UNIVERSITI PUTRA MALAYSIA

ENHANCED MEDIUM ACCESS CONTROL PROTOCOL FOR RESOLVING NODE MISBEHAVIOR IN WIRELESS NETWORKS-1

NOORSALWATI BINTI NORDIN

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By

NOORSALWATI BINTI NORDIN

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

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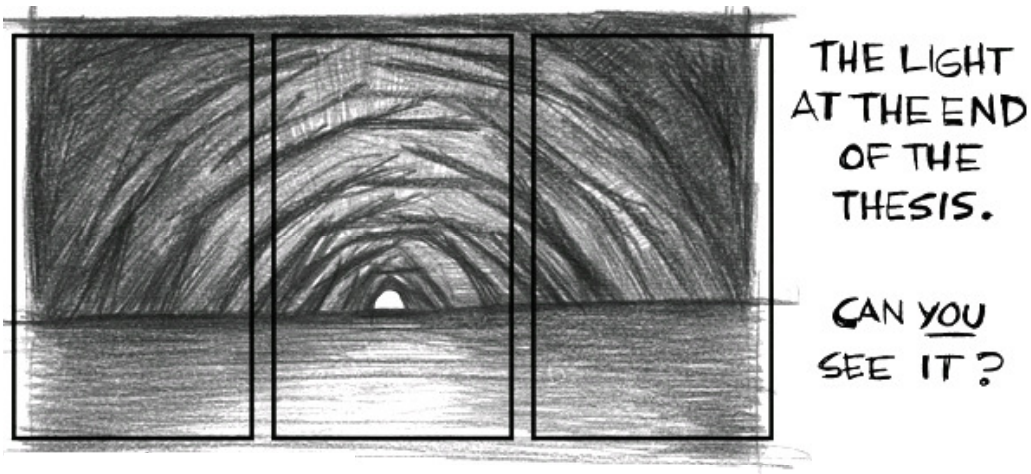

"Piled Higher and Deeper" by Jorge Cham (www.phdcomics.com)

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

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June 2007

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In this research, two schemes that enhance the existing misbehavior handling strategy are proposed. The first scheme correlates misbehavior with the traffic characteristics generated by the node deviating from the stipulated protocol. It eliminates the stereotyping of deviation by deriving a multi-scale deviation definition ranging from misbehavior to the underestimation of resource allocation. The scale adaptively enables varying types of misbehavior according to resource requirement. From the performance analysis, it was determined that the scheme is successful in differentiating between misbehavior due to selfishness and under-allocation of resource. In addition, the scheme also enables nodes that are allocated with inadequate resource to achieve higher share of throughput as per its requirement.

The second proposed scheme further extends the existing misbehavior handling strategy by detecting excessive allocation of resources. This scheme effectively diminishes the wastage of resources by re-distributing them among the rest of the nodes. The allocation of the resources is carried out on a First-Come-First-Serve basis in order maintain fair characteristics of the 802.11 access mechanism. From the analysis, it was found that when this scheme is employed, the presence of nodes that are over-allocated with resources enables the rest of the nodes to increase their throughput share.

The performance analysis of the proposed schemes was conducted with the use of a discrete-event simulator. The simulator was specifically developed for wireless networks incorporating the proposed schemes. It simulates a wireless network comprising non-deviating nodes and nodes that deviate from the MAC protocol due to selfishness, under-allocation and over-allocation of resources. The metrics employed to measure the performance of the proposed algorithms are average throughput, fairness index, channel utilization and throughput ratio.

From the analysis of the metrics, it is concluded that with the employment of the proposed scheme, if a node deviates from the protocol and it is allocated with inadequate resources, the scheme will adaptively allow the node to gain the resource as per the degree of its resource under-allocation. On the other hand, if it deviates due to over-allocation, the excess resources will be

distributed to other nodes, hence, enabling for the increase of overall network throughput.

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

PEMBAIKAN PROTOKOL KAWALAN CAPAIAN MEDIA UNTUK PENGENDALIAN NOD YANG BERKELAKUAN BURUK DALAM RANGKAIAN WAYARLES

Oleh

NOORSALWATI NORDIN

Jun 2007

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Di dalam kajian ini, dua skema yang memperbaiki strategi pengendalian kelakuan buruk pada masakini dicadangkan. Skema yang pertama mengaitkan kelakuan buruk nod-nod yang menyimpang dari protokol yang ditetapkan dengan jenis trafik yang ia hasilkan. Ia tidak lagi menyamakan penyimpangan dari protokol sebagai kelakuan buruk, dengan menggunakan skala penyimpangan yang merangkumi kelakuan buruk hingga ke tahap peruntukan sumber yang tidak mencukupi. Skala ini dapat membezakan jenis kelakuan buruk berdasarkan keperluan sumber. Berdasarkan analisa prestasi protokol tersebut, skema ini didapati berjaya membezakan antara kelakuan buruk berdasarkan penting diri dari kelakuan yang disebabkan oleh kurang peruntukan sumber. Di samping itu juga, skema ini membolehkan nod-nod yang dibekalkan dengan sumber yang tidak mencukupi untuk mencapai truput yang lebih tinggi mengikut keperluannya.

Skema kedua yang dicadangkan meluaskan strategi menangani kelakuan buruk yang sedia ada dengan mengesan peruntukan sumber yang berlebihan. Skema ini berjaya mengurangkan pembaziran sumber dengan mengagihkan sumber tersebut kepada nod-nod yang lain. Pengagihan semula sumber ini dijalankan menurut kaedah Tiba Dahulu Layan Dahulu supaya dapat mengekalkan sifat adil mekanisme capaian 802.11. Berdasarkan analisa, apabila skema ini digunakan, kehadiran nod-nod yang dibekalkan dengan sumber yang berlebihan membolehkan nod-nod yang lain meningkatkan truput mereka.

Analisa prestasi kedua-dua skema yang dicadangkan telah dijalankan dengan menggunakan pensimulasi peristiwa diskret. Pensimulasi ini dibangunkan khas untuk rangkaian wayarles dengan menggabungkan skema-skema yang dicadangkan. Ia mensimulasikan rangkaian wayarles yang terdiri daripada nod-nod yang patuh dan nod-nod yang menyimpang dari skema disebabkan oleh penting diri, kurang peruntukan sumber dan peruntukan sumber yang berlebihan. Metrik-metrik yang digunakan untuk mengukur prestasi algoritma-algoritma yang dicadangkan adalah truput purata, indeks kesaksamaan, penggunaan saluran dan nisbah truput.

Dari analisa metrik-metrik tersebut, rumusan yang dapat dibuat adalah, sekiranya sesebuah nod menyimpang dari protokol itu diperuntukkan dengan sumber yang tidak mencukupi, skema-skema yang dicadangkan ini akan

memudahsuaikan nod tersebut untuk memperoleh sumber yang banyak mengikut keperluannya. Di samping itu juga, sekiranya sesebuah nod menyimpang disebabkan oleh peruntukkan yang berlebihan, sumber yang berlebihan itu akan diagihkan kepada nod-nod yang lain, dan seterusnya meningkatkan truput rangkaian tersebut secara keseluruhannya.

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I certify that an Examination Committee has met on the 11th of June 2007 to conduct the final examination of Noorsalwati Binti Nordin on her Master of Science thesis entitled "Enhanced Medium Access Control Protocol for Resolving Node Misbehavior in Wireless Networks" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the student be awarded the relevant degree.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science.

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Date: 15 November 2007

DECLARATION

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

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NOORSALWATI BINTI NORDIN

Date:

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LIST OF ABBREVIATIONS

ABA	Adaptive Bandwidth Allocation
ACK	Acknowledgment
AODV	Ad Hoc On Demand Distance Vector
AP	Access Points
BEB	Binary Backoff Exponential
BD	Backoff Deviation index
BI	Bandwidth Increase index
BS	Base Station
BSS	Basic Service Set
CBA	Cooperative Bandwidth Allocation
CBR	Constant-Bit-Rate
CCS	Credit Clearance Service
CONFIDANT	Cooperation Of Nodes: Fairness In Dynamic Ad-hoc NeTworks
CORE	COllaborative REputation
CPU	Central Processing Unit
CSMA	Carrier Sense Multiple Access
CSMA/CA	Carrier Sense Multiple Access with Collision Avoidance
CTS	Clear To Send
CW	Contention Window
DCF	Distributed Coordination Function
DES	Discrete Event Simulator

DI	Deviation Index
DIFS	DCF Interframe Space
DIFS	Distributed Inter Frame Space
DOMINO	Detection Of Greedy Behavior In MAC Layer Of IEEE 802.11 Public Network
DoS	Denial of Service
DSR	Dynamic Source Routing
DSSS	Direct Sequence Spread Spectrum
ERA-802.11	Ensuring Randomness for 802.11
ESS	Extended Service Set
FCFS	First-Come-First-Serve
FHSS	Frequency Hopping Spread Spectrum
GPL	General Purpose Language
GPRS	General Packet Radio Service
IDM	Intrusion Detection Model
IDS	Intrusion Detection System
IEEE	Institute of Electrical and Electronics Engineers
IFS	Interframe Space
IRM	Intrusion Response Model
ISM	Industrial, Scientific, And Medical
KV	Kyasanur and Vaidya
LAN	Local Area Network
LARS	Locally-Aware Reputation System

LIDS	Local Intrusion Detection System
LIDS	Local Intrusion Detection System
MAC	Medium Access Control
MANET	Mobile Ad Hoc Network
MIB	Management Information Base
MIT	Massachusetts Institute of Technology
ns-2	Network Simulator-2
OCEAN	Observation-based Cooperation Enforcement in Ad hoc Networks
Opnet	OPtimized Network Enginerring Tool
OSI	Open Systems Interconnection
Otcl	Object Tcl
PC	Point Coordinator
PD	Percentage of Deviation
PIFS	Point Coordination Interframe Space
PM	Percentage of Misbehavior
PPM	Packet Purse Model
PTM	Packet Trade Model
QoS	Quality of Service
RTS	Request To Send
SCFQ	Self-Clocked Fair Queuing
SIFS	Short Interframe Space
SNMP	Simple Network Management Protocol

SPRITE	Simple, Cheat-Proof, Credit-Based System
SSD	Stationary Secure Database
SSFNet	Scalable Simulation Framework simulator
STA	Station
TCP	Transport Control Protocol
Tcl	Tool Command Language
TIARA	Techniques for Intrusion-Resistant Ad Hoc Routing Algorithms
UDP	User Datagram Protocol
VBR	Variable-Bit-Rat
VCG	Vickrey, Clarke and Grove
WSN	Wireless Sensor Networks

CHAPTER 1

INTRODUCTION

The adoption of wireless Local Area Network (LAN) is growing rapidly. According to the research done by In-Stat, the wireless LAN chipset market is on a phenomenal growth pace that is projected to soar from just over 140 million annual chipset unit shipments in 2005 to 430 million in 2009 [1].

Wireless LAN is a group of computers and devices that share a common communication link via radio frequencies. Wireless LANs mostly operate under the specifications established by the Institute of Electrical and Electronics Engineers (IEEE), which is known as the 802.11 standard. In the next section, background information on the 802.11 standard is provided in more detail, as it is the domain area of this research.

1.1 Background

The 802.11 standard defines the physical and Medium Access Control (MAC) layers of wireless LAN for two topologies, which are the infrastructure-based (Figure 1.1) and ad hoc (Figure 1.2) networks [2]. Both topologies comprise at least one Basic Service Set (BSS). The minimum BSS is made up of two nodes that can communicate with each other.