

**A STUDY OF SECURITY LIMITATIONS IN VIRTUAL LOCAL
AREA NETWORK IMPLEMENTATION**

By

ARUMUGAM BALASUNDARAM

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfillment of the Partial Requirements for the
Degree of Master of Science**

December 2003

DEDICATION

This thesis is dedicated to
my loving parents, brothers and wife

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the partial requirements for the degree of Master of Science

A STUDY OF SECURITY LIMITATION IN VIRTUAL LOCAL AREA NETWORK IMPLEMENTATION

By

ARUMUGAM BALASUNDARAM

December 2003

Chairman: Associate Professor Abdul Rahman Ramli, Ph.D.

Faculty: Engineering

Virtual Local Area Network (VLAN) in simple terms is defined as a group of Local Area Network (LAN) that has different physical connections, but communicates as if they are connected on a single network segment. VLAN was developed mainly for the need in network segmenting solution, since network traffic increases in proportional to the network size in the same time to offer additional network security.

This technology has now become possible by the advancement of various LAN Switches which offer the VLAN feature. Few researches has been carried out which explain the technology part of the system. This thesis provides a study on VLAN mainly covering the implementation of the system and the security weakness present in certain conditions of implementation.

For the VLAN system, an onsite study was conducted to explore the implementation of the system in real life environment followed by a practical test conducted to

examine the weaknesses part of the system. The results obtained from the test showed that under certain type of implementation, the security features of the VLAN system can be exploited. Solutions are proposed to further improve the security of the system in which certain part of the solution was gathered upon verifying the issue with the switch manufacturer.

Abstrak tesis yang dikemukakan kepada Senat Univeristi Putra Malaysia sebagai memenuhi sebahagian keperluan untuk ijazah Master Sains

**KAJIAN KESELAMATAN KEKANGAN DALAM
PENGIMPLIMENTASIAN RANGKAIAN KAWASAN SETEMPAT
MAYA**

Oleh

ARUMUGAM BALASUNDARAM

Disember 2003

Pengerusi: Profesor Madya Abdul Rahman Ramli, Ph.D.

Fakulti: Kejuruteraan

Rangkaian Kawasan Setempat Maya (“Virtual Local Area Network (VLAN)”) didefinisikan sebagai satu kumpulan rangkaian kawasan setempat (LAN) yang mempunyai sambungan fizikal yang berbeza, tetapi berkomunikasi seperti ia disambung pada rangkaian segmen tunggal. VLAN dibangunkan kerana ia amat diperlukan dalam penyelesaian pengasingan rangkaian. Ini adalah kerana trafik rangkaian meningkat sejajar dengan pertambahan saiz rangkaian dan pada yang sama untuk memperbaiki lagi keselamatan rangkaian.

Kini, teknologi ini menjadi nyata dengan adanya pelbagai suis rangkaian kawasan setempat (LAN) berteknologi tinggi yang mempunyai ciri-ciri VLAN. Beberapa kajian telah dijalankan yang menerangkan ciri-ciri teknologi sistem tersebut. Tesis ini merupakan kajian terhadap VLAN terutamanya bagi membincangkan perlaksanaan sistem dan kelemahan keselamatan pada masa sekarang.

Bagi sistem VLAN ini, kajian telah dijalankan untuk mengkaji pelaksanaan sistem ini dalam persekitaran yang sebenar diikuti dengan ujian praktikal yang dijalankan untuk menguji bahagian kelemahan dalam system ini. Daripada keputusan yang diperolehi dari ujian yang dijalankan, didapati ciri-ciri keselamatan sistem VLAN boleh dieksploitasikan. Beberapa penyelesaian didapati untuk memperbaiki lagi keselamatan sistem di mana beberapa bahagian penyelesaian telah digabungkan bagi mengesahkan isu ini dengan pembuat suis (switch manufacturer).

ACKNOWLEDGEMENTS

I would like to thank my advisor, Dr. Abdul Rahman Ramli, for his thoughtful, patient guidance and support throughout this work. His friendship and selfless role modeling have contributed to my professional development. I would extend my gratitude to members of my committee, Mr. Syed Abdul Rahman and Mdm Wan Azizun Adnan, for their helpful comments and suggestions.

I would like to thank Mr. R. Krishnamurthi from Philips Semiconductor (M) Sdn Bhd for allowing me to carry out the onsite study, Enterasys Network Systems Engineer Mr. Pranjat Indrajaya Inc for providing technical information for this research. Shell Refining Company (M) Bhd Mr. Ambikaipalan in allowing me to use the required equipment for this project and Cisco Support Engineer Mr. Talminder Bhangle for giving his feedback related to the thesis.

Thanks to my parents, wife and brothers for their moral support given to me to towards this studies, Most of all, I thank my brother Mr Pandian for his advice from the very beginning that helped to bring this research to completion.

Special thanks also go to all the colleagues and fellow friends, Jeevan Rao Subramaniam, Subbarao Sinnanaidu and R.Kalaiselvi, for their assistance through my research.

I certify that an Examination Committee met on 26th December 2003 to conduct the final examination of Arumugam Balasundaram on his Master of Science thesis entitled 'A Study of Security Limitation in Virtual Local Area Network (VLAN) Implementation', in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommended that the candidate be awarded the relevant degree. Member of the Examination Committee are as follows:

Borhanuddin Mohd. Ali, Ph.D.

Professor
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Abdul Rahman Ramli, Ph.D.

Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Member)

Syed Abd. Rahman Al-Hadad Syed Mohamed

Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Member)

Wan Azizun Adnan

Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Member)

GULAM RUSUL RAHMAT ALI, Ph.D.

Professor / Deputy Dean

School of Graduate Studies

Universiti Putra Malaysia

Date:

This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the partial requirements for the degree of Master of Science. The members of the Supervisory Committee are as follows:

Abdul Rahman Ramli, Ph.D.

Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Syed Abd. Rahman Al-Hadad Syed Mohamed

Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Member)

Wan Azizun Adnan

Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Member)

AINI IDERIS, Ph.D.
Professor/Dean
School of Graduate Studies
Universiti Putra Malaysia

Date :

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or currently submitted for any other degree at UPM or other institutions.

ARUMUGAM BALASUNDARAM

Date: 23rd April 2004

TABLE OF CONTENTS

	Page
DEDICATION	ii
ABSTRACT	iii
ABSTRAK	v
ACKNOWLEDGEMENT	vii
APPROVAL	viii
DECLARATION	x
LIST OF FIGURES	xiv
LIST OF ABBREVIATIONS	xvi

CHAPTER

1	INTRODUCTION	
1.1	Problem Statements	2
1.2	Research Objective	3
1.3	Organization of the Thesis	4
2	LITERATURE REVIEW	
2.1	Introduction	5
2.2	Overview of Virtual Local Area Network (VLAN)	5
2.3	VLAN Operation	10
2.4	Various Benefits Of VLAN	13
2.4.1	Increased Performance	13
2.4.2	Improved Manageability	13
2.4.3	Network Tuning And Simplification Of Software Configuration	14
2.4.4	Physical Topology Independence	14
2.4.5	Advantage for Mobile Users	14
2.4.6	Increase Security Options	15
2.5	Limitations Of VLAN	15
2.5.1	Broadcast Limitations	16
2.5.2	Device Limitations	16
2.5.3	Port Constraints	17
2.6	VLAN Technical Details	17

2.6.1	VLAN Tagging and Trunking	19
2.6.2	VLAN Trunking and Types Of Connection	19
2.7	Method of Frame Handling in VLAN System	21
2.8	Processing Incoming Frames (Ingress Rules)	22
2.8.1	Untagged Frame based on VLAN Membership	22
2.8.2	Untagged Frame based on Priority Assignment	23
2.8.3	Tagged Frame based on VLAN Membership	23
2.8.4	Tagged Frame based on Priority Assignment	23
2.9	Ingress Filtering	26
2.10	Forwarding Frames	26
2.10.1	VLAN Forwarding (Egress) List	26
2.10.2	Acceptable Frame Type	28
2.11	VLAN Security	29
2.12	VLAN Security Model	29
2.13	Security Issue Related To IP Address Authentication and Firewalls	32
2.14	Security Problem by Using Default VLAN ID	34
2.15	Conclusion	35

3 VLAN IMPLEMENTATIONS AND CASE STUDIES

3.1	Methods of Implementations	36
3.1.1	Port-Based VLAN	36
3.1.2	MAC Address-Based VLAN	37
3.1.3	Layer 3 (or protocol)-Based VLAN	38
3.2	Requirements To Set Up VLAN	39
3.3	Implementation Approach	40
3.3.1	Infrastructural VLAN	40
3.3.2	Serviced-Based VLAN	41
3.4	Implementation of VLAN	43
3.5	Details of Hub Room with VLAN Enabled Switch	44
3.5.1	Main Hub Room	45
3.5.2	Maintenance Area Hub Room	45
3.5.3	Production Hub Room	46
3.6	Problems Encountered during Implementation	48
3.7	Communication Process in Philip's Seremban VLAN Setup	48
3.8	Centralized Management of VLAN	49
3.9	SPECTRUM VLAN Manager	51
3.9.1	SPECTRUM VLAN Manager Features	51
3.9.2	VLAN Server	51
3.9.3	VLAN Manager Client	53
3.10	VLAN Maintenance	56
3.10.1	Troubleshooting VLAN	56
3.11	Conclusion	57

4	VLAN SECURITY AND TEST METHODOLOGY	
4.1	Introduction	59
4.2	Port Based Security Features Used in the Test	60
4.3	Cisco VLAN Specification	60
4.4	Cisco Layer 2 VLAN Model	61
4.5	Cisco Layer 3 VLAN Model	62
4.6	VLAN with ISL Protocol	63
4.7	Communications Between VLAN in Cisco Switch	64
4.8	Methodology	65
4.8.1	Equipment Used in Test and Technical Specification	65
4.8.2	Network Associates Sniffer Pro 1.2.0.01 Software	65
4.8.3	Preparation	65
4.9	Configuring Cisco Switches	68
4.9.1	Backup Process	68
4.9.2	General Configuration tasks on Both Switches	68
4.10	Configuring Switches	69
5	RESULTS AND DISCUSSION	
5.1	Results from Insertion into Same VLAN Port	75
5.2	Results from Frames Insertion into different VLAN	77
5.3	VLAN Hopping Test Using Same Switch	78
5.4	VLAN Hoping Test and Result by Changing Trunk Port	81
5.5	Summary of Results	82
5.6	Proposed Solutions to Overcome the VLAN Hopping Problem	83
6	CONCLUSION	
6.1	Summary	85
6.2	Contributions	87
6.3	Further and Relevant Work	88
	REFERENCE	89
	APPENDICES	92
	BIODATA OF THE AUTHOR	109