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Performance Study of IEEE 802.11p for Vehicle to Vehicle Communications Using OPNET

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Abstract

IEEE 802.11p is the recently finalised protocol located at the bottom of the Dedicated Short Range Communication (DSRC) protocol suite, which supports Intelligent Transportation System (ITS) applications for both road safety and added value communication purposes. It has evolved from widely applied Wireless Local Area Network (WLAN) standards and it cooperates with peculiar higher layer protocols in order to carry out inter-vehicle communication. In this thesis, we focus on the performance study of road safety communication as being the vital application in ITS, which is very necessary not only because IEEE 802.11p is a relatively new protocol but also because it heavily relies on broadcast mode, thus distinguishing itself from other 802.11 counterparts. With the aid of OPNET, a powerful commercial simulator, different scenarios have been deployed in which one or more variable factors are involved, such as vehicle number, data packet size, communication distance, vehicle fleet topology, etc., in order to find out their impacts on DSCR and characteristics of 802.11p.

After analysing results data collected from hundreds of simulations, we found out that 802.11p represented a desirable performance in terms of latency and priority-oriented services throughout our simulation scenarios. However, packet collision caused by either media contention or hidden nodes turned out to be a relatively serious issue of vehicle communication and 802.11p seems in shortage of an effective mechanism to deal with it. What we can only hope is that under practical application, the media should always be lightly occupied and that there are few ACs with high priorities trying to contend resources simultaneously at any given time. Meanwhile, our analyses indicate that current 802.11p protocol might still need further modifications in order to address its inherent issues and enhance the communication performance.

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GLOSSARY

3G	Third Generation
AC	Access Category
ACK	Acknowledgement
ADSL	Asymmetric Digital Subscriber Line
AGC	Automatic Gain Control
AIFS	Arbitrary Inter-frame Space
AIFSN	Arbitration Inter-Frame Space Number
AP	Access Point
ASTM	American Society for Testing and Materials
BCH	Basic Channel
BEB	Binary Exponential Backoff
BER	Bit Error Rate
BS	Base Station
BSS	Basic Service Set
BTS	Base Transceiver Station
CCA	Clear Channel Assessment
CCH	Control Channel
CDMA	Code Division Multiple Access
CRC	Cyclic Redundancy Code
CSMA/CA	Carrier Sense Multiple Access with Collision Avoidance
CTS	Clear to Send
CW	Contention Window
DCF	Distributed Coordination Function
D-MAC	Directional MAC
DSRC	Dedicated Short Range Communications
EDCA	Enhanced Distributed Channel Access
EDCAF	Enhanced Distributed Channel Access Function
EDCF	Enhanced DCF

EIFS	Extended Inter-frame Space
EIRP	Equivalent Isotropically Radiated Power
ERP	Extended Rate PHY
ESOP	End of Service Period
FCC	Federal Communications Commission
FEC	Forward Error Correction
FI	Frame Information
GI	Guard Interval
GPS	Global Positioning System
GSM	Global System for Mobile Communications
HCCA	HCF Controlled Channel Access
HCF	Hybrid Coordination Function
HR/DSSS	High-Rate Direct Sequence
IANA	Internet Assigned Numbers Authority
IBSS	Independent BSS
ICI	Inter Carrier Interference
IFFT	Inverse Fast Fourier Transform
IFS	Interframe Spaces
IR	Intentional Radiator
ISI	Intern Symbol Interference
ISM	Industrial, Scientific and Medical
ISTEA	Intermodal Surface Transportation Efficiency Act
ITS	Intelligent Transport System
ITU	International Telecommunication Union
LOS	Line of Sight
MAC	Media Access Control
MANET	Mobile Ad-Hoc Network
MIB	Management Information Base
MIMO	Multiple-input and Multiple-output
MPDU	MAC Protocol Data Unit

MS	Mobile Station
MSDU	MAC Service Data Unit
MTU	Maximum Transmission Unit
NAT	Network Address Translation
NHTSA	National Traffic Safety Administration
NLOS	Non-LOS
OBU	Onboard Unit
OFDM	Orthogonal Frequency-Division Multiplexing
OSI	Open Systems Interconnection
PCF	Point Coordination Function
PER	Packet Error Rate
PHY	Physical Layer
PLCP	Physical Layer Convergence Procedure
PMD	Physical Medium Dependent
PPDU	PLCP Protocol Data Unit
PSDU	PLCP Service Data Unit
PSID	Provider Service ID
PtMP	Point to Multipoint
PtP	Point to Point
QoS	Quality of Service
RIR	Regional Internet Registries
RR-ALOHA	Reliable Reservation-ALOHA
RSU	Roadside Unit
RTS	Request to Send
SAP	Service Access Point
SC	Sub-Carrier
SCH	Service Channel
SIFS	Short Interframe Spaces
SNR	Signal to Noise Ratio
STA	Station

TDMA	Time Division Multiple Access
TG	Task Group
TID	Traffic Identifier
TSID	Traffic Stream Identifier
TXOP	Transmission Opportunity
UNII	Unlicensed national Information Infrastructure Band
UP	User Priority
USDOT	U.S. Department of Transportation
V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle
V2X	V2V and V2I
VANET	Vehicular Ad-Hoc Network
WAVE	Wireless Access in Vehicular Environment
WBSS	WAVE Basic Service Set
WG	Working Group
WIBSS	WAVE IBSS
Wimax	Worldwide Interoperability for Microwave Access
WLAN	Wireless LAN
WME	WAVE Management Entity
WRA	WAVE Routing Advertisement
WSA	WAVE Service Advertisement
WSM	WAVE Short Message
WSM	WAVE Short Message
WSMP	WAVE Short Message Protocol