



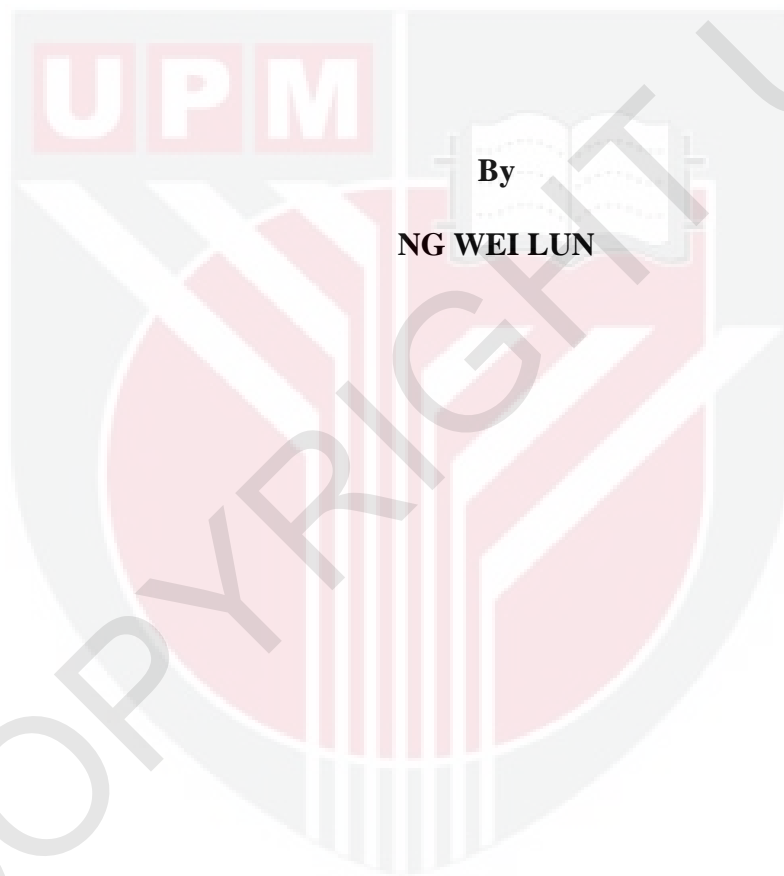
UNIVERSITI PUTRA MALAYSIA

***WIRELESS CONTROLLER AREA NETWORK USING TOKEN FRAME
SCHEME***

NG WEI LUN

FK 2012 26

**WIRELESS CONTROLLER AREA NETWORK USING TOKEN FRAME
SCHEME**



By
NG WEI LUN

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

July 2012

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the Degree of Master Science

WIRELESS CONTROLLER AREA NETWORK USING TOKEN FRAME SCHEME

By
NG WEI LUN

July 2012

Chairman: Professor Borhanuddin b. Mohd. Ali, PhD

Faculty: Engineering

Traditional network employ address-centric approach in transmitting messages in a network. The approach is done by assigning each network interface that is connected to the network with an IP (internet protocol) address; given either by manual configuration or a dynamic mechanism such as DHCP (dynamic host configuration protocol). On the other hand, data-centric approach protocol such as sensor and control network that allows all routing nodes to look into the data content and perform aggregation on multiple input packets. Researches have proved that the data-centric approach has the advantage over address centric approach in a large scale network.

In this thesis, a new wireless MAC protocol referred to as wireless controller area network (WCAN) is introduced. WCAN is an adaptation of its wired cousin, controller area network (CAN) protocol which follows the data-centric approach. However, yet, WCAN has not been properly defined and several researches have been proposed. Unfortunately, these approaches do not consider the network

scalability issue of WCAN. Hence, a new WCAN protocol that utilizes token frame method has been proposed in this thesis.

The proposed WCAN uses token frame method in providing channel access to nodes in the system. The token frame method follows the example used in wireless token ring protocol (WTRP) by Ergen et al; a MAC protocol for wireless networks that has efficiency in reducing the number of retransmission due to collisions. This method allows nodes to share a common broadcast channel by taking turns in transmitting upon receiving the token frame that are circulating around the network for a specified amount of time. The token frame allows nodes to access the network one at a time, giving 'fair' chance to all nodes instead of competing against one another. Moreover, the token frame method provides high throughput in a bounded latency environment.

The proposed method was built using QualNet platform to validate its algorithm. From the obtained results, it is shown that WCAN outperforms IEEE 802.11 by 62.5% in terms of throughput with increasing network size. Additionally, at a higher data interval rate, WCAN shows an improvement of 6% compared to IEEE 802.11.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
bagi memenuhi keperluan untuk ijazah Master Sains

WIRELESS CONTROLLER AREA NETWORK MENGGUNAKAN SKEMA TOKEN FRAME

Oleh

NG WEI LUN

Julai 2012

Pengerusi: Profesor Borhanuddin b. Mohd. Ali, PhD

Fakulti: Kejuruteraan

Rangkaian tradisi menggunakan pendekatan-alamat dalam memindahkan mesej dalam satu rangkaian. Pendekatan ini dilakukan dengan memberikan setiap nod yang disambungkan kepada rangkaian dengan alamat IP (protokol internet); diberikan sama ada oleh konfigurasi manual atau mekanisme dinamik seperti DHCP (protokol tatarajah hos dinamik). Sebaliknya, pendekatan-data dalam memindahkan mesej seperti sensor dan rangkaian kawalan membolehkan semua nod untuk melihat kandungan data dan melaksanakan pengagregatan pada paket tersebut. Kajian telah membuktikan bahawa pendekatan yang berteraskan data mempunyai kelebihan berbanding pendekatan berpusatkan alamat dalam rangkaian yang besar.

Dalam tesis ini, MAC protokol yang baru dipanggil sebagai Wireless Controller Area Network (WCAN) diperkenalkan. WCAN merupakan adaptasi sepupu wayarnya, Controller Area Network (CAN) protokol yang menggunakan pendekatan-data. Walau bagaimanapun, WCAN belum ditakrifkan sebagai protokol yang sah dan beberapa kajian telah dicadangkan bagi memenuhinya. Malangnya, pendekatan yang dicadangkan tidak menyelesaikan isu rangkaian skalabilitas WCAN. Oleh itu,

protokol WCAN yang baru yang menggunakan kaedah token frame dicadangkan dalam tesis ini.

WCAN yang dicadangkan menggunakan kaedah token frame dalam menyediakan akses saluran kepada nod dalam sistem. Kaedah token frame menggunakan contoh dalam Wireless Token Ring Protocol (WTRP) oleh Ergen et al; protokol MAC untuk rangkaian tanpa wayar yang mempunyai kecekapan dalam mengurangkan bilangan penghantaran semula oleh insiden pelanggaran. Kaedah ini membolehkan nod untuk berkongsi saluran dengan mengambil token frame yang mengelilingi rangkaian bagi amaun masa yang ditetapkan. Token frame membolehkan satu nod untuk mengakses rangkaian pada satu-satu masa, memberi peluang 'adil' kepada semua nod dan bukannya bersaing dengan satu sama lain. Di samping itu, kaedah kerangka tanda menyediakan throughput yang tinggi dalam persekitaran kependaman terbatas.

Kaedah yang dicadangkan dibina menggunakan platform QualNet untuk mengesahkan algoritmanya. Daripada keputusan yang diperolehi, ia menunjukkan bahawa WCAN melebihi keupayaan IEEE 802.11 sebanyak 62.5% dari segi throughput dalam saiz rangkaian yang meningkat; manakala pada kadar selang data yang lebih tinggi, WCAN menunjukkan peningkatan sebanyak 6% berbanding dengan IEEE 802.11.

ACKNOWLEDGEMENTS

This thesis would have never come to fruition if not, without the help of various people. First and foremost, I would like to thank my supervisor, Professor b. Mohd. Ali, for guiding me always in the time of need. He has provided me with guidance and experience in helping me on my completion of this thesis. A special thank you also given to Associate Professor Dr. Nor Kamariah binti Noordin for her time in analyzing and proof-reading this thesis. Besides that, I am also grateful to my project co-supervisor Dr. Fakhru Zaman for his invaluable encouragement in the development of this project.

Additionally, I would like to thank my colleagues of wireless lab; especially Ee Gee Keng and Lee Siao Ping for the wonderful discussion session we had every day. Your support and insight provides me the essential knowledge needed in finishing this project. Not forgetting my wonderful friend and post doctorate, Dr. Michael Ng Chee Kyun. The jokes and motivation you provide brighten up my days in UPM.

Also, a special thank you to my family members for supporting me always in my time of need. Last but not least, to my love, for believing me always. Thank you.

I certify that a Thesis Examination Committee has met on _____ to conduct the final examination of Ng Wei Lun on his thesis entitled “Wireless Controller Area Network using Token Frame Scheme” in accordance with Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Degree of Master Science.

Members of the Examination Committee are as follows:

Faculty of Engineering,
Universiti Putra Malaysia
(Chairman)

Faculty of Engineering,
Universiti Putra Malaysia
(Internal Examiner)

Faculty of Engineering,
Universiti Putra Malaysia
(Internal Examiner)

Seow Heng Fong, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

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

Borhanuddin b. Mohd. Ali, PhD

Professor
Faculty of Engineering,
Universiti Putra Malaysia
(Chairman)

Assoc. Prof. Dr. Nor Kamariah bt Noordin, PhD

Associate Professor
Faculty of Engineering,
Universiti Putra Malaysia
(Member)

Dr. Fakhru Zaman Bin Rokhani, PhD

Senior Lecturer
Faculty of Engineering,
Universiti Putra Malaysia
(Member)

BUJANG BIN KIM HUAT, PHD

Professor and Dean
School of Graduate Studies,
Universiti Putra Malaysia

Date:

DECLARATION

I 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, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or other institutions.

NG WEI LUN

Date: 16 July 2012



TABLE OF CONTENTS

	Page
ABSTRACT	ii
ABSTRAK	iv
ACKNOWLEDGEMENTS	vi
APPROVAL	vii
DECLARATION	ix
LIST OF TABLES	xiii
LIST OF FIGURES	xiv
LIST OF ABBREVIATIONS	xvii
CHAPTER	
1 INTRODUCTION	
1.1 Background	1
1.2 Problem Statement and Motivation	3
1.2.1 Network Scalability Limitation	3
1.2.2 Throughput Limitation	4
1.3 Aim and Objectives	5
1.4 Study Module	6
1.5 Thesis Organization	7
2 LITERATURE REVIEW	
2.1 Background	8
2.2 Introduction to Network	9
2.2.1 Local Area Network	9
2.2.1.1 Basic LAN protocol	9
2.2.2 Wireless LAN	11
2.2.2.1 IEEE 802.11 MAC protocol	11
2.2.2.2 Distributed Coordination Function	12
2.2.2.3 RTS / CTS Frame	13
2.3 Controller Area Network	14
2.3.1 Message Based Protocol	15
2.3.2 Arbitration Mechanism	15
2.3.3 Standard and Extended CAN	17
2.4 Wireless CAN	18
2.4.1 Hybrid Wired / Wireless Networking	19
2.4.2 WCAN using RTS / CTS scheme	21
2.4.3 WCAN with RFMAC and WMAC access method	22
2.5 Token Ring Network	24
2.5.1 Token Frame	24
2.5.2 Channel Access Method	26
2.6 Wireless Token Ring Protocol	27
2.6.1 WTRP System Architecture	27
2.6.2 WTRP Token Frame Format	28

2.6.3	Successor, Predecessor and Ring Owner	29
2.6.4	WTRP Protocol Description	30
2.7	Conclusion	31
3	METHODOLOGY	
3.1	Background	33
3.1.1	Design and Performance Parameter	36
3.1.1.1	Throughput	36
3.1.1.2	End-to-End Delay	37
3.1.1.3	Packet Delivery Ratio	37
3.1.2	QualNet Simulator	38
3.2	Proposed WCAN System Architecture	39
3.3	Token Frame	41
3.3.1	Token Frame Format	41
3.4	State Diagram and Normal Operation	43
3.4.1	Normal Operation	45
3.5	Channel Access Procedure	46
3.5.1	Timing Diagram	49
3.6	WCAN Implementation	51
3.6.1	WCAN Token Frame	52
3.6.2	Data Flow	55
3.6.3	Token Dispatcher Event	56
3.6.4	Data Structure	57
3.7	Conclusion	57
4	RESULTS AND DISCUSSION	
4.1	Overview	59
4.2	Simulation Setup	59
4.2.1	Research Assumption	60
4.2.2	Simulation Area Setup	61
4.3	Simulation Scenario	62
4.3.1	Performance in High Density Network	62
4.3.1.1	Throughput	63
4.3.1.2	Average End-to-End Delay	65
4.3.1.3	Packet Delivery Ratio	66
4.3.2	Performance in Comparison of Packet Size	67
4.3.2.1	Throughput	68
4.3.2.2	Average End-to-End Delay	71
4.3.2.3	Packet Delivery Ratio	73
4.3.3	Performance in Comparison of Data Interval Rate	76
4.3.3.1	Throughput	76
4.3.3.2	Average End-to-End Delay	77
4.3.3.3	Packet Delivery Ratio	78
4.4	Conclusion	79
5	CONCLUSIONS	
5.1	Conclusion	81
5.2	Thesis Contribution	82
5.3	Future Works	82

REFERENCES	84
BIODATA OF STUDENT	86
LIST OF PUBLICATIONS	87



© COPYRIGHT UPM