UNIVERSITI PUTRA MALAYSIA

AN ADAPTIVE RATE ALLOCATION SYSTEM TO MITIGATE FAIRNESS ISSUES IN Wi-Fi MESH NETWORKS

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By

SEYED DAWOOD SAJJADI TORSHIZI

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

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DEDICATIONS

This thesis is dedicated to:

My dearest wife, Maryam, for her whole-hearted and substantial support

And

My caring and devoted parents for their unconditional love and support

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

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October 2013

Chair: Fazirulhisyam Hashim, Ph.D.

Faculty: Engineering

Wireless Mesh Network (WMN) is a high potential networking technology that is equipped with self-healing and self-organized capabilities. In addition to being widely used in the traditional applications of ad-hoc networks, WMNs are undergoing rapid commercialization in many other scenarios such as broadband home and community networking, high-speed metropolitan area networks, and enterprise networking. To this date, a rich surge of researches involving deployments with thorough solutions have been conducted on WMNs. However, fair distribution of network resources, especially the available bandwidth among mesh stations is still one of the open issues for research. In WMNs, stations which are more hops away from the gateway generally suffer from higher throughput degradation and hence higher delay. Moreover, current fairness issues among simultaneous uplink and downlink flows of WLANs aggravate starvation dilemma in access layer of WMNs. These incidents are mainly due to the unpredictable nature of IEEE 802.11 protocol and its operation in contention mode. In this dissertation, a thorough solution based on a messaging framework and adaptive rate allocation mechanism is proposed to alleviate current fairness issues of WMNs. The proposed framework consists of two main components. The first one is a lightweight messaging system and the second one is an adaptive fair rate allocation algorithm. It is important to note that the presented solution is independent from MAC and underlying layers. Thus, this property distinguishes it from many other related works on addressing fairness problems in WMNs. Furthermore, the ability of traffic control over UDP and TCP streams, supporting multi-radio mesh routers and restriction of internal greedy traffic within WMNs can be regarded as the main advantages of the offered

solution in comparison to the earlier works. The consistency of presented results from the algorithm simulation and real-life test-bed experiments substantiates the efficiency of proposed architecture in terms of achieving higher end-to-end throughput and fairness improvement more than 94% in some of the conducted scenarios. Furthermore, in the existence of any malicious activity such as UDP food or DoS (Denial of Service) attacks by mesh stations, it is feasible to block abusive users through definition of appropriate policies by the offered system. This capability enhances the stability of any communication platform which is working based on the presented solution to control and addressing users' demands.

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

PENYESUAIAN KADAR SISTEM PERUNTUKAN UNTUK MENGURANGKAN ISU ADIL DALAM Wi-Fi MESH NETWORKS

Oleh

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Rangkaian JejaringWayarles (WMN) adalah rangkaian teknologi berpotensi tinggi yang dilengkapi dengan keupayaan pemulihan dan keupayaan mengatur sendiri. Selain digunakan secara meluas dalam aplikasi tradisional seperti rangkaian adhoc, WMNs juga dikomersilkan dengan pesat dalam pelbagai senario yang lain seperti rangkaian jalur lebar, rangkaian komuniti, rangkaian kelajuan tinggi di kawasan metropolitan, dan rangkaian untuk kegunaan perusahaan. Sehingga masa kini, banyak kajian yang melibatkan pelaksanaan dan penyelesaian yang menyeluruh telah dijalankan ke atas WMN. Walaubagaimanapun, pengagihan yang adil terhadap sumber rangkaian, terutamanya jalur lebar yang sedia ada di kalangan stesen jaringan masih menjadi salah satu isu terbuka untuk penyelidikan. Dalam WMN, stesen yang lebih jauh daripada laluan get biasanya akan mengalami kemerosotan truput yang lebih tinggi dan juga kelewatan yang lebih tinggi. Selain itu, isu-isu kesamarataan di kalangan aliran pautan naik dan pautan turun yang berlaku secara serentak dalam WLAN memburukkan lagi dilema kebuluran di lapisan akses WMNs. Kejadian ini adalah disebabkan oleh sifat protocol IEEE 802.11 yang tidak menentu dan cara kendaliannya masih lagi dalam perdebatan. Dalam kajian ini, beberapa penyelesaian berdasarkan rangka kerja mesej dan mekanisma penyesuaian peruntukan kadar telah dicadangkan untuk mengurangkan isu kesamarataan semasa WMNs. Rangka kerja yang dicadangkan terdiri daripada dua komponen utama. Komponen pertama adalah sistem pesanan ringan dan yang kedua ialah algoritma penyesuaian kadar kesamarataan. Adalah penting untuk diberi perhatian bahawa penyelesaian yang diutarakan adalah bebas daripada lapisan MAC dan lapisan dasar. Justeru, kaedah ini berbeza daripada kaedah

lain yang digunakan untuk menangani masalah kesamarataan dalam WMNs. Selain itu, keupayaan kawalan trafik ke atas UDP dan aliran TCP, sokongan multi radio dan sekatan trafik terhadap sifat tamak dalaman WMNs boleh dianggap sebagai kelebihan utama penyelesaian yang ditawarkan berbanding dengan kajian yang terdahulu. Hasil yang konsisten daripada simulasi algoritma dan eksperimen-ujian sebenar mengesahkan kecekapan seni bina yang dicadangkan dalam rangka mencapai pemprosesan akhir-ke-akhir yang lebih tinggi dan peningkatan kesamarataan lebih daripada 94% dalam beberapa senario yang telah dijalankan. Tambahan pula, kewujudan apa-apa aktiviti berbahaya seperti UDP makanan atau DoS (Penafian Perkhidmatan) serangan oleh stesen jaringan, boleh disekat dengan menyekat pengguna kesat melalui definisi polisi yang sewajarnya oleh sistem yang ditawarkan. Keupayaan ini meningkatkan kestabilan platform mana-mana komunikasi yang bekerja berdasarkan penyelesaian yang dikemukakan untuk mengawal dan memenuhi permintaan pengguna.

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I certify that a Thesis Examination Committee has met on 4 October 2013 to conduct the final examination of Seyed Dawood Sajjadi Torshizi on his thesis entitled "AN ADAPTIVE RATE ALLOCATION SYSTEM TO MITIGATE FAIRNESS ISSUES IN Wi-Fi MESH NETWORKS" in accordance with the 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 Master of Science.

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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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DECLARATION

I declare that the thesis is 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 at any other institution.

SEYED DAWOOD SAJJADI TORSHIZI

Date: 4 October 2013

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