UNIVERSITI PUTRA MALAYSIA

PATH RECOVERY FOR AD-HOC ON-DEMAND DISTANCE 6LOWPAN ROUTING PROTOCOL

EE GEE KENG

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By

EE GEE KENG

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PATH RECOVERY FOR AD-HOC ON-DEMAND DISTANCE 6LOWPAN ROUTING PROTOCOL

By

EE GEE KENG

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Chairman: Professor Nor Kamariah binti Noordin, PhD

Faculty: Engineering

Internet Protocol version 6 over low power wireless personal area network (6LoWPAN) has become a new technology to provide the Internet connectivity to the traditional wireless sensor network (WSN). The introduction of 6LoWPAN adaptation layer enables header compression, packet fragmentation and reassembly, and layer-two forwarding from the network layer to media access control (MAC) layer in the 6LoWPAN protocol stack. In order to route the delivered packet from a source node (also named as originator) to a destination node, the Mobile Ad hoc Network (MANET) working group has simplified the existing Ad-hoc On-Demand Distance Vector (AODV) routing protocol for 6LoWPAN with 6LoWPAN Ad-Hoc On-Demand Distance Vector Routing (LOAD) protocol. However, the conceptual LOAD routing protocol, which currently uses the MAC address to route the packet in the personal area network (PAN), has not proposed any path recovery mechanism in 6LoWPAN.

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In this thesis, an originator recognition (OR) path recovery mechanism is proposed for the 6LoWPAN LOAD-based routing protocol. In the proposed OR path recovery mechanism, the participated nodes will memorize the originator address from the data packet during the data forwarding. When a link break happens on the path to a destination node, the conceptual LOAD protocol message is modified by inserting an identity key, which is the memorized originator address, in the generated route error (RERR) message and is forwarded towards the originator for the failure notification. The identity key is then used by the originator of a fail forwarded data packet to initialize path recovery during the link failure in order to retransmit the failed data packet to the unreachable destination node. Instead of using the MAC address in the LOAD routing protocol, the IP address is used in the proposed 6LoWPAN Ad-Hoc On-Demand Distance Vector Routing with Originator Recognition path recovery mechanism (OR-LOAD) routing protocol which is designed for the global routing.

The developed OR-LOAD routing protocol was examined under noisy 6LoWPAN environment in Qualnet simulator. Its performance is then evaluated and compared to AODV routing protocol in terms of packet delivery ratio, throughput, average end-to-end delay and average energy consumption. The simulation results show that the proposed OR-LOAD routing protocol outperforms AODV routing protocol with average of 19.4 % and 30.6 % in terms of packet delivery ratio and throughput respectively. This is because the OR path recovery mechanism in the OR-LOAD routing protocol lessens the packet loss caused by irreparable broken link and reduces the delay taken for link break handling. Thus, the results show that OR-LOAD routing protocol has a higher reliability than AODV routing protocol.

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However, it has induced slightly higher average end-to-end delay compared to AODV routing protocol with comparable average energy consumption in both routing protocols.

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

MEKANISME PEMULIHAN UNTUK PROTOKOL LALUAN 6LOWPAN AD-HOC ATAS PERMINTAAN JARAK VEKTOR

Oleh

EE GEE KENG

Februari 2013

Pengerusi: **Professor Nor Kamariah binti Noordin, PhD**

Fakulti: **Kejuruteraan**

IPv6 dalam wayarles rangkaian kawasan peribadi kuasa rendah (6LoWPAN) telah menjadi satu teknologi baru untuk menyediakan sambungan Internet kepada rangkaian sensor tanpa wayar (WSN) tradisional. Pengenalan lapisan penyesuaian 6LoWPAN yang membolehkan mampatan header, pemecahan paket dan pemasangan semula, dan lapisan-dua penghantaran dari lapisan rangkaian ke lapisan kawalan akses media (MAC) dalam timbunan protokol 6LoWPAN. Bagi laluan paket yang dihantar dari nod sumber (juga dinamakan sebagai pengasas) kepada nod destinasi, kumpulan kerja Mudah alih Ad Hoc Rangkaian (MANET) telah mempermudahkan protokol laluan Ad-hoc On-Demand Distance Vektor (AODV) yang sedia ada untuk 6LoWPAN kepada protokol laluan 6LoWPAN Ad-Hoc On-Demand Distance Vector Routing (LOAD). Walau bagaimanapun, protocol laluan LOAD konsep, yang kini menggunakan alamat MAC untuk laluan paket dalam rangkaian kawasan peribadi (PAN), tidak mencadangkan mana-mana mekanisme laluan pemulihan dalam 6LoWPAN.

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Dalam tesis ini, satu mekanisme pemulihan yang bernama pengiktirafan pengasas (OR) telah dicadangkan untuk protokol laluan yang berasaskan LOAD. Dalam mekanisme pemulihan OR yang dicadangkan, nodus yang menyertai akan menghafal alamat pemula dari data paket semasa penghantaran data. Apabila kerosakan pautan berlaku di atas jalan untuk nod destinasi, mesej protokol LOAD konsep diubahsuai dengan memasukkan kunci identity, yang merupakan alamat pemula menghafal, dalam kesesatan laluan janaan (RERR) mesej dan dikemukakan ke arah pemula bagi pemberitahuan kegagalan. Kunci pengenalan ini kemudiannya digunakan oleh pengasas data paket yang gagal untuk memulakan pemulihan jalan semasa kegagalan pautan untuk menghantar semula data paket gagal ke nod destinasi tidak dapat dicapai. Sebaliknya daripada menggunakan alamat MAC dalam protokol laluan LOAD, alamat IP digunakan dalam protokol laluan OR-LOAD yang direka untuk laluan global yang dicadangkan.

Protokol laluan OR-LOAD yang direka telah diperiksa di bawah persekitaran 6LoWPAN yang terdapat banyak gangguan isyarat dalam simulator Qualnet. Prestasinya kemudian dinilai dan dibandingkan dengan protokol laluan AODV dari segi nisbah penyerahan paket, kendalian, purata kelewatan dari pengasas ke destinasi dan purata penggunaan tenaga. Keputusan simulasi menunjukkan bahawa cadangan protokol laluan OR-LOAD melebihi performa AODV laluan protokol dengan purata sebanyak 19.4 % dan 30.6 % masing-masing dari segi nisbah penghantaran paket dan pemprosesan. Ini adalah kerana mekanisme pemulihan OR dalam protokol laluan OR-LOAD mengurangkan kehilangan paket yang disebabkan oleh pautan rosak yang tidak boleh diperbaiki dan mengurangkan kelewatan yang diambil untuk pengendalian kerosakan pautan. Walau bagaimanapun, ia telah mencetuskan lebih

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tinggi sedikit purata kelewatan berbanding daripada protokol laluan AODV. Walau bagaimanapun, purata penggunaan tenaga dalam kedua-dua protokol routing adalah hampir sama. Oleh itu, walaupun keputusan prestasi menunjukkan beberapa tukar ganti antara kedua-dua protokol laluan, cadangan protokol laluan OR-LOAD melakukan lebih baik daripada AODV laluan protokol kerana kelebihan yang ketara di bawah persekitaran 6LoWPAN.

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I certify that a Thesis Examination Committee has met on to conduct the final examination of Ee Gee Keng on his thesis entitled "Path Recovery For LOAD-Based 6LoWPAN Routing Protocol Using Originator Recognition (OR) Mechanism" 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)

Name of Faculty,
Name of Organisation
(External Examiner)

SEOW HENG FONG, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

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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:

Nor Kamariah binti Noordin, PhD
Professor
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Borhanuddin bin Mohd. Ali, PhD
Professor
Faculty of Engineering
Universiti Putra Malaysia
(Member)

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_____
BUJANG BIN KIM HUAT, PhD
Professor and 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 concurrently submitted for any other degree at Universiti Putra Malaysia or other institutions.

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EE GEE KENG

Date: 8

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