UNIVERSITI PUTRA MALAYSIA

ENHANCED ALGORITHM FOR ENERGY-SAVING MECHANISM AND FRAME RESPONSE TIME REDUCTION IN IEEE 802.16E WIMAX

ALAA M. BAKER

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By

ALAA M. BAKER

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

December 2010

Dedicated to

My dearest Parents (Mahmood Mohammed and Zina), who are simply the best parents of all time

My Brother (Ziad M. Baker)

For their extraordinary love, their endless care and encouragement

Thank you

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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Chair: Associate Professor Nor Kamariah Noordin, PhD

Faculty: Engineering

Mobile Units have many constraints for reliable communication in today's mobile environments. Unlike wired networks, mobility induces moving around with no power source connected. Hence, an efficient utilization of battery power is important for wireless users. Traffic plays a major role for energy consumption because of the unpredictable incoming flow nature.

Many studies have been conducted as an effort to conserve energy and schedule wireless nodes to sleep periodically. The Institute of Electrical and Electronic Engineers (IEEE) standard 802.16, more popularly known as Worldwide Interoperability for Micro Wave Access or WiMAX had finalized the standard IEEE 802.16e for mobile devices. The standard defines a sleep mode operation for conserving power to support the battery life for the mobile broadband wireless access devices. The system saves energy when it goes through a sleeping period. However it

faces some delay in the packet arrival response time. The relationship between the energy consumption and the delay is studied to ensure best performance for mobile devices. This relationship has been analyzed by using a mathematical model and a real time scalable model. A new scheduling method is proposed to adjust the sleeping cycle periods by adding a small increase to the next sleeping cycle comparing with the previous cycle. The simulated results had been obtained after adjusting the length of the first sleeping cycle period (T_{min}) and adjusting the length of the last sleeping cycle period (T_{max}). Adjusting T_{min} results in reducing 54% time needed for every frame to get response especially at lower traffic region. At high traffic region, the reduction of 21.5% is obtained in energy consumption for each sleep mode operation. Adjusting T_{max} results in reducing 53% of frame response time. Further simulation conducted, showed that the proposed algorithm performs better than the traditional algorithm in reducing the end-to-end delay, and maintains a small reduction in the energy consumption and increases the throughput at the subscriber station. Therefore, the proposed idea confirms a faster frame response time along with lower energy consumption.

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

KAEDAH BERKESAN (ALGORITHM) YANG TELAH DIUBAHSUAI BAGI MEKANISMA PENJIMATAN TENAGA DAN PENGURANGAN RANGKA MASA RESPONS DALAM IEEE 802.16e WIMAX

Oleh

ALAA M. BAKER

Disember 2010

Pengerusi: Profesor Madya Nor Kamariah Noordin, PhD

Fakulti: Kejuruteraan

Dalam dunia komunikasi, terdapat banyak sekatan yang didapati pada sistem komunikasi teknologi bergerak masakini.

Berbeza dengan jaringan yang berwayar, sistem teknologi bergerak memudahkan capaian tanpa menggunakan tenaga. Oleh itu, adalah penting bagi pengguna sistem komunikasi bergerak tanpa wayar menggunakan kuasa bateri yang lebih berkesan.

Trafik memainkan peranan utama bagi penggunaan tenaga kerana aliran masuk pengguna yang tidak dijangka.

Banyak kajian telah dikendalikan dalam usaha menjimatkan tenaga dan menjadualkan node tanpa wayar supaya berehat secara berperingkat. Institut Jurutera

Elektrik dan Elektronik (IEEE) 802.16, lebih dikenali dengan Worldwide Interoperability for Micro Wave Access atau WiMAX telah menyiapkan standard IEEE802.16e bagi sistem komunikasi teknologi bergerak.

Di bawah standard ini, kuasa dapat dijimatkan melalui operasi mode rehat (sleep mode operation) untuk mengukuhkan tempoh tamat bateri bagi alat akses jalur lebar bergerak.

Sistem ini menjimatkan tenaga semasa ia melalui proses rehat. Bagaimanapun, ia menghadapi sedikit kelewatan dari segi masa respons di peringkat permulaan. (arrival response time). Kajian mengenai hubungan di antara penggunaan tenaga dengan kelewatan itu dibuat untuk mempastikan prestasi yang terbaik bagi alat komunikasi bergerak.

Hubungan ini telahpun dianalisakan dengan menggunakan satu model mathematik dan model tepat masa yang boleh diukur.Satu kaedah penjadualan dicadang bagi menyesuaikan tempoh kitaran rehat dengan menambah sedikit kenaikan kepada kitaran rehat yang baru dengan yang sebelumnya. Hasil simulasi telah diperolehi selepas menyesuaikan tempoh kitaran rehat pertama (T_{min}) dengan tempoh kitaran rehat terakhir (T_{max}).

Dengan menyesuaikan T_{min} rangka masa respons (frame response time) dapat dikurangkan sebanyak 54% terutama di kawasan trafik yang lebih rendah. Di kawasan trafik tinggi, pengurangan tenaga dikurangkan 21.5 peratus bagi setiap

operasi mode rehat. Dengan menyesuaikan T_{max} rangka masa respons dapat dikurangkan sebanyak 53 peratus.

Simulasi seterusnya menunjukkan kaedah (algorithm) yang dicadangkan ini menghasilkan prestasi yang lebih baik berbanding kaedah tradisional dalam mengurangkan kelambatan setiap hari, dan mengekalkan sedikit penurunan pada penggunaan tenaga serta meningkatkan pengeluaran di stesen pengguna.

Oleh itu, idea yang dicadangkan mengesahkan rangka masa respons lebih pantas dan penggunaan tenaga yang lebih rendah.

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I certify that a Thesis Examination Committee has met on 6 December 2010 to conduct the final examination of Alaa M. Baker on his master of science thesis entitled "Enhanced Algorithm For Energy Saving Mechanism And Frame Response Time Reduction In Ieee 802.16e Wimax" 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 degree of 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. The members of the Supervisory Committee were as follows:

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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.

ALAA M. BAKER

Date: 6 December 2010

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