Faculty of Computer Science and Information Technology

Improving Channel Assignment for Vehicular Ad-hoc Sensor Network in Disaster Management System

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Improving Channel Assignment for Vehicular Ad-hoc Sensor Network in Disaster Management System

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DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Malaysia Sarawak. Except where due acknowledgements have been made, the work is that of the author alone. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

……

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ABSTRACT

The disaster is categorized as unavoidable and essential planetary action. When these natural phenomena form in extreme format, they could significantly impact daily life, property, the environment generally, and global economics particularly. This aims for design making and actions taken through the collaboration and cooperation of many experts from various disciplines. Although primary and secondary research suggested that there is room for limitations in the existing information and communication technology (ICT) that affects the effectiveness and efficiency of an emergency response task. Due to this, this research focuses on building improved Channel assignments on Vehicular Ad-hoc Sensor Network (VASNET) to investigate the proposed algorithms and methods to improve the reliability of the Disaster Management System (DMS) during emergency operations for natural and man-made disasters. The conventional VASNET in terms of infrastructure that consists of Roadside Sensor Unit (RSU) may partially or entirely destroyed during the post-disaster scenario. As such, performance degradation of VASNET affects the network infrastructure with high packet loss, delay and a massive of energy consumption on Disaster Management System. Therefore, modification of VASNET is a must to improve and solve the current problem of VASNET technology. The proposed algorithms and methods are implemented using an Omnet++ network simulator with network formation, Channel assignment, and Packet Scheduling to reduce node-to-node interference with computational overhead that significantly impacts the performance. Furthermore, large bandwidth is the major problem in current VASNET architecture as the study of network formation and channel assignment to further improved by introducing a backup path in terms of reliability. To assign or allocate the channel in a multi-channel and multi-node environment. We need a medium so-called multi-interface that include switchable and fixed interface on every node UEs (User

Equipment) in the VASNET topology. This is because the channel assigns might under-utilize or fully utilize in multi-node situations. Moreover, a high spectrum and spectrum scarcity could affect the VASNET packet broadcasting performance. Therefore, in this research, we proposed an OFDMA and SC-FDMA implementation in this research study to overcome those problems on the uplink and downlink stage, to ensure Channel Assignment is fully implemented to achieve this research objective and answer the research question as well. This research shows that packet loss has a more significant influence when measured over the proposed methods and algorithms, as well as delay and energy consumption during the evaluation stage. LTE-A Improved Channel (LTE-AIC) was suggested and implemented with proposed algorithms and methods to compare with conventional LTE-A and LTE as a benchmark. According to the simulation result, the packet loss able to reduce on LTE-AIC with an average of 54.82% with respect to normal LTE-A and 64.05% compared to LTE on low data rate (CQI=2). On a high data rate (CQI=7), an average of 10.98% improved for LTE-AIC compared to normal LTE-A and an average of 19.70% with respect to LTE. On the other hand, 36.32% improved on LTE-AIC with an average end-to-end delay compared to normal LTE-A and an average of 49.44% compared to LTE on low data rate. Moreover, an average of 22.91% for LTE-AIC with respect to normal LTE-A and 38.63% compared to LTE for high data rate. In terms of energy consumption, an average of 20.90% improved on LTE-AIC compared to normal LTE-A and 33.36% with respect to LTE on a low data rate. Lastly, an average of 23.69% was reduced on LTE-AIC compared to normal LTE-A, and 44.04% compared to LTE for 1km coverage in this simulation. Consequently, this research study greatly contributes to the proposed methods and algorithms for VASNET in LTE-AIC on improved Channel Assignment for Disaster Management Systems explicitly proposed.

Keywords: VASNET, Channel Assignment, LTE-A, LTE, LTE-AIC

Kaedah Penyerahan Saluran yang Ditambahbaikan untuk Rangkaian Ad-Hoc Kenderaan dalam Sistem Pengurusan Bencana

ABSTRAK

Bencana dikategorikan sebagai tindakan yang tidak dapat dielakkan. Apabila fenomena alam ini terbentuk dalam format yang melampau, ia boleh memberi impak yang besar kepada kehidupan harian, harta benda, alam sekitar dan ekonomi global khususnya. Ini adalah matlamat membuat reka bentuk dan tindakan yang diambil melalui kerjasama pakar dari pelbagai disiplin. Walaupun penyelidikan primer dan sekunder mencadangkan bahawa terdapat ruang untuk batasan dalam teknologi maklumat dan komunikasi (ICT), dari aspek keberkesanan dan kecekapan semasa kecemasan. Disebabkan ini, fokus penyelidikan ini adalah membina Tugasan Saluran yang ditambahbaik ke atas VASNET untuk menyiasat sama ada algoritma dan kaedah yang dicadangkan mampu meningkatkan keupayaan Sistem Pengurusan Bencana (DMS). Kelemahan VASNET yang terdiri daripada RSU dimusnahkan sebahagian atau sepenuhnya di pasca bencana. Oleh itu, kemerosotan VASNET menjejaskan rangkaian dengan kehilangan paket yang tinggi, kelewatan, dan menghasilkan sejumlah besar tenaga dalam Sistem Pengurusan Bencana ini. Akibatnya, pengubahsuaian VASNET adalah satu kemestian untuk menyelesaikan masalah teknologi VASNET. Algoritma dan kaedah yang dicadangkan menggunakan simulator Omnet++ dengan pembentukan rangkaian, penugasan Saluran dan Penjadualan Paket untuk mengurangkan gangguan nod-ke-nod yang memberikan impak besar dari segi prestasi. Tambahan pula, lebar jalur yang besar pada peranti-ke-peranti adalah masalah utama dalam pembinaan VASNET. Untuk menetapkan saluran dalam persekitaran berbilang saluran dan nod. Medium yang dipanggil berbilang muka yang termasuk muka boleh tukar dan tetap pada setiap UE nod dalam topologi VASNET. Ini kerana peruntukan saluran mungkin kurang

digunakan sepenuhnya dalam situasi berbilang nod. Selain itu, kekurangan spektrum yang tinggi boleh menjejaskan prestasi VASNET semasa penyiaran paket. Oleh itu, dalam penyelidikan ini, kami mencadangkan pelaksanaan OFDMA dan SC-FDMA, untuk mengatasi masalah tersebut pada peringkat uplink dan downlink, bagi memastikan Channel Assignment dilaksanakan sepenuhnya. Kajian ini menunjukkan bahawa kehilangan paket mempunyai pengaruh yang besar apabila diukur ke atas kaedah dan algoritma yang dicadangkan serta kelewatan dan penggunaan tenaga semasa peringkat penilaian. LTE-AIC dicadangkan dan dilaksanakan dengan algoritma dan kaedah untuk dibandingkan dengan LTE-A dan LTE konvensional sebagai penanda aras. Berdasarkan keputusan simulasi, kehilangan paket dikurangkan ke purata 54.82% LTE-AIC berbanding dengan LTE-A biasa dan 64.05% berbanding LTE pada kadar data rendah (CQI=2). Pada kadar data yang tinggi (CQI=7), purata 10.98% bertambah baik ke atas LTE-AIC berbanding LTE-A biasa dan purata 19.70% berbanding dengan LTE. Sebaliknya, 36.32% bertambah baik pada purata kelewatan hujung ke hujung berbanding LTE-A biasa dan purata 49.44% berbanding LTE pada kadar data rendah. Selain itu, purata 22.91% dari LTE-AIC berbanding LTE-A biasa dan 38.63% berbanding LTE untuk kadar data yang tinggi. Dari segi penggunaan tenaga, purata 20.90% bertambah baik di LTE-AIC berbanding LTE-A biasa dan 33.36% berbanding dengan LTE pada kadar data yang rendah. Akhir sekali, purata 23.69% berkurangan dari LTE-AIC berbanding LTE-A biasa dan 44.04% bertambah baik berbanding LTE, untuk liputan 1km dalam simulasi ini. Akhirnya, kajian penyelidikan ini menyumbang kepada kaedah dan algoritma yang dicadangkan untuk VASNET dari segi keupayaan dalam protokol LTE-A pada Penyerahan Saluran yang dipertingkatkan untuk Sistem Pengurusan Bencana yang dicadangkan secara eksplisit.

Kata kunci: *VASNET, Penugasan Saluran, DMS, LTE-A, LTE, LTE-AIC*

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LIST OF ABBREVIATIONS

3GPP	3rd Generation Partnership Project
AM	Acknowledge Mode
ANC	Announcement Packet
ANN	Artificial Neural Networks
AODV	Ad-Hoc On-demand Distance Vector Routing
AP	Access Point
APPS	Application
BB	Base Band
BFT	Beam Forming Transmission
BSC	Base Station Controller
BSS	Base Station
BTS	Base Transceiver Controller
BW	Bandwidth
CC	Compensation Counter
CDD	Cooperative Data Dissemination
CDMA	Collision Detection Multiple Access
CELL_DCH	Cell Dedicated Channel
CELL_PCH	Cell Paging Channel
CIF-Q	Channel-Condition Independent Packet Queueing
CoMP	Coordinated Multipoint
CQI	Channel Quality Indication
CR	Cognitive Radio

CRN	Cognitive Radio Networks
CS	Control Server
CSMA	Carrier Sense Multiple Access
CSMA/CD	Collision Sense Multiple Access with Collision Avoidance
CTS	Clear-To-Send
CVN	Cognitive in Vehicle Networks
D2D	Device To Device
DC	Deficit Counter
DCF	Distributed Coordination Function
DE-OLSR	Differential Evolution Optimized Link State Routing
DFT	Discrete Fourier Transform
DINS	Distributed Inter-Node Space
DL	Downlink
DMS	Disaster Management System
DRR	Deficit Round Robin
DSR	Diameter Signalling Router
DSRC	Dedicated Short-Range Communication
DSRP	Dynamic Source Routing Protocol
DSS	Disaster Surveillance Services
E-UTRAN	Evolved UTMS Terrestrial Radio Access Networks
eNodeB	Evolved Node B
ePDG	Evolved Packet Data Gateway
FAMA	Flow Acquisition Multiple Access
FDD	Frequency-Division Duplex
FFT	Fast Fourier Transform

FSF	Frequency Selective Fading
FTP	File Transfer Protocol
GERAN	GSM Edge Radio Access Networks
GPS	Global Positioning System
GUI	Graphical User Interface
HSS	Home Subscriber Service
IaaS	Infrastructure as a Service
ICI	Intercarrier Interface
I-CSDPS	Improved Channel State Dependent Packet Scheduling
ICT	Information Communication Technology
IEEE	Institution of Electrical and Electronic Engineer
IFDMA	Interleaved SC-FDMA
IFFT	Inverse Fast Fourier Transform
IMT-A	International Mobile Telecommunication-Advanced
IoT	Internet of Things
IPv4	Internet Protocol version 4
IPv6	Internet protocol version 6
ISI	Inter-symbol Interference
ISM/UNIF3	Industrial, Scientific, and Medical/ Unlicensed F3 band
ITS	Intelligent Transportation System
ITSS	Intelligent Transportation System and Service
IWFQ	Idealized Wireless Fair Queueing
LoTEM	Location-based Temporal Macro Task
LTE	Long Term Evolution
LTE-A	Long Term Evolution-Advanced

LTE-AIC	Long Term Evolution-Advanced Improved Channel
MAC	Medium Access Control
MACA	Multiple Access with Collision Avoidance
MAI	Multiple Access Interference
MAN	Metropolis Area Networks
MaxCIR	Maximum Carrier-to-Interference Ratio
MBMS	Multimedia Broadcast Multimedia Service
MC-IF	Multi-Channel Interface
MC-MAC	Multi-Channel Medium Access Control
MIMO	Multi-Input Multi-Output
MME	Mobility Management Entity
MU-MIMO	Multi User Multi Input Multi Output
NetIF4	Network Interface
NLOS	Non-Line of Sight
NS-2	Network Simulator-2
NS-3	Network Simulator-3
OBU	On-Board Unit
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiplexing Access
OLSR	Optimized Link State Routing
OSPF	Open Shortest Path First
PaaS	Platform as a Service
PAPR	Peak to Average Power Ratio
PCRF	Policy and Charging Rules Function
PDNGW	Packet Data Network Gateway