CHAPTER 1

INTRODUCTION

This chapter provides a brief description and purpose of this study including the problems needing to be addressed, project objectives and motivations. The project scope is also discussed to define the coverage extent of this project as well as any project limitations that arise. Ending this chapter is a general organization of this thesis report with a short explanation of the chapters included.

1.1 Thesis Definition

Ever since the 1980s, networking has become an increasing necessity in everyday life to provide connectivity services. As the speed and processing power of computers continued to grow in time, more demands were made onto the links connecting them to exchange rising amounts of data. For many years, the local area network (LAN) was commonly built on wired shared or switched Ethernet connections with link speeds of 10Mbps and 100Mbps (Fast Ethernet) and this still remains the staple type of connection for most data networks. Fast Ethernet is now eclipsed by Gigabit Ethernet and 10-Gbps Ethernet that were introduced to provide the bandwidth required for catering to huge data loads and is now common in constructing network backbone links.

A little over a decade ago, wireless networks were introduced to replace physical cabling in constructing networks. Whilst the initial cost of wireless hardware was high compared to their wired counterparts, this has since changed and the constant introduction of faster and more affordable wireless networking products has resulted in the rapid adoption of wireless networking in both home and commercial/office networks. With wireless transmission now reaching speeds of 54Mbps, wireless networking has become a force to be reckoned with in the networking industry.

With the advantages of providing mobility whilst still having connectivity to the network, unfortunately wireless networks do suffer from more problems than a wired network. Many of the problems are caused by the fact that wireless networks use radio waves – a medium that has no physical boundaries. The need to improve the performance and reliability in wireless communication therefore becomes increasingly important and thus this thesis has the base motivation to improve the overall performance in wireless networks.

1.2 Motivation

Wireless networks have become increasingly popular in recent years due to falling costs plus the ease of installation. This has caused the number of wireless hotspots to rise so dramatically that the possibility of overlapping zones becomes greater. As shown in the tables on the following page, the yearly survey done by the Gartner Research Group shows that the sales of wireless networking hardware (Gartner 2003a) and the number of public access hotspots (Gartner 2003b) has been consistently increasing year by year indicating the increasing adoption of wireless networking.

Table 1.1 – Sales of mobile terminals to end users by region

Region	Quantity of sales (in thousands of units)			
	2001	2002	2003	2004
Africa	7903.8	10582.8	12661.6	14289.4
Asia-Pacific	135475.5	148902.1	165921.2	182764.3
Eastern Europe	26670.6	32450.2	32368.6	31669.1
Latin America	30386.7	28006.9	32166.8	34352.7
Middle East	7285.3	9203.5	11265.3	12153.5
North America	89331.4	98222.2	115193.1	123827.2
Western Europe	115269.2	97748	105497.5	102738.9
Totals	412322.5	425115.7	475074	501795.2

Table 1.2 – Available public WLAN hotspot locations worldwide

Location	Number of hotspots			
	2001	2002	2003	2004
Airports	85	152	292	378
Hotels	569	2274	11687	22021
Retail outlets	474	11109	50287	82149
Enterprise Guesting Areas	84	624	1762	3708
Stations and Ports	-	88	623	2143
Community Hot Spots	2	266	5637	20561
Others	-	240	790	1526
Total	1214	14752	71079	132486

Amid the increasing amount of wireless networks, improperly setup networks also increase in number even though simpler set up procedures are introduced. This is because the concept of an easy to set up network often lures inexperienced users to set up a wireless network without properly understanding the technology involved. Many wireless networks are being used right out-of-the-box without taking into account the impact of creating a new wireless networking zone. There might be a

wireless hotspot existing in the surrounding vicinity using the same settings and this will cause interference to both networks resulting in poor performance. It is hoped that the implementation of fuzzy logic into the wireless network architecture can help alleviate these rising problems and provide better experience for the users.

1.3 Thesis Objectives

This thesis undertakes a detailed study into the implementation of fuzzy logic control into the MAC layer of the 802.11x architecture in order to improve network performance. The objectives of this thesis can be summarized as follows

- To study and understand the available wireless LAN protocols, standards, architecture.
- Study and understand prior research and published papers about techniques for improving wireless network performance.
- Examine the various fuzzy logic techniques and implementations.
- Evaluate existing network simulators for use in this project.
- Propose an adaptation of the current WLAN architecture to implement fuzzy logic control with the goal of improving network performance.
- Create test environments for simulations to assess the impact of the implemented control.

1.4 Scope and Limitations

The scope of this thesis is defined to provide a guideline into the depth and range of the research performed. A general scope of this thesis can be summarized as follows

- The study of common wireless network protocols (HomeRF, IEEE802.11x, etc.) including their architecture, topology style and structure.
- The survey of problems that occur in wireless networks and their respective causes.
- To study and evaluate published methods of improving the performance in wireless networks.
- The study of the NS module structure and programming styles.
- The study of fuzzy logic controls and implementations in various situations.
- Propose and implement fuzzy logic control into the existing wireless architecture followed by an evaluation of the performance impact after the implementation.

This project also has a small number of limitations which unfortunately cannot be avoided either due to technical or time constraints. These include the following:

- Implementation of the IEEE 802.11b simulation model is only up to the point of the affected components used in this thesis.
- Although interference between wireless channels is included in the code, it remains untested against real world situations and performance. This will not affect the project's outcome and results as only one channel is used throughout the simulation.
- The implementation of fuzzy logic control is divided into the different classes (layers) in the NS simulator even though in actual fact, it is often best

incorporated into a single file only. This is done to reduce the number of function calls and variable passing to a minimum so as to increase simulation performance.

- Any limitations of the fuzzy logic method equally apply to this thesis.
- It is assumed that the other layers/modules in the simulator to be working properly and in accordance to any standards emulated. Any inaccuracies due to incorrect code in other portions of the simulator is not corrected. Correcting the code is avoided as would require a major effort since the code is split into several hundred files written and contributed by many individuals. It is therefore assumed that any errors or discrepancies will affect all simulations equally in the same way.

1.5 Thesis Organization

This thesis report covers a total of 7 chapters which is organized as follows

Chapter 1 - The introduction which gives a general overview about what this thesis is about and states the definition, objectives, scope and limitations.

Chapter 2 - Chapter 2 begins by providing a review dealing with the numerous current and emerging wireless protocols. This is followed by an explanation of the available wireless network topologies, layering structure, standards and practices. Common problems faced when running wireless networks are also discussed in this chapter.

Chapter 3 – Chapter 3 discusses the fuzzy set theory and fuzzy logic which will be later implemented into the simulator as the proposed fuzzy logic mechanism to improve the performance in wireless networks.

Chapter 4 – This chapter begins with an evaluation of a few existing network simulators available both commercially and for free for use in research purposes. The latter part of the chapter describes the chosen network simulator, NS, and the major components in the simulator that pertain to the work done in the following chapters.

Chapter 5 - Chapter 5 mostly details the work done in the thesis. This is divided into two parts with the first being the modifications to the existing source code in the network simulator to incorporate the IEEE 802.11b model. The second part describes the implementation of the fuzzy logic control into the implemented IEEE 802.11b model.

Chapter 6 - This chapter describes the simulations performed to test the implemented code together with the topologies, parameters and settings used. Simulations and analysis of the results are also presented in this chapter.

Chapter 7 - The final chapter summarizes the efforts of this thesis and suggests improvements that can be carried out in the future.