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# STUDY AND ANALYSIS ON VANET BASED FLUID MECHANICS

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## ABSTRACT

Accurately estimated data transmission ability is important in operating a vehicular ad-hoc network (VANET), which has limited bandwidth and highly dynamic typology. The mobility behavior of traditional wireless networks is different from VANET's, and existing results on the former are not applicable to VANET directly. Most existing studies on VANET capacity estimation focus on asymptotic descriptions. In them, messages sent and received by vehicle nodes are composed of data packets, and vehicle nodes can move along roads only. In this paper, a modeling and calculation approach for accurate VANET capacity is proposed. We transfer vehicle nodes to data packets and then abstract data packets that can move along roads into data flow in virtual pipelines.

## 1. INTRODUCTION

VANET is a homogeneous system that is composed of many self-driven vehicle nodes. It originates from a mobile ad hoc network and has been studied for years [1], [2]. Various kinds of services and applications must transmit data over a network. VANET turns every participating vehicle node into a wireless router and enables vehicle nodes to connect to each other. Vehicle nodes share wireless resources, and communications among vehicle nodes lead to interference and collision, which greatly decrease communication quality. Therefore, VANET capacity as a data transmission ability metric plays an important role in ensuring proper VANET implementation.

A VANET's environment is dynamic instead of stationary, and network capacity changes accordingly. The existing wireless capacity calculation methods cannot be applied directly to it because it is different from traditional wireless networks.

1) Topology: A wireless ad hoc network is a twodimensional topological structure. As long as a destination node is in the communication range of a source node, the latter can communicate directly with the former. While the vehicle nodes of a VANET are distributed in a plane, because of building obstruction, vehicle nodes cannot communicate directly, even though the straight-line distance of two vehicle nodes is less than their communication range.

2) Node mobility: The node mobility of a wireless ad hoc network is far less than that of VANET. Vehicle nodes move at high speed, and when a source vehicle node sends

packets to a destination one, the network topology can change greatly. Therefore, a packet may not reach the destination according to their original routing path. 3) Network scale: In a wireless ad hoc network, the number of nodes is small. Therefore, it is a small-scale isomorphic network. However, the number of vehicle nodes in a VANET may be massive, and vehicle nodes may be widely distributed.

This work considers a VANET in an urban scene, and proposes a hierarchical model to abstract its data transmission process, as shown in Fig. 1. It consists of physical space, transport, and data flow layers. We analyze the characteristics of vehicle movement and communications among vehicle nodes in an urban scene, and abstract data packets transmitted among nodes into data flow.

## 2. LITERATURE REVIEW

A. Capacity of Wireless Ad Hoc Networks

When n identical randomly located nodes form a wireless network, and each capable of transmitting at 1 bits per second and using a fixes range, Gupta and Kumar [8] show that capacity obtainable by each node for a randomly chosen destination is ( √ 1 n log n ). Grossglauser and Tse [9] give a model of an ad hoc network where nodes communicate in random sourcedestination pairs.

Their results show that the per-user throughput can increase dramatically when nodes are mobile rather than fixed. Bansal and Liu [10] consider a theoretical framework and propose a routing algorithm that exploits the patterns in the node mobility to provide delay guarantee. On the basis of percolation theory, Franceschetti et al. [11] propose a method closing the gap in the capacity of wireless networks. Their results demonstrate that randomly scattered nodes can achieve, with high probability, the same transmission rate of arbitrarily located nodes.

Dousse and Thiran study the connectivity and capacity of a finite-area ad hoc wireless network. Their results show that, with an increasing number of nodes, the properties of the network strongly depend on the shape of the attenuation function. Moraes et al. consider two schemes for node mobility, and their results show that mobility is an entity that can be exchanged with capacity and delay. Diggavi et al. assume that nodes are restricted to move along one-dimensional paths, and study the capacity of an ad hoc wireless network.

Their results show that the throughput per user is constant. Lozano et al. divide the communication domain into overlapping neighborhoods, and study throughput scaling. Their results show that achievable throughput is a function of properties of node locations and neighborhood dimensions. Mammen and Shah show that particular mobility restriction affects neither the maximal throughput scaling nor the corresponding delay scaling of the network.

Garetto et al. address the problem of characterizing the capacity of an ad hoc wireless network with n mobile nodes and propose a general framework to characterize the capacity of networks with arbitrary mobility patterns. Mhatre et al. propose a new scheduling scheme to counter the effect of packet losses, and the scheme provides tight guarantees on end-to-end packet loss probability.

**B. Capacity of VANET**

Pishro-Nik et al.provide a general framework to study VANET, and their results show how the road geometry affects VANET capacity. Nekoui and Pishro-Nik introduce capacity scaling laws for VANET considering a more realistic physical model.

Nekoui et al. propose a framework to study the asymptotical capacity of VANET when vehicle nodes are expected to communicate only when they reside within a certain distance of each other. Wu et al. analyze the transport capacity characteristic of VANET in 802.11. Their results show that a one-hop one-channel can reduce collision/interference efficiently. Jacquet and Muhlethaleranalyze the performance of carrier sense multiple access in a linear network, and derive an exact model to compute the number of simultaneous transmissions in a linear VANET.

Ozturk et al.investigate the capacity limits in a variable duty-cycle VANET that uses the IEEE 802.11p standard. Their results show that the performance of typical traffic on those channels can be greatly improved by a judicious choice of the value for each duty cycle. Shi et al.deduce and evaluate the upper bound of transmission capacity in a linear VANET.

## 3. ANALYTICAL MODEL

In this work, we consider the neighborhood of a single RSU operating in a non-saturation regime deployed on a bidirectional road segment as shown in Figure 1. According to the location to RSU, the road segment is divided into multiple regions [3]. In each region (Rgi ) within the RSU coverage area, vehicles have different payload transmission rates according to their distance to the RSU. Also, we consider OBU devices equipped with a single networking interface only. Each vehicle can transmit frames from data classes ACk, k D 0; : : : ; 3, in either channel, CCH or SCH. Packets from data class k in channel x arrive to the node according to a Poisson process with rate x;k. Time unit in our model is one backoff slot. For data class k within channel x at each region (Rgr ), we assume variable frame size of ldx;k;r slots, which includes payload, medium access control header, and physical header. The probability generating function (PGF) for frame size within the transmission range L of the RSU is

$$Ld_{x,k}(z) = \sum_{r=1}^{Rg_{\max}} \frac{l_r}{L} z^{ld_{x,k,r}} \qquad (1)$$

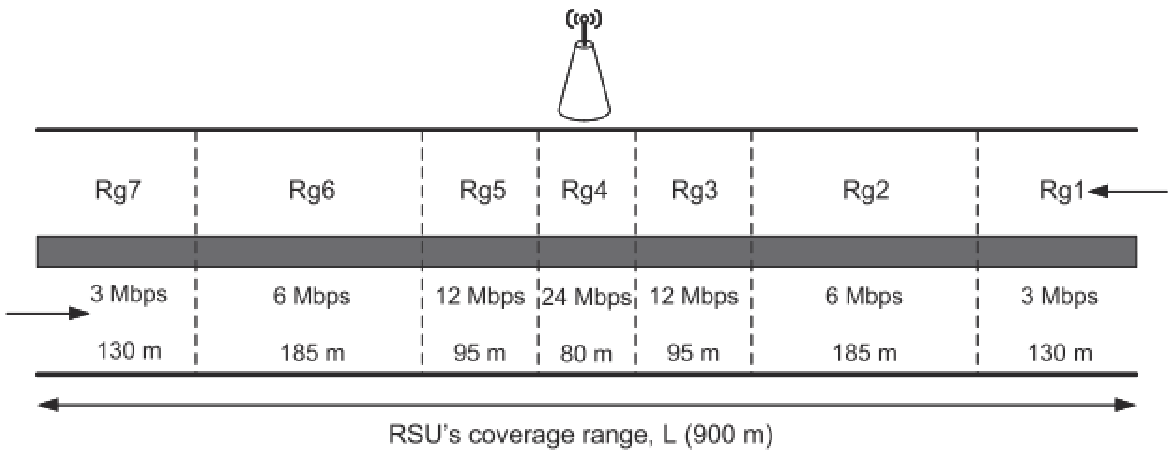


Figure 1.Road segment.RSU, roadside unit.

wherelr is the length of the region Rgr . Duration of the Short Interframe Space (SIFS) period in slots will be denoted as sifs. We assume that request-tosend (RTS)/clear-to-send (CTS) transmission scheme is used. Duration of RTS, CTS, and ACK frames expressed in slots will be denoted as rts, cts, and ack, respectively. We model the channel errors through bit error rate (ber).

**Model of control channel/service channel switching**

Let us consider Figure 2 and denote the durations in backoff slots of CCH, SCH, and guard periods as cch, sch, and grd, respectively. Sum of channel time durations and guard intervals (in slots) must be constant and equal to the synchronization interval si D cch C sch C 2grd.

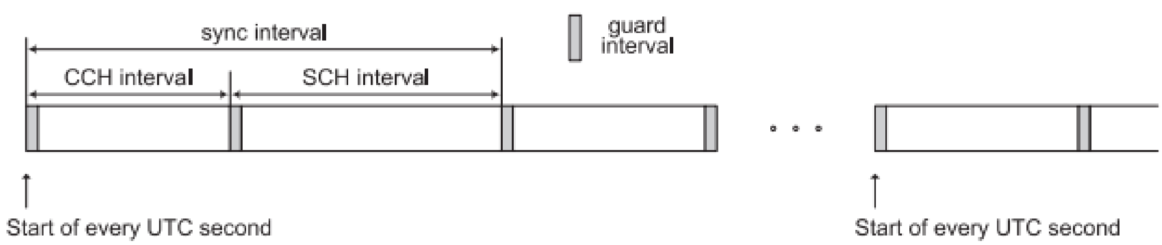


Figure 2. Control channel (CCH)/service channel (SCH) timing. UTC, coordinated universal time.

Then, the probability that the backoff process started in a given CCH interval will be completed in that same CCH is

$$Pl^{[1]}_{c,d,k} = \frac{1}{cch}\sum_{l=0}^{cch}\sum_{i=l}^{cch} b_{c,d,k,i-l} = \frac{1}{cch}\sum_{l=0}^{cch}\sum_{i=0}^{l} b_{c,d,k,i} \quad (7)$$

Consequently, the PGF for the duration of backoff process interleaved with durations of opposite channel can be expressed as

$$Bofe_{c,d,k}(z) = Bof_{c,d,k}(z)\left[Pl^{[1]}_{c,d,k} + \sum_{\kappa=1}^{\kappa_{\max}}\left(Pl^{[\kappa+1]}_{c,d,k} - Pl^{[\kappa]}_{c,d,k}\right) z^{\kappa(si-cch)}\right]$$

In order to model the impact of channel switching on the duration of backoff, we focus on the backoff process belonging to data combination d and traffic class k started in a random slot in one CCH (SCH). If the backoff process has started relatively close to the end of channel time and if it is long, because of collisions, it will exceed the current channel time and, consequently, it will have to be continued in the following CCH (SCH) time. This will effectively extend the backoff time and the entire frame service time. In order to evaluate the impact of this extension, we need to calculate its duration and average it over all slots in CCH (or SCH).

## CONCLUSION

In this paper, we studied the effect of duty cycle—that is, time allocation between CCH and SCHs in an IEEE 802.11p-based network—needed to balance the capacity of those channels. The balance is needed in order to maximize the revenues from services (such as infotainment) provided on the SCH while not compromising safety, which is accomplished through high-priority messages on the CCH. Our results indicate that the default duty cycle value of SO D 0:5 leads to unsatisfactory performance on the SCH; much more balanced results are obtained when the SCH is allocated more time, for example, at a duty cycle value of about SO D 0:3. However, more work is needed to investigate this behavior and, possibly, design an adaptive scheme that will try to obtain the desired trade-off in different vehicular networking scenarios.

## REFERENCES

1. IEEE Trial-use Standard for Wireless Access in Vehicular Environments (WAVE)—Multi-channel Operation. IEEE: New York, NY , IEEE Std 1609.4, 2007.

2. Öztürk S, Mišic J. On non-saturation regime in ieee ´ 802.11p-based VANET with mobile nodes, In Proc. IEEE PIMRC, Toronto, ON, 2011; 740–744.

3. Öztürk S, Mišic J, B. Mišic V. Reaching spatial or networking saturation in vanet. EURASIP Journal on Wireless Communications and Networking 2011; 2011(1): 174.

4. Roess RP, Prassas ES, McShane WR. Traffic Engineering, 3rd ed. Pearson Prentice Hall: Upper Saddle River, NJ, 2004.

5. Tan WL, Lau WC, Yue O. Modeling resource sharing for a road-side access point supporting drive-thru internet, In ACM VANET'09, Beijing, China, September 2009; 33–42.

6. Zhuang Y, Viswanathan V, Pan J, Cai L. Upload capacity analysis for drive-thru internet. Techical Report, University of Waterloo, ON, 2010. Available from: https://129.97.58.88/ojs-2.2/index.php/pptvt/article/view/619/213 [Accessed on September 2012].

7. Bruno R, Conti M. Throughput and fairness analysis of 802.11-based vehicle-to-infrastructure data transfers, In IEEE MASS 2011, Valencia, Spain, October 2011; 232–241.

8. Luan TH, Ling X, Shen XS. MAC in motion: impact of mobility on the MAC of drive-thru internet. IEEE Transactions on Mobile Computing 2012; 11: 305–319.

9. Zhang G, Wang Y, Wei H, Chen Y. Examining headway distribution models using urban freeway loop event data. Transactions Research Record 2007; 1999: 141–149.

10. Fricker JD, Whitford RK. Fundamentals of Transportation Engineering: a Multimodal Systems Approach. Prentice Hall, 2004.

11. Mišic J, Badawy G, Miši ´ c VB. Performance character- ´ ization for IEEE 802.11p network with single channel devices. IEEE Transactions on Vehicular Technology 2011; 60(4): 1775–1787.

12. Takagi H. Queueing Analysis, vol. 1: Vacation and Priority Systems. North-Holland: Amsterdam, The Netherlands, 1991.