A Survey on Data Dissemination Techniques used in VANETs

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ABSTRACT
In vehicular ad hoc networks data transfer is typically done with the help of multihop communication in which the high speed vehicles are acting as the data carrier. The vehicles are constrained to move on definite path depending on the road layout and the traffic conditions. In vehicular ad hoc network multihop data delivery is very complicated job because of the high mobility and frequent disconnections occurring in the vehicular networks. The biggest challenge in vehicular ad hoc networks is the collection of information like accident, speed limit, any obstacle on road, road condition, traffic condition, commercial advertisement, etc, for the safety and convenience purpose. In many dissemination techniques, the vehicle carries the packet until it finds any other vehicle in his range which is moving towards the direction of the destination and then it forwards the packet to that vehicle. Since the road layouts are already defined, the vehicle selects the next road having minimum latency to forward the packet to the destination. We can only calculate the probabilistic estimate that which path should be followed for minimizing delay so that limited available bandwidth can be efficiently utilized.

Keywords
Vehicular Ad hoc Networks; Road Side Unit; carry and forward; data dissemination; dissemination capacity; vehicular density

1. INTRODUCTION
The vehicular ad hoc networks (VANETs) are actually the mobile ad hoc networks (MANETs) having very high mobility in which every vehicle node is acting as a host as well as router and forwarding packets to other mobile nodes [1, 2, 3] and changing their topology very fast. Therefore, the protocols used for MANETs are not necessarily be suits to VANETs and can be optimized for providing better results. VANETs forms decentralized networks. VANETs perform the communication between the vehicle-to-vehicle (V2V) and vehicle-to-roadside (V2R), which not only enhances traffic safety but can also enable infotainment applications via multihop communication, between vehicles [4, 5]. The mobile node can send their current location information to the nodes existing at some particular location using location management protocol and can reply of their request [6, 7]. The multihop data delivery is a challenging job due to large, highly mobile and sparsely connected vehicular networks. There are some techniques based on the density of the vehicles on the particular road. It is supposed that the delay is tolerable up to some limit and [1, 8] provides the model of effective route of destination and reply from that vehicle in tolerable delay. The road side unit (RSU) is typically the buffering point or they act as a router to provide communication between vehicles. At every intersection the data packets can be transferred to the RSU and the packet will be delivered to the vehicles that can transfer this packet to the destination with minimum delay.

In vehicular ad hoc network the delivery is not only single hop but multihop delivery of data could be done and even the vehicle which is miles away from the destination can also query there request like – traffic condition in the city can be obtained by the vehicles when they are out of city. In these situation vehicle can forward their request to the other vehicles and can receive the response in some seconds or in fraction of minutes. Many data dissemination protocols [9] have been proposed to disseminate information about obstacles information, traffic conditions and mishap on the roads.

There are two type of the communication in VANETs, first in which the delay could be tolerated and in others it could not be. The data like commercial advertisements, parking condition at the parking place, remaining stock status at the commercial stores, estimated arrival time of bus at stop, schedule of the meeting etc are some of the examples where slight delay is tolerable. The prediction of available parking space information sharing model has been proposed in [10]. By using inter vehicle communication vehicles can collect traffic jam information by calculating the approximate arrival time of vehicles at any location proposed in [11]. However, these types of services are already available in 3rd generation mobile systems but these services are very costly and are not available in the infrastructure less environment or infrastructure damaged environment. The cost of vehicular ad hoc networks is very high but the facilities obtained on traffic safety, commercial applications given in [12, 13, 14] can show the requirement of VANETs. On the other hand, there are many places where slight delay may be responsible for the loss of life. Ex- During the war period vehicle may find some poisonous gases or detects some mines or any other dangerous substance or activity then it needs to forward this message to other members of the mission and save many lives. This has been expressed that with the help of the relay, carry and forward the message can be send to destination with out establishing end to end connectivity. There was the problem of the efficient delivery of data. Vehicle assisted data delivery (VADD) has been proposed [1] for those vehicles whose requests can tolerate some delay on their request. As a result packet delivery ratio, data packet delay, protocol overhead was found outstanding.

In this paper we are presenting some available techniques which are based on pull and push based mechanism. One mechanism deals with data pouring (DP) and buffering concepts that how the limited available bandwidth could be efficiently utilized and dissemination capacity (DC) of network could be improved. By performing data pouring data is periodically broadcast to the road and buffering makes this data available not only for those vehicles which are coming on this road but also for those vehicles which are moving on cross roads and approaching to intersection with this road. In some situation the message should be delivered in least time, like- warning messages, because human requirement typically ranges from 0.7 seconds to 1.5 to response on any message and more than 60% accidents could be avoided if the message is received at proper time. The mechanism of multihop emergency message dissemination in VANETs is discussed in [15].

VANET is facing many challenges in regard to Media Access Control (MAC), data aggregation, data validation, data dissemination, routing, network congestion, performance analysis, privacy and security [16]. The more popular data (push data) needs more bandwidth than less popular data (pull data) is proposed in [17]. Spectrum of 75 MHz in the 5.9 GHz band has been allocated by Federal Communications Commissions (FCC) for Dedicated Short Range Communication (DSRC) [18]. This enhances the bandwidth and reducing latency for vehicle to vehicle and vehicle to infrastructure communication.

The rest of this paper is organized as follows: Section-2 describes several data dissemination techniques in the vehicular ad hoc networks and finally section-3 concludes this paper and explains the future.

2. DATA DISSEMINATION TECHNIQUES

Data dissemination is a challenging task because by utilizing limited bandwidth, maximum data has to disseminate over the vehicular network. Many researchers have provided several techniques to disseminate data so that the data can be accessed more efficiently. Some of the techniques are described here.

Xu *et al*. have proposed data dissemination issues in the VANET in the scheme called opportunistic dissemination (OD) scheme [19] and similar type of approach has been discussed in [20, 21, 22]. In this approach, the data center is periodically broadcasting the data, and the vehicles which are passing through the range of data center, they are receiving and storing the data. Whenever two vehicles will reach into the transmission range of each other, they exchange data. There is no need of any infrastructure and hence, is suitable for highly dynamic VANETs. But drawback of this scheme is that the data can not be efficiently updated in the urban areas where the vehicle density is too high because using this scheme media access control (MAC) layer collision [23] occurs.

In push based data dissemination scheme data is managed by data center which collects the data from the out side world and make it ready to deliver to the vehicles. The data center can be a computer having a wireless interface; it may be a wireless access point, or an infostation [24]. Data center makes a list of the data items that has to be disseminated over network. It transmits this information on the road with header which stores all the necessary information like source id, source location, forwarding direction, packet generation time, etc. Data item also has two attributes.

1. Dissemination zone in which packet can transmit.
2. Expiration time after which time the packet will expire.

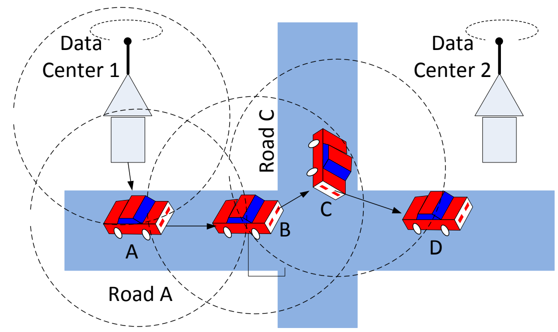

Figure 1. Directional broadcast.

Zhao, Cao [8] have proposed Data Pouring and buffering scheme for push based data dissemination. The Data Pouring (DP) scheme selects one or some road having high density and mobility of vehicles i.e. axis road (A-road) and data center delivers data not only on that road but on the crossing roads (C-roads) if the vehicles are near to the intersection on C-roads as explained in figure 1. The Data Pouring Intersection Buffering (DP-IB) mechanism uses relay and broadcast stations which are actually the buffers (IBer) [25, 26]. These IBers are placed at the intersection points and used to store data at the intersections. In the DP-IB scheme the data has been transferred from data center to the buffers present at the intersections by this way the availability of the data is increased at the intersection and the load on the server is reduced and data delivery ratio is increased. IBers periodically rebroadcast data so that vehicles passing through C-road can receive data packets. IBers update themselves with the updated data send by data center. There may be possibility of collision between the new data item send by data center and broadcast data by IBer. To avoid this collision, broadcast period is divided into two parts.

1. Busy period in which IBer can only broadcast data
2. Idle period in which IBer only listen the forwarded data.

The broadcast cycle time at the intersection T_i is used to determine DC, delivery ratio of DP and DP-IB scheme. This T_i should be less than the time taken by vehicles to go through intersection region i.e. t_i to guarantee that all the vehicles moving from the intersection can receive the broadcast data.

The delay in the DP scheme is more because many time receiver can not receive data packets in a single cycle and in Reliable DP (R-DP) scheme, vehicles uses request to send/clear to send (RTS/CTS) handshakes to reduce collision and hidden node problem but due to this handshake, delay is more as it blocks the flow until it receives the acknowledge of the previous packets and in DP-IB scheme the delay is more as IBer uses only idle cycle to receive the forwarded packets. The delivery ratio of DP is good for very small set of data but as size of data set increases it decreases. The R-DP and DP-IB have very high data delivery ratio for limited data set size but as the data set size increases more the delivery ratio of R-DP falls whereas DP-IB scheme keeps the same delivery ratio.

The pull based dissemination scheme is mainly used by vehicles to query the data for the specific response from data center or from other vehicles. Pull based scheme is used by some specific users. In this scheme the data is managed by the data center and the vehicles which are moving on the road. When the vehicle needs any data query then firstly these vehicles sends beacon message to find the list of neighbor vehicles. These vehicles are already equipped with digital maps, having street-level maps and traffic details like traffic density and vehicle speed on roads at different times [27].

The carry and forward mechanism is used to deliver the data in this approach. In this mechanism data packets are carried by the vehicles and when they found and other vehicle moving in the direction of destination in his range, it forward that packet to this vehicle. This mechanism takes tolerable delay to transfer data to the destination. In this approach data packets are mostly transferred using wireless channels but if the packet has to be transferred through the roads then those roads will be chosen for data transfer through which highly mobile vehicles are moving. Since the vehicular ad hoc network are unpredictable in nature, so optimal path for successful routing can not be computed before sending the packet. So the dynamic path selection is done through out the packet forwarding process.

Since, pull based mechanism is generally used for making queries and receiving the response. So this whole process is typically divided into two sub processes.

A. Requesting data from moving vehicle to fixed location-

This mechanism is explained in Vehicular Assisted Data Dissemination (VADD) protocol and forwards packet either in Intersection mode or in straightway mode until it reaches to the destination.

B. Receiving response from fixed location to moving Vehicle-

If the GPS system is used then using this exact location of the vehicle may be calculated and the trajectory of vehicle could be calculated and this trajectory could be included with the query response packet and forward to the intermediate vehicles and these intermediate vehicles will calculate the destination position.

Zhao, Cao [1] have proposed Vehicular Assisted Data Dissemination (VADD) scheme for pull based data dissemination. VADD protocol deals with the pull based mechanism of data dissemination in VANETs. When the data has to be forwarded from one place to another place then this protocol suggests that path selection should be done on the basis of high density of vehicle even by following that path data has to traverse more distance but data forwarding delay will be less on this path.

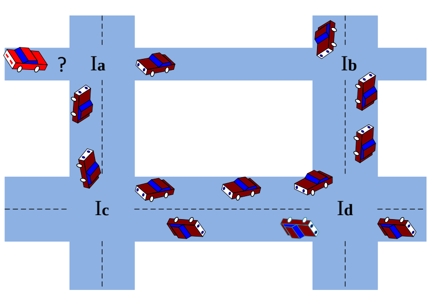

Figure 2. Find a path to the destination.

Suppose any vehicle is coming closer to the intersection I_a and it is willing to send a request to his friend at the corner of intersection I_b (as shown in figure 2). To forward the request through $I_a \rightarrow I_c$, $I_c \rightarrow I_d$, $I_d \rightarrow I_b$ would be faster than through $I_a \rightarrow I_b$ even though the latter provides geographically shortest possible path. The reason is that in case of disconnection, the packet has to be carried by the vehicle, whose moving speed is significantly slower than the wireless communication. VADD follows the following basic principles.

A. Vehicle in Intersection Mode

As shown in figure-3 vehicle A has a packet to forward to certain destination. There are two available vehicles for carrying the packet; B moving south and C moving north. A has two choices on selecting the next hop for the packet: B or C. If B is selected then it is geographically closer to D and can easily and immediately forward packet to D, whereas C could also be selected because by selecting C packet will move in the north direction as the vehicle C is moving towards the north direction.

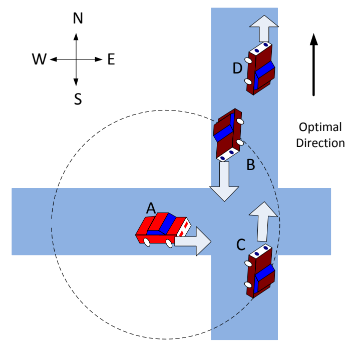

Figure 3. Select the next vehicle to forward the packet.

These two choices lead to two different forwarding protocols: Location First Probe (L-VADD) and Direction First Probe (D-VADD).In location first probe, the vehicle reaching to the intersection checks the priority order of the direction of flow of data packet and forwards the packet to the vehicle having high priority order. But in the L-VADD there are chances of the routing loop in which the vehicle is forwarding some packet to the vehicle in its range and that packet is forwarding the same packet back to the vehicle from which he got that packet as the next hop forwarding. This routing loop is avoided by simply using a mechanism in which every vehicle is using the previous hop information and never transfers the packet to that vehicle from which it has taken the packet as a previous hop. Now in the direction first probe the packet is forwarded to the vehicles which are moving in the direction of desired packet forwarding direction. The D-VADD protocol is free from routing loops. In Multi-Path Direction First Probe (MD-VADD) packets may be forwarded in more than direction. In this scheme the packet carrier forwards the packet using D-VADD protocol but it does not delete the packet from its buffer and waits for any vehicle which is moving in the higher priority direction and forwards the packet as it finds any such vehicle. The process of data buffering is continued until it finds any vehicle having highest priority. L-VADD shows better performance than all other VADD protocols when there is no routing loop occurs but when the routing loop occurs then the performance affects severely and data delivery ratio decreases. So Hybrid probe H-VADD is developed in which both L-VADD and D-VADD protocols are used. Firstly packet is forwarded using L-VADD protocol but as the routing loop occurs the L-VADD protocol is dropped and D-VADD protocol is used.

B. Vehicle in straightway mode

In this mode simple greedy approach is used to forward the packet to the destination in which packets waits for vehicles moving in the direction of destination and as it finds such vehicle it forwards the packet to that vehicle.

The delivery ratio of the H-VADD protocol provides best delivery ratio of all other protocols. Delay in H-VADD is equivalent to the MD-VADD when the vehicle density is low as it depends more on D-VADD protocol to avoid the routing loops and when vehicle density is more, delay becomes equal to L-VADD**.** H-VADD has advantage of both D-VADD and L-VADD.

Gupta *et al.* proposed Vehicle Density Dependent Data Delivery (VD4) [28] protocol that deals with efficient data delivery in VANETs. As the packet can be forwarded through multiple paths but that path should be chosen which is going to take minimum tolerable delay. Therefore, at every intersection data packets are transferred to RSU and RSU forwards this packet to the vehicle which is moving to the optimal road to the destination with minimum delay.

In this protocol, the packet is transmitted from source to destination using the intermediate node. The vehicle needs two types of transmission

1. In which packet is forwarded to the vehicle which is farthest to this vehicle in its range.
2. In which packet is carried by the vehicle until it is getting any vehicle in its range as shown in figure 4. This transmission is slower than previous one but very important during the forwarding process.

As the vehicle reaches to the RSU, the time of arrival of vehicle, the speed of vehicle, direction of movement and data packets are obtained by RSU. If this packet is already present at that RSU then it is dropped else the packet is forwarded to the farthest vehicle present in its range traveling towards the destination.

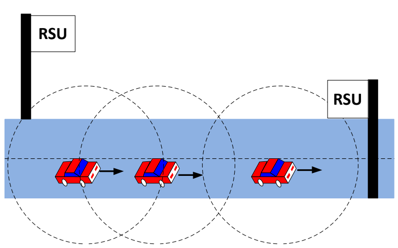

Figure 4. Packet carried partially by a vehicle and partially wirelessly transmitted.

Similarly, if the packet is found as acknowledge packet then it is deleted from the memory of RSU but if it is not present then its entry is made in the memory of RSU and the also the packet is forwarded to the farthest vehicle present in its range traveling towards the destination. These packets are delivered to all the vehicles moving towards the destination until one of the packets is delivered to the RSU at the next hop. When this packet is delivered at next hop, the acknowledgement is sent by that RSU to the source RSU via traveling in the same direction. When the acknowledge packet is received by source RSU, the packet transmission stops and packet deleted from the memory of the RSU. In the case of high density vehicular conditions, the VD4 performance is nearly similar to the performance of Hybrid-VADD. But in case of high density road conditions VD4 performance is better than the performance of Hybrid-VADD.

X. Yang *et al.* have proposed Vehicle Collision Warning Communication (VCWC) [13] protocol for forwarding warning messages to other vehicles moving on the road. When any vehicle is suffering some kind of mechanical failure or any accident has occurred on the road to any vehicle. Then this vehicle is danger to the other vehicles that are passing through the same road. The vehicles that are behaving abnormally are Abnormal Vehicle (AV) vehicles (figure 5) and they generate Emergency Warning Messages (EWMs) which includes speed, direction of motion and location of event. In VCWC protocol, EWM message is send by the AV's and this message is repeatedly transmitted as the every vehicle approaching to AV needs that message. But this retransmission of the same data packet actually creates the redundancy of same data.

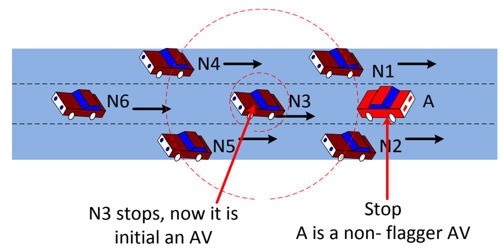

Figure 5a. N3 sends EWM and A becomes a non-flagger AV.

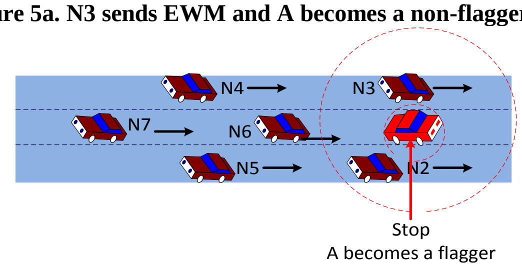

Figure 5b. N3 drives away; A identifies itself as a flagger.

Every AV may be in one of the three states, initial AV, non-flagger AV and flagger AV. As the vehicle becomes abnormal it is an initial AV. Initial AV becomes non-flagger AV by eliminating redundant EWMs and this transmission of message will be further carried by only that vehicle which has over headed the AV vehicle and depending upon the road situations non-flagger AV can be converted into flagger AV If non-flagger AV is not receiving any EWM message from its followers after the Flagger Timeout (FT) timer expires that was set by non flagger AV. and resumes the EWM messages transmissions at the minimum required rate.

As shown in figure 5a, trailing vehicle N3 stops by receiving EWM messages from vehicle A. and then N3 starts transmitting EWM messages. Since both A and N3 are messaging the same warning so A stops messaging and enters in the non flagger state. After some time when the vehicle N3 is getting way on some other lane then vehicle A has again to start EWM messaging and will enter into flagger state (As shown in Figure -5b).

In VCWC different kind of messages have different priority levels and EWMs have highest priority. EWM delivery delay is the time taken between the occurrences of emergency at A and first successful receives of EWM message at V. EWM message may suffer some delay due to queuing delay, channel allocation delay and may face some retransmission delay due to collision, etc. Waiting time can be viewed as figure - 6. In this mechanism the delay in retransmission of the packet depends on the k^{th} retransmission and initial transmission rate λ. This VCWC protocol can satisfy emergency warning delivery requirements and support a large number of AVs at the low cost of channel bandwidth.

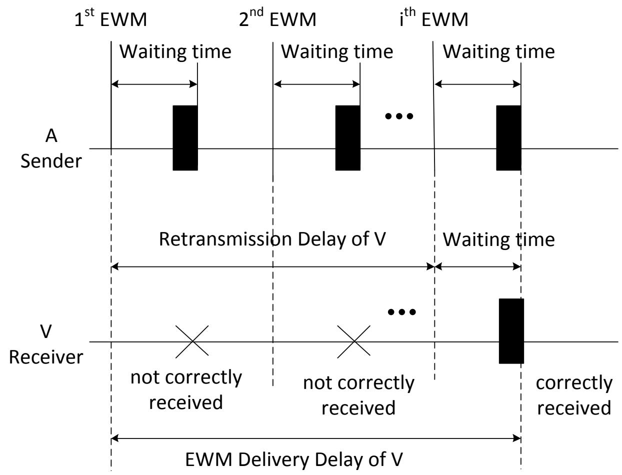

Figure 6. Waiting Time and Retransmission Delay.

3. CONCLUSIONS

Depending upon particular road situation and the vehicle condition, the protocol is changing as every protocol has its own advantages and disadvantages. Some protocol needs high priority as they are providing safety to the vehicles in which packet forwarding delay is not allowed, on the other hand several other protocols may be used at the situation where slight delay is tolerable. Simultaneously since there is limited bandwidth, protocol used should not allow the redundant packets so that maximum data can be disseminated over the network, which is a big challenge. In future we will try to device an algorithm which can work for both push and pull based data transmission and which can reduce the redundant data transfer so that maximum data can be disseminated over the road and efficient utilization of available bandwidth could be done. In future we will work on the selection criteria that in which case the vehicle should participate in the broadcasting.

We hope that this concise work will help to make better understanding to those researchers who are new to applications of VANETs and pave their way for developing new ideas to enhance the working of these networks.

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