MODIFIED CSMA/CA MAC STRATEGY FOR IOT ENABLE INTRA-VEHICULAR WIRELESS COMMUNICATION SYSTEMS

MD JAHAN ALI

Master of Science

UNIVERSITI MALAYSIA PAHANG

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.

_____

(Supervisor's Signature)

Full Name : DR. MD ARAFATUR RAHMAN

Position : SENIOR LECTURER

Date :

STUDENT'S DECLARATION

I hereby declare that the work in this 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 Malaysia Pahang or any other institutions.

_____

(Student's Signature)

Full Name : MD JAHAN ALI

ID Number : MCC15006

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MD JAHAN ALI

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ABSTRAK

Konsep *Internet of Things* atau *Internet* untuk segalanya *(IoT)* boleh digunakan di dalam komunikasi kenderaan berikutan peningkatan mendadak di dalam nod peranti pengeran kerana permintaan tinggi terhadap aplikasi perlindungan, keselamatan, keselesaan yang berbeza. Bagi menjalankan komunikasi di antara nod-nod di dalam kenderaan, rangkaian kawalan jaringan beserta seni bina sambungan wayar merupakan solusi yang utama. Walau bagaimanapun, solusi ini tidak berdaya maju dan keanjalan kerana seni bina yang kompleks di dalam sambungan wayar beserta permintaan pengesan yang tinggi di dalam kenderaan; menyebabkan seni bina sambungan wayar digantikan dengan tanpa wayar. Selain itu, boleh skala merupakan isu utama dalam pengenalan konsep *IoT* di dalam *Intra-Vehicular Wireless Sensor Networks* atau Rangkaian peranti pengeran tanpa wayar intra-kenderaan *(IVWSNs). IoT* membolehkan *Intra-Vehicular Wireless Sensor Networks (IoT-IVWSNs)* yang merujuk kepada rangkaian di mana sejumlah besar peranti pengeran berhubung antara satu sama lain untuk berkongsi maklumat status kenderaan dalam membangunkan sistem kenderaan pintar. Bilangan nod peranti pengeran di dalam kenderaan telah meningkat secara mendadak berikutan dari peningkatan penggunaan kenderaan. Fenomena kesesakan lalu lintas menimbulkan masalah di dalam *IVWSNs* di mana bebanan lalu lintas serta bilangan peranti pengeran meningkat. Masalah ini dapat diselesaikan dengan mengurangkan had protokol *Media Access Control* atau Kawalan akses media *(MAC)* yang sedia ada. Dalam kajian ini, pertama sekali, adalah menyelidik prestasi rangkaian di dalam *IoT-IVWSNs* dengan protokol sedia ada dengan mempertimbangkan pelbagai parameter rangkaian yang dioptimumkan serta menentukan batasan-batasannya. Tambahan itu, kajian ini akan membincangkan reka bentuk senario IVWSN, komponen rangkaian, teknologi tanpa wayar yang sesuai dan parameter dalam menilai prestasi dan kebolehpercayaan rangkaian dengan cara yang berskala. Kedua, strategi *History Based CSMA/CA MAC* dicadangkan untuk mempertingkatkan lagi prestasi rangkaian dengan mengurangkan batasan di dalam persekitaran *IoT-IVWSNs*. Akhir sekali, prestasi rangkaian diuji melalui simulasi diskret berangka bagi menunjukkan dapatan berkesan yang diperolehi. Dapatan yang dihasilkan menunjukkan bahawa prestasi rangkaian meningkat 75% dari segi metrik prestasi rangkaian kelewatan hujung-ke-hujung.

ABSTRACT

The concept of the Internet of Things (IoT) can be utilized in vehicular communication since the number of sensor nodes is raising tremendously because of the uplifting demand of different secure, safety and convenience applications. In order to do the communication among these nodes inside the vehicle, controller area network with wired architecture provides a prominent solution. However, this solution will not be viable and flexible because of the architectural complexity of wire connections in the demand of a large number of sensors inside the vehicle; hence the wired architectures are replaced by wireless ones. Moreover, scalability will be an important issue while introducing the IoT concept in Intra-Vehicular Wireless Sensor Networks (IVWSNs). The IoT enabled Intra-Vehicular Wireless Sensor Networks (IoT-IVWSNs) refer to the network where a large number of sensors are connected with each other for sharing the vehicle's status information to develop a smart vehicular system. The number of sensor nodes in the vehicle has increased significantly due to the increasing vehicular applications. The phenomenon of congestion poses a problem in the IVWSNs where the traffic load and the number of sensors are increased. These problems can be resolved by mitigating the limitation of the existing Media Access Control (MAC) protocols. In this study firstly, it is investigated the network performance in IoT-IVWSNs with existing protocol by considering different optimized network parameters and defines the limitations. Moreover, it discusses the design of IVWSN scenario, network components, suitable wireless technology and parameters for evaluating the performance and network reliability in a scalable fashion. Secondly, a History-Based CSMA/CA MAC strategy is proposed to minimize the end to end of the network. The developed new MAC improves the network performance by reducing the limitations in the IoT-IVWSNs environment. Finally, the performance has been tested through discrete numerical simulation to show the result effectively. The results show that the network performance is increased 75% approximately in term of network performance metrics end-to-end delay.

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LIST OF SYMBOLS

dBm	Decibel-milliwatts
d	Distance
P_L	Path loss
P_t	Transmit power
P_r	Receiver power
C_f	Carrier frequency
Rs	Receiver sensitivity
Xσ	Gaussian random variable
σ	Shadowing deviation
γ	Path loss exponent

LIST OF ABBREVIATIONS

BE	Backoff Exponent
BEB	Binary Exponent Backoff
CAN	Controller Area Network
CAP	Contention Access Period
CCA	Clear Channel Assessments
CEF	Contention-Free Period
CSMA/CA	Carrier Sense Multiple Access-Collision Avoidance
CU	Control Unit
ECU	Electronic Control Unit
ED	End Device
FFD	Full Function Device
GST	Guaranteed Time Slot
IoT	Internet of Things
ITS	Intelligent Transportation System
IVWSNs	Intra-Vehicle Wireless Sensor Networks
IoT-IVWSN	IoT enabled Intra-Vehicle Wireless Sensor Networks
IVS	Intelligent Vehicular System
NB	Number of Backoff Stages
MAC	Medium Access Protocol
PAN	Personal Area Network
PHY	Physical
PU	Processing Unit
RFD	Reduced Function Device
RFID	Radio Frequency Identifier
SBE	Saved BE
SNB	Saved NB
UWB	Ultra-wideband
VANETs	Vehicular Ad-hoc Networks
V2V	Vehicle-to-Vehicle
V2I	Vehicle-to-Infrastructure
WSNs	Wireless Sensor Networks

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