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

Anup Chitraker

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 1.

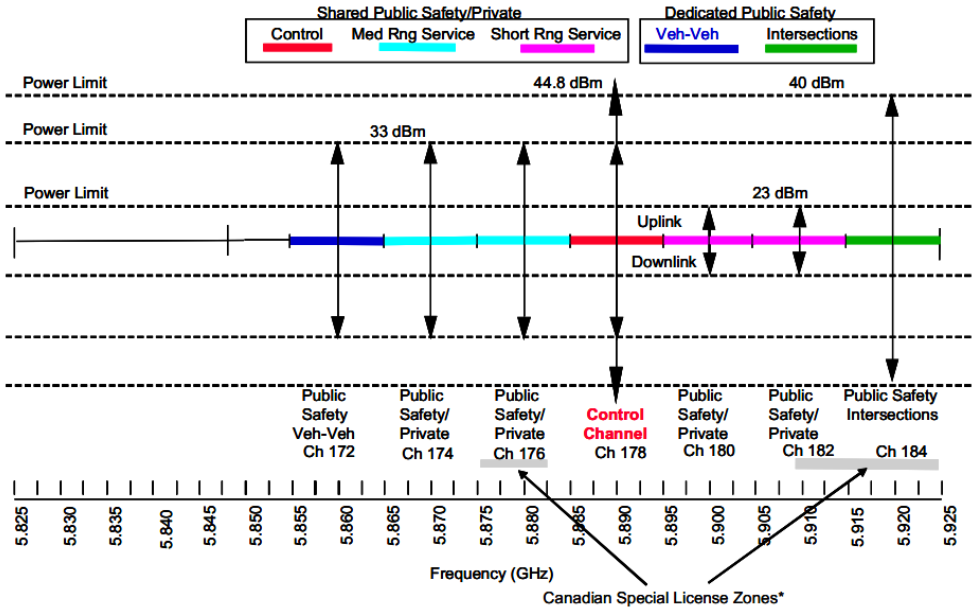

Fig. 1. DSRC channels and Power Limit [17]

1.2 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:

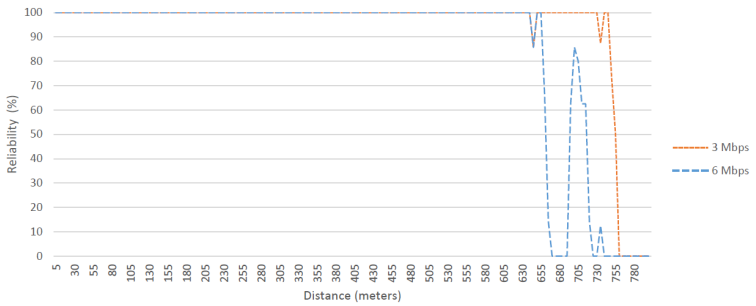

Fig. 2. Reliability of DSRC communication over various data transmit rate

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?)

4 Conclusions

References

1. A. Serageldin, and A. Krings, *The Impact of Dissimilarity and Redundancy on the Reliability of DSRC Safety Applications*, Proc. Tenth International Symposium on Frontiers of Information Systems and Network Applications, (FINA 2014), Victoria, Canada, May 13-16, 2014.
2. A. Serageldin, and A. Krings, *The Impact of Redundancy on DSRC Safety Application Reliability under Different Data Rates*, Proc. 6th International Conference on New Technologies, Mobility and Security, (NTMS 2014), Dubai, March 30 - April 2, 2014.
3. X. Wu, S. Subramanian *Vehicular Communications Using DSRC: Challenges, Enhancements, and Evolution*, IEEE J. Sel. Areas Commun., vol. 31, no. 9, pp. 399-408, Sep., 2013
4. Y.P. Fallah, C.L. Huang, R. Sengupta, and H. Krishnan, *Congestion Control Based on Channel Occupancy in Vehicular Broadcast Networks*, IEEE Vehicular Technology Conference (VTC-Fall), September 2010.
5. F. Ye, R. Yim, J. Zhang, and S. Roy, *Congestion Control to Achieve Optimal Broadcast Efficiency in VANETs*, Communications (ICC), 2010 IEEE International Conference on, 2010, pp. 15.
6. *Amendment of the Commission's Rules Regarding Dedicated Short-Range Communication Services in the 5.850-5.925 GHz Band (5.9 GHz Band)*, Federal Communications Commission FCC 03-324, 2004.
7. M.S.Bouassida and M.Shawky, *On the congestion control within vanet*, Wireless days,2008. WD '08 1st IFIP Digital Object Identifier: 10.1109/WD.2008.4812915 Publication Year: 2008 , Page(s): 1 5
8. R. Stanica, E. Chaput, A. Beylot, *Reverse back-off mechanism for safety vehicular ad hoc networks*, Universit de Lyon, INSA Lyon, CITI-INRIA UrbaNet, F-69621, Villeurbanne, France.
9. X. Yin, X. Ma, and K. S. Trivedi, *An Interacting Stochastic Models Approach for the Performance Evaluation of DSRC Vehicular Safety Communication*, IEEE Trans. on Computers, accepted, 2012.
10. *Adaptive Congestion Control of DSRC Vehicle Networks for Collaborative Road Safety Applications*, IEEE International workshop on Wireless Local Networks, 2011
11. S.J. Lee and M. Gerla, *Dynamic Load-Aware Routing in Ad hoc Networks*, Proceedings of ICC 2001.
12. Z. Y. Rawshdeh and S. M. Mahmud, *Media Access Technique for Cluster-Based Vehicular Ad Hoc Networks*, IEEE 68th Vehicular Technology Conference Fall (VTC 2008-Fall). September 2008
13. N. Balan and J. Guo, *Increasing Broadcast Reliability in Vehicular Ad Hoc Networks*, Proc. 3rd ACM Int. Workshop VANET, ACM MobiCom, pp.104 -105 2006
14. Xin, W., Kar, K., *Throughput Modelling and Fairness Issues in CSMA/CA Based Ad-Hoc Networks*, 24th Annual Joint Conference of the IEEE Computer and Communications Societies (2005)
15. P. Li, Y. Fang, and J. Li, *Throughput, Delay, and Mobility in Wireless Ad Hoc Networks*, INFOCOM, 2010.
16. R. M. de Moraes, H. R. Sadjadpour, and J. Garcia-Luna-Aceves, *Throughput-Delay Analysis of Mobile Ad-hoc Networks with a Multi-Copy Relaying Strategy*, SECON, 2004.

17. J. Zhu and S. Roy, *MAC for Dedicated Short Range Communications in Intelligent Transport Systems*, IEEE Commun. Mag., vol. 41, no. 12, 2003