandwidth allocation. A good and accurate predictor is not easy to be constructed and trained. An inaccurate predictor can affect the bandwidth utilisation. The inaccurate prediction will lead to an inaccuracy in re-allocation (long queues and high packets dropping rate). There is no guidance in choosing the learning rate for Neural Network. It will be difficult to get a suitable learning rate.

The tuning process for the Fuzzy Logic is complex and tedious. Mistuning of Fuzzy Logic may decrease the performance of the dynamic bandwidth allocation. Fuzzy Logic provides the capabilities of simultaneously achieving several objectives (bandwidth utilization) and avoiding the drawbacks (complex calculation). The proposed Fuzzy Logic takes three parameters in its decision-making procedure. The other parameter such as congestion level should be taken into the consideration too.

Three re-allocation methods have been presented and analysed in this study in order to perceive the dynamics in the ATM network. In this case, the best application is using the Average Re-allocation method. This method allocates the bandwidth with the next predicted average incoming traffic. Although some of the methods achieve approximately 100% of utilisation, but this is impossible in the real ATM network operation. If we compare the Static Allocation and Maximum Re-allocation, we can conclude that an inaccuracy of prediction leads to more packets being dropped. High packets drop rate will cause the packets retransmission and the congestion will happen. This is caused by the fact that some of the higher layer has a retransmit mechanism, but this situation is ignored in this simulation. Per-VP buffer is costly and it is not likely in the real ATM network.

For simplicity of the simulation, several issues are not considered in this research:

- Network topology
- Transmission delay
- Processing overhead at physical layer
- Complexity end-to-end bandwidth control
- Capabilities of multiplexer

5.3 Suggestions

Suggestions for further work are listed below:

- Implementing the dynamic bandwidth allocation on other service classes like Variable Bit Rate and Unspecified Bit Rate. It is extremely complex to control several types of service classes with a Fuzzy Logic.
- High bandwidth changing rate must be avoided (if the difference is too small). The Adaptive Algorithm in [59] can solve this problem.
- Fuzzy Logic should consider more parameter, e.g. congestion level.
- Capturing the real Available Bit Rate traffic for the Neural Network training and its simulation.
- Integrate the Dynamic Bandwidth Allocation with traffic management or Connection Admission Controller to avoid the network congestion problem.