CS520 Semester Project 2015
DSRC Reliability during Congestion in Intelligent Transportation System

Anup Chitraker and Chihsiang Wang

Department of Computer Science
University of Idaho
Moscow, Idaho 83843
chit8942@vandals.uidaho.edu

Abstract. In VANET (Vehicular Ad-hoc Network), vehicles equipped with short range radios communicate with each other (Vehicle-to-Vehicle - V2V) and with the road side infrastructure (Vehicle-to-Infrastructure - V2I) to enable range of applications from internet access and driver assistance to transportation safety and emergency response. Network topology in VANET changes frequently due to high node mobility. V2V and V2I operates in the 75 MHz Dedicated Short Range Communication (DSRC) spectrum. The spectrum is allocated within 5.85 - 5.925 GHz band which is divided into one control channel and six service channels.

All vehicles will broadcast their state information such as location, speed, vehicle size, etc., frequently in Basic Safety Message (BSMs). According to the standards, each vehicle should transmit one BSM every 100 milliseconds in DSRC. When many vehicles compete for the media access, the channel capacity might not handle the flood of BSMs thereby reducing the reliability of system.

This paper summarizes ongoing research on identifying possible solutions that deals with congestion specially on VANET and how they addressed the reliability issues of the communication.

Keywords: Congestion Control, VANET, Bandwidth Efficiency, Power Control, Node Density, Redundancy, DSRC

1 Introduction

1. How Reliability of DSRC is presented in literature?
2. Show the reliability of DSRC with increasing distance.
3. Show the effect of power and channel switching in the reliability of the DSRC
   – Power modulation won't work (from experimental data we have).
   – Channel switching somehow increases the reliability however it does not seem to work during congestion - consumes more bandwidth (since we have limited bandwidth).

4. Solution could be to review the MAC layer.
   – review some congestion control algorithm and see if they might help increasing the reliability of the DSRC.

Quality of Service is one of the main concerns in any type of wireless communication. In high density environment, each vehicle broadcasts message flood at a high frequency, that can easily congest the CCH channel. Keeping CCH channel free from congestion is very important in order to ensure timely and reliable delivery of BSMs.

1.1 DSRC

Note: Channels, bandwidth, standards..

In U.S. Federal Communications Commission (FCC) has allocated 75 MHz DSRC spectrum in the 5.9 GHz band. The spectrum consists of one control channel (CCH) and six service channels (SCHs) to be used by Intelligent Transportation Systems (ITS) as shown in Figure 2.

1.2 Current DSRC Challenges

Note: BSM failure, Mutipath delay spread, Doppler spread

PHY Layer Vehicular communications occur in a challenging environment involving fast moving vehicles and a wide range of obstacles that can degrade radio performance such as buildings, surrounding bigger vehicles, intersections, tunnels, bridges, surrounding bigger vehicles, intersections, tunnels, bridges.[18]

1. Muti-path Delay Spread
2. Mobility

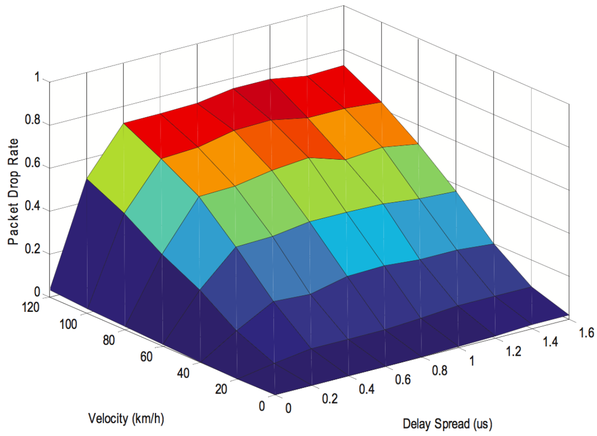
In summary, the vehicular communication channel can be highly frequency selective due to multipath delay spread, and highly time selective due to vehicle mobility. It can be easily estimated that the 50% coherence bandwidth in some scenarios is roughly in the order of 1MHz and 50% coherence time can be as short as 0.2ms. This leads to two challenges of adapting the traditional IEEE 802.11 solution to vehicular communications.[3]

1. Channel estimation error in vehicular environment due to time-selective and frequency selective fading;
2. Lack of time-interleaving in fast time-selective fading channels.

MAC Layer

Fig-Channel-power.png

Fig. 1. DSRC channels and Power Limit [17]



and DS.png

Fig. 2. Conventional IEEE 802.11a implementation [3]

1.3 MAC Protocol in DSRC

2 Related Work

1. Describe related work on channel redundancy and message dissimilarity.
2. Many paper claims increasing data rate might increase performance however our experiment may present counter to their literature.
3. Data collected from Experimental Setup:
4. Specifications:
   BSM per second
   - Data Transmit Rate: 3Mbps and 6Mbps
   - Transmit Power: 18 dBm
   - Channel 172
   - Continuous Mode
5. Result:
   – Increase in BSM transmit rate; Compete for media access; Decrease in Reliability

3 Analysis of MAC Layer Performance

1. Investigate the impact of increasing BSM rates:
   – Show model for calculating PDR impact of collisions in unjammed environment, i.e., simply based on message density (vehicle density).
2. Introduce "Figure direct" and argue how normal, 2x and 3x approaches affect 90% PDR requirement from Standard.
3. The case of the hidden nodes is significantly worse. (Include or not?)

pdr-3-vs-6-Mbps.png

Fig. 3. Reliability of DSRC communication over various data transmit rate

4 Conclusions

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