Enhancing the Wi-Fi Direct protocol for Vehicular Ad-hoc Networks

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Declaration

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Abstract

We present a technique for enhancing Wi-Fi Direct (WD) for vehicular environments. Dedicated short range communication (DSRC) has been standardized for communication in Intelligent Transportation Systems (ITS). However, due to high costs at initiation, alternative communication strategies are of interest in order to facilitate the quick deployment of ITSs. WD, which is a relatively mature technology available in mobile devices, has come across as a possible alternate candidate. However, the presence of large communication delays in the WD protocol stack is a shortcoming in deploying this in highly dynamic vehicular scenarios. The objective of our work is to propose and evaluate a method to overcome some of the large transmission delays in WD. Our proposal is to use a broadcast mechanism in the downlink between the group owner (GO) and the clients of a WD group, as an alternative to the currently used peer-to-peer (P2P) method.

We study our technique by simulating a bi-directional highway scenario with multiple lanes. We set up the vehicular channel model using two well-known models: Friis propagation model and the Nakagami fading model. Performance measures such as average total delay, average energy consumption of the GO, average packet loss ratio, and average packet reception ratio are presented.

While the proposed GO Broadcast method reduces the downlink delay, it increases the probability of packet losses due to the lack of retransmissions. Our results demonstrate a gain in terms of average total delay and the average energy consumption of the GO. We use a theoretical analysis as well as a simulation study using OMNeT++. It is also shown that the degradation in performance on the downlink due to packet losses is within tolerable limits, given that the size of the group is selected properly.

Index terms— Broadcast mechanism, Group formation, Peer-to-Peer (P2P), Vehicular Ad-hoc Network (VANET), Wi-Fi Direct (WD)

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List of Abbreviations

Abbreviation	Description
ACK	Acknowledgement
AP	Access Point
BPSK	Binary Phase Shift Key
CSMA/CA	Carrier Sense Multiple Access with Collisions Avoidance
CTS	Clear to Send
D2D	Device-to-Device
DHCP	Dynamic Host Configuration Protocol
DSRC	Dedicated Short Range Communication
GO	Group Owner
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
ITS	Intelligent Transportation System
IV	Intent Value
LAN	Local Area Network
MAC	Medium Access Control
MANET	Mobile Ad-hoc Network
MTU	Maximum Transmission Unit
NED	NEtwork Description
NIC	Network Interface Controller
OBU	On Board Unit
P2P	Peer To Peer
PLR	Packet Loss Ratio
PRR	Packet Reception Ratio
QoS	Quality of Services
RSSI	Received Signal Strength Indicator
RSU	Road Side Unit
RTS	Request to Send

SSRC	Stations Short Retry Count
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
VANET	Vehicular Ad-hoc Network
WD	Wi-Fi Direct
WPS	Wi-Fi Protected Setup