A review of various Congestion Control Algorithms in VANETs

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Abstract- Vehicular ad hoc network (VANETs) technology has become an emerging and promising approach for Intelligent Transport System (ITS). In such system, vehicles within a network, communicate with each other and roadside infrastructure to provide various applications. Some of the few applications are Road Safety, Traffic Management and Internet Services. However congestion control is the major challenge for all VANET applications due to lack of base station (central coordination), frequent change of topology and bandwidth limitations. Several research papers have proposed solution to address congestion in VANETs. These solutions are mainly based on rate of packet generation, utility of packets, transmit power control, career sense threshold or a combination of all. This study reviewed the previous research papers published alongwith their limitations is done.

Keywords- Base Station, Congestion Control, Packet Generation, Bandwidth

I. INTRODUCTION

The network without any centralized/pre-established infrastructure or in other words decentralized type of network is called an ad-hoc network. Ad-hoc because it does not rely on any pre-established infrastructure like 'Access Points in managed wired networks' or 'Routers in wired networks [1]'. Ad-hoc network can be categorized on the basis of its application such as Wireless Mesh Networks (WMN), Mobile Ad-Hoc Networks (MANETs), Wireless Sensor Networks (WSN), and Vehicular Ad Hoc Networks (VANETs). VANET is a specific type of MANET in which Vehicle plays the role of node. However unlike MANET, vehicles move on predefined roads and velocity. These vehicles have to follow traffic speed and signs [2]. VANETs provide comfort and safety to the roadside users. It can be considered as one of the influencing area in advancement of Intelligent Transport System (ITS). VANETs application can be classified into the following three main categories [3]:

1. Safety Application [4] such as Post Crash Notification (PSN), Slow/Stop Vehicle Advisor (SVA), Road Hazard Control Notification (RHCN), Emergency Electronic Brake Light (EEBL), Cooperative Collision Warning (CCW).
2. Convenience Application [4] such as Parking Availability Notification (PAN), Congested Road Notification (CRN).
3. Commercial Application [4] such as Remote Vehicle Personalization/Diagnosis Service Announcement, Real Time Video Relay and Content Map Database Download.

The Federal Communication Commission (FCC) assigned a frequency spectrum to VANETs wireless communication. Later In 2003, a dedicated short range communications (DSRC) was established by the commission. The DSRC as communication service, for providing public safety and private application, employs the 5.850-5.925 GHz band [5]. The IEEE establishes a working group for Wireless Access in Vehicular Environments (WAVE) standard [6] or IEEE 802.11p to provide DSRC for VANETs communication. The Federal Communication Commission (FCC) categorize this spectrum into seven channels of 10 Mhz. Service Channels (SCH) comprise six of these channels and the remaining one is known as Control Channel (CCH) [7]. The CCH channel is used for safety messages. WAVE-mode short messages and non-safety services are to be supplied from the SCH channels [8, 9]. The basic target of VANET is to increase the Users road safety and comfort. However Quality of Service (QoS) in VANET is affected by Inaccurate State of Information, Dynamically Varying Network Topology, Absence of Central Coordination, Hidden Terminal Problem, Limited Resource Availability Error Prone Shared Radio Channel, and Insecure Medium. Congestion control is one of the solutions to improve the QoS.

ARCHITECTURE of VANET

In a VANET, the communication will be of 3 types-

1. Inter-Vehicle Communication i.e vehicle to vehicle communication
2. Vehicle to Roadside communication i.e communication between roadside unit(RSU) and vehicles
3. Inter-Roadside Communication i.e communication between roadside unit and the base station.

Vehicular Communication based applications range from simple exchange of vehicle status data to highly complex, large-scale traffic management including infrastructure integration.

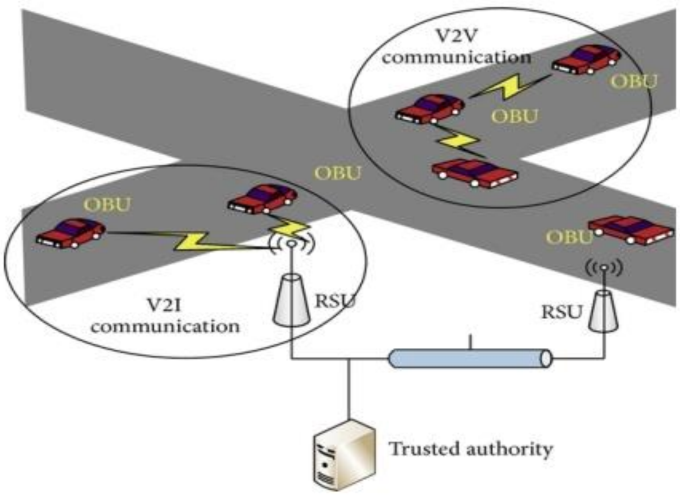

Fig.1: Sample architecture of VANET

VANETs are composed of vehicles equipped with advanced wireless communication devices without any base stations. Each vehicle equipped with VANET device will be a node in the ad-hoc network and can receive and relay others messages through the wireless network. The safety applications can be categorized in two types; 1) periodic (beacon) and 2) event-driven safety messages. The periodic safety message exchange is preventive in nature, and its objective is to avoid the occurrence of dangerous situations. The periodic safety message may contain information regarding the position, direction, and speed of vehicles. While the event-driven safety message may be generated as a result of a dangerous situation or when an abnormal condition is detected such as road accident [10,11]. The event-driven safety messages disseminated within a certain area with high priority and need to be deliver to each neighbor with almost no delays. Both of these safety messages will send through one single channel kwon as Control Channel (CCH).

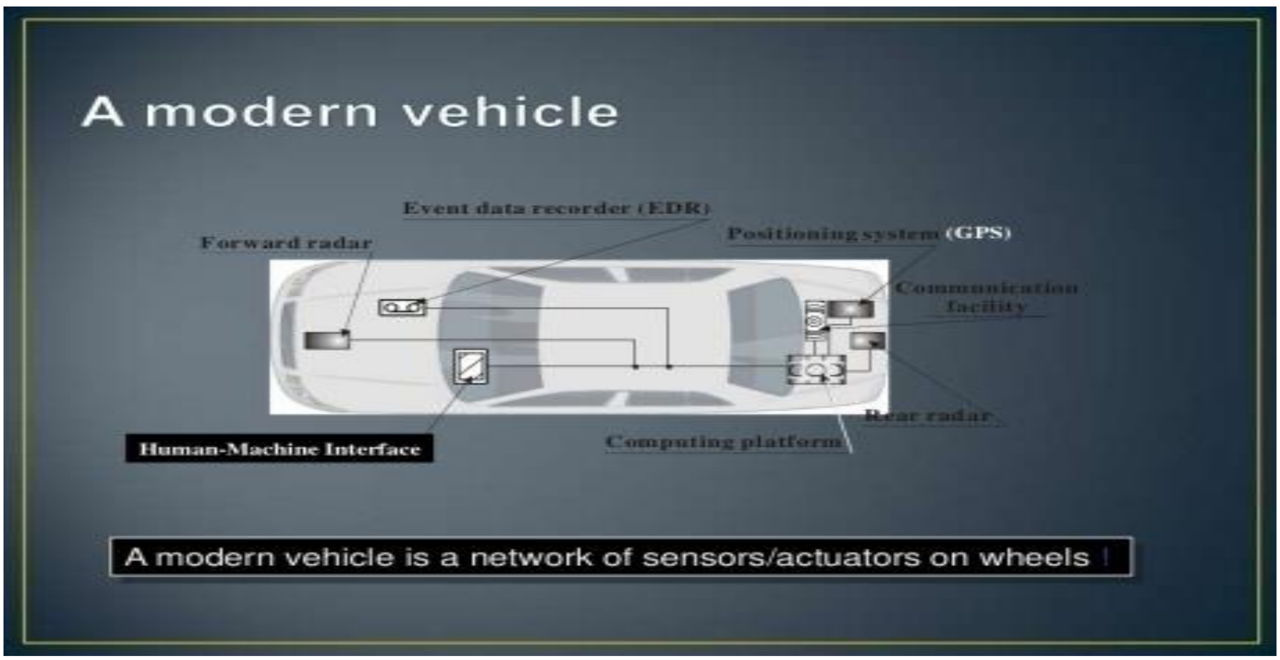

Fig.2: Architecture of Modern Vehicle

REVIEW

S.No.	Name	Author	Objective	Limitations
1.	The congestion control within VANET[12]	Bouassida, M.S. and Shawky, M	1. Developed a congestion control approach based on the concept of Dynamic priority-based scheduling 2. Evaluated dynamic priority factor based on: node speed consideration, message utility consideration and message validity consideration	1. This approach requires context exchange between neighbor nodes which generates a communication overhead 2. In addition this research does not address the problem of broadcast

				storm.
2.	Congestion Control in wireless networks for vehicular safety application [14]	Zang, Y.P. , Stibor, L. , Cheng, X. , Reumerman, H.J. , Paruzel A. , & Barroso, A.	1. Developed a congestion control algorithm for event-driven safety messages. 2. This algorithm evaluated the performance of the safety Electronic Brake Light with Forwarding (EEBL-F) 3. Set the predefined threshold based on channel usages level. 4. Each device periodically senses the channel usages level, and detects the congestion whenever the measured channel usages level exceeds the predefined threshold.	1. Measuring the channel usages level is too difficult to analyze under realistic environment due to different traffic load. 2. In addition this research fails to notice important issues of uni-priority and reliability
3.	Adaptive congestion control for DSRC vehicle networks.[13]	He. J., Chen, H.C.	1. Proposed congestion control algorithm for DSRC based on safety applications. 2. They just assumed the control channel (CCH) is successfully reserved for event-driven application. 3. Set the channel occupancy time as threshold 4. If the channel occupancy time measured at a node in CCH interval is longer than a given threshold, all beacon safety messages will be blocked immediately in the remainder of that CCH interval and the CCH interval followed to reduce channel load and reserve space for event-driven safety message.	1. CCH is reserved without testing the successfully rate for event-driven safety messages. 2. Measuring the channel occupancy time is too difficult to analysis; it needs the proper rate control design.
4.	Distributed fair transmit power adjustment for VANETs[15]	M. Torrent-Moreno, P.Santi and H. Hartenstein	1. Research defined Max Beaconing Load (MBL) as threshold and assumed that threshold of MBL is set to a fixed level	1. According to optimal bandwidth usages the control channel cannot be achieved through assigning a fixed MBL value in some cases such as a. By having a fixed MBL value, a specific bandwidth will be scheduled for sending event driven messages. This results in having wastage in control channel bandwidth in times of not having notable number of event-driven messages to send b. When a few number of beacons are needed to be sent because of slow change of network topology in traffic james on the street or

				highways
5.	Congestion control framework for emergency messages in VANETs,[16]	M. Y. Darus and K. A. Bakar	1. Scans the messages queues and monitor channel communications based on defined threshold. 2. Forward phase is responsible to deliver emergency messages to the adjacent node and also the farthest node for fast propagation	1. Measurement to defined threshold is too difficult 2. Forward phase is totally dependent on the threshold
6.	A Taxonomy for congestion control algorithms in vehicular ad hoc networks. [Online][17]	M. R. J. Sattari, R. M. Noor, and H. Keshavarz.	1. A scheme for congestion control by sending Beacon Adaptive methods of setting the rate or range of transmission, instead of using the fixed values of 10Hz and 250m. 2. The beacon messages are used by the neighboring vehicles (nodes) to be aware of their environment as well as preventing potential dangers. The event-driven safety messages are generated when an abnormal condition or an imminent danger is detected and are disseminated within a certain range with higher priority.	1. Fixed range of transmission sometimes becomes the problem in proper dissemination 2. Beacon messages generate the load into the network.
7.	Congestion control in vehicular ad hoc networks[18]	L. Wischhof and H. Rohling	1. The control algorithm uses an application specific utility function and encodes the quantitative utility information in each transmitted data packet in a transparent way for all users within a local environment. 2. A decentralized algorithm then calculates the "average utility value" of each individual node based on the utility of its data packets and assigns a share of the available data rate proportional to the relative priority.	1. Every transmitted Packet contain extra information the leads extra overhead in to the network. 2. Extra calculation required for each and every transmission
8.	Discovering automobile congestion and volume using VANET's[19]	M. F. Fahmy and D. N. Ranasinghe	1. Vehicles listen for the neighbors beacons and decide that it is in congestion. All the vehicles are equipped with short range wireless devices and each node has a unique ID which is an Integer. 2. Each device does the beaconing in random intervals. Here each vehicle builds a speed map based on the speed of other vehicles in its vicinity and transmits it to neighboring vehicle.	1. A node can experience very long channel access delays due to the risk of the channel being busy during its listening period messages.
9.	Vehicle traffic congestion management in vehicular ad-hoc	B K Mohandas, R. Liscano and O. W. W. Yang	1. A traffic information sharing and route selection procedure to address the problem of vehicle traffic congestion is presented	

	networks[20]			

II. CONCLUSION

In conclusion, the above mentioned research papers provide some fascinating insights into the congestion control in VANETs. At the same time, the review gives the various limitations of proposed work in the research papers. The analytical study and its results suggest that we have much more to learn about congestion control in VANETs. This research and other research to follow will contribute to the effective evolution of congestion control management in vehicular Ad-hoc network.

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