A

Seminar II Report

on

VADD : VEHICLE ASSISTED DATA DELIVERY IN VANET

Submitted in Partial Fulfillment of
the Requirements for the Degree
of

Bachelor of Engineering

in

Computer Engineering

to

North Maharashtra University, Jalgaon

Submitted by

Kajal K.Patil

Under the Guidance of

Mr. P. D. Sharma

DEPARTMENT OF COMPUTER ENGINEERING
SSBT's COLLEGE OF ENGINEERING AND TECHNOLOGY,
BAMBHORI, JALGAON - 425 001 (MS)
2016 - 2017

SSBT's COLLEGE OF ENGINEERING AND TECHNOLOGY,
BAMBHORI, JALGAON - 425 001 (MS)
DEPARTMENT OF COMPUTER ENGINEERING

CERTIFICATE

This is to certify that the seminar II entitled *VADD : Vehicle Assisted Data Delivery In VANET*, submitted by

Kajal K.Patil

in partial fulfillment of the degree of *Bachelor of Engineering* in *Computer Engineering* has been satisfactorily carried out under my guidance as per the requirement of North Maharashtra University, Jalgaon.

Date: September 29, 2016
Place: Jalgaon

Mr. P. D. Sharma
Guide

Prof. Dr. G. K. Patnaik
Head

Prof. Dr. K. S. Wani
Principal

Acknowledgements

First of all I would like to extend our deep gratitude to almighty God, who has enlightened us with power of knowledge.I would like to thanks to our Principal,Dr.K.S.Wani sir.I wish to express my sincere and deep gratitude to Dr. G. K. Patnaik sir (Head of computer department, COET Jalgaon) for giving me such a great opportunity to develop this seminar. Inspiration and Guidance are invaluable in all aspects of life especially on the fields of gratitude and obligation and sympathetic attitude which I received from my respected Project Guide, Mr. P.D. Sharma sir, whose guidance and encouragement contributed greatly to the completion of this Seminar. Thanks to all faculty members of Computer Engineering Department and all friends for their co-operation and supports in making this seminar successful. Acknowledge my sincere gratitude to all who have directly or indirectly helped me in completing this seminar successfully.

Kajal K.Patil

Contents

List of Figures

Abstract

Multi-hop data delivery through vehicular ad hoc networks is complicated by the fact that vehicular networks are highly mobile and frequently disconnected. To address this issue, we adopt the idea of carry and forward, where a moving vehicle carries the packet until a new vehicle moves into its vicinity and forwards the packet. Different from existing carry and forward solutions, we make use of the predicable vehicle mobility, which is limited by the traffic pattern and the road layout. Based on the existing traffic pattern, a vehicle can find the next road to forward the packet to reduce the delay.We propose several vehicle-assisted data delivery (VADD) protocols to forward the packet to the best road with the lowest data delivery delay. Experimental results are used to evaluate the proposed solutions. Results show that the proposed VADD protocols outperform existing solutions in terms of packet delivery ratio, data packet delay and protocol overhead. Among the proposed VADD protocols, the Hybrid Probe (H-VADD) protocol has much better performance.

Chapter 1

Introduction

1.1 Summary

Vehicular ad hoc networks is useful in road safety and many commercial applications. vehicular network can be used to alert drivers to potential traffic jams, providing increased convenience and efficiency.

In this chapter section 1.2 describes Problem Defination, section 1.3 describes Concept, section 1.4 describes Data Delivery in sparsely connected AD HOC Networks ,section 1.5 describes THE VADD MODEL.

1.2 Problem Defination

Vehicular ad hoc networks is useful in road safety and many commercial applications. For example, a vehicular network can be used to alert drivers to potential traffic jams, providing increased convenience and efficiency. It can also be used to propagate emergency warning to drivers behind a vehicle (or incident) to avoid multi-car collisions. To realize this vision, FCC has allocated 75 MHz of spectrum for dedicated short range communications (vehicle-vehicle or vehicle-roadside), and IEEE is working on standard specifications for inter vehicle communication. As more and more vehicles are equipped with communication capabilities that allow for inter vehicle communication, large scale vehicular ad hoc networks are expected to be available in the near future.

Most of the aforementioned works are limited to one hop or short range multi hop communication. On the other hand, vehicular ad hoc networks are also useful to other scenarios. For example, without Internet connection, a moving vehicle may want to query a data center several miles away through a vehicular ad hoc network. To further motivate our work, consider the widely deployed Wireless LANs or info stations which can be used to deliver advertisements and announcements such as sale information or remaining stocks at a department store; the available parking lot at a parking place; the meeting schedule at a conference room; the estimated bus arrival time at a bus stop. Since the broadcast range is limited, only clients around the access point can directly receive the data. However, these data may be beneficial for people in moving vehicles which are far away. For example, people driving may want to query several department stores to decide where to go; a driver may query the traffic cameras or parking lot information to make a better road plan; a passenger on a bus may query several bus stops to choose the best next stop for bus transfer. All these queries may be issued miles or tens of miles away from the broadcast site. With a vehicular ad hoc network, the requester can send the query to the broadcast site and get reply from it. In these applications, the users can tolerate up to seconds or minute of delay as long as the reply eventually returns.

1.3 Concept

Multi-hop data delivery through vehicular ad hoc networks is complicated by the fact that vehicular networks are highly mobile and sometimes sparse. The network density is related to the traffic density, which is affected by the location and time. For example, the traffic density is low in rural areas and during night, but very high in the large populated area and during rush hours. Although it is very difficult to find an end-to-end connection for a sparsely connected network, the high mobility of vehicular networks introduces opportunities for mobile vehicles to connect with each other intermittently during moving. Namboodiri[1] showed that there is a high chance for moving vehicles to set up a short path with few hops in a highway model. Further, a moving vehicle can carry the packet and forward it to the next vehicle. Through relays, carry and forward, the message can be delivered to the destination without an end-to-end connection for delay tolerant applications.

Specifically, when a vehicle issues a delay tolerant data query to some fixed site, we propose techniques to efficiently route the packet to that site, and receive the reply within reasonable delay. The proposed vehicle-assisted data delivery (VADD) is based on the idea of carry and forward. Different from existing carry and forwarding approaches we make use of the predicable mobility, which is limited by the traffic pattern and road layout. Extensive experiments are used to evaluate the proposed data delivery protocols. Results show that the proposed VADD protocols outperform existing solutions in terms of packet delivery ratio, data packet delay and protocol overhead.

1.4 Data Delivery in sparsely connected AD HOC Networks

Data delivery in an ad-hoc network heavily relies on the routing protocol, which has been extensively studied for many years. However, most protocols assume that intermediate nodes can be found to setup an end-to-end connection; otherwise, the packet will be dropped. To deal with disconnections in sparse ad hoc networks, researchers adopt the idea of carry and forward, where nodes carry the packet when routes do not exist, and forward the packet to the new receiver that moves into its vicinity

1.4.1 Protocols that differ mainly on how much control is posed on the mobility

There exist two categories of data delivery protocols that differ mainly on how much control is posed on the mobility in order to forward the message from one node to another. One option is to follow the traditional ad hoc network literature, and add no control on mobility. The other option is to control the mobility of the mobile nodes to help message forwarding.

There are several protocols in the first category.The work by Vahdat and Becker uses epidemic routing.[3] Whenever two nodes meet, they exchange the data that they do not possess. The extensive data exchanges ensure eventual message delivery, given unbounded time and buffer, at the cost of many redundant packets. Epidemic routing seems to be an ideal solution to deal with partitioned network. However, to implement it in vehicular ad hoc network appears to be much more difficult than it seems, particularly in high density areas where info stations are usually deployed. Synchronizing these nodes to reduce collisions turns out to be a tough problem, and the excessively redundant data exchange easily leads to severe congestion in these areas, affecting both packet delivery ratio and delay. This limits its usefulness in large scale vehicular ad hoc networks. Davis et al. improved the epidemic routing protocol by exploiting the mobility history to assist packet dropping to meet the buffer size constraint. However, they assume that nodes frequently met in the past should meet in the future, but this assumption may not hold in vehicular ad hoc networks where most vehicles meet only once even if they meet.

1.4.2 Protocols that exploits controllable mobility

The protocols in the second category exploits controllable mobility. Li and Rus proposed to have mobile nodes [2] to proactively modify their trajectories to transmit messages.

Zhao et al. proposed to add message ferry into the network, and control their moving trajectory to help data delivery.[2] However, in vehicular networks, it is impossible to modify the trajectories of the moving vehicles or to find such ferries. Briesemeister and Hommel proposed a protocol to multicast a message among highly mobile vehicles.[4] In this protocol, not all vehicles are equipped with wireless transceivers, and a vehicle is allowed to buffer the message until a new receiver moves into its vicinity. The idea of carry and forward .

The existing data delivery schemes either pose too much control or no control at all on mobility, and hence not suitable for vehicular networks. Different from the aforementioned work, we make use of the predictable vehicle mobility which is limited by the traffic pattern and road layout. For example, the driving speed is regulated by the speed limit and the traffic density of the road; the driving direction is predictable based on the road pattern; and the acceleration is bounded by the engine speed. Next, we propose protocols which exploit the vehicle mobility pattern to better assist data delivery. In this paper, we will not consider security issues and the motivation for vehicles to relay, which can be addressed by many existing techniques

1.5 THE VADD MODEL

In this section, we first give the assumptions, the overview of Vehicle-Assisted Data Delivery (VADD), and then present the VADD delay model.

1.5.1 Assumptions

We assume vehicles communicate with each other through short range wireless channel (100m-250m).[3] The packet delivery information such as source id, source location, packet generation time, destination location, expiration time, etc, is specified by the data source and placed in the packet header. A vehicle knows its location by triangulation or through GPS device, which is already popular in new cars and will be common in the future. Vehicles can find their neighbors through periodic beacon messages, which also enclose the physical location of the sender.

We assume that vehicles are equipped with pre-loaded digital maps, which provide street-level map and traffic statistics such as traffic density and vehicle speed on roads at different times of the day. Such kind of digital map has already been commercialized. The latest one is developed by Map Mechanics , which includes road speed data and an indication of the relative density of vehicles on each road. Yahoo is also working on integrating traffic statistics in its new version of Yahoo Maps, where real traffic reports of major US cities are available. We expect that more detailed traffic statistics will be integrated into digital map in the near future.

1.5.2 VADD overview

VADD is based on the idea of carry and forward. The most important issue is to select a forwarding path with the smallest packet delivery delay. Although geographical forwarding approaches such as GPSR which always chooses the next hop closer to the destination, are very efficient for data delivery in ad hoc networks, they may not be suitable for sparsely connected vehicular networks.

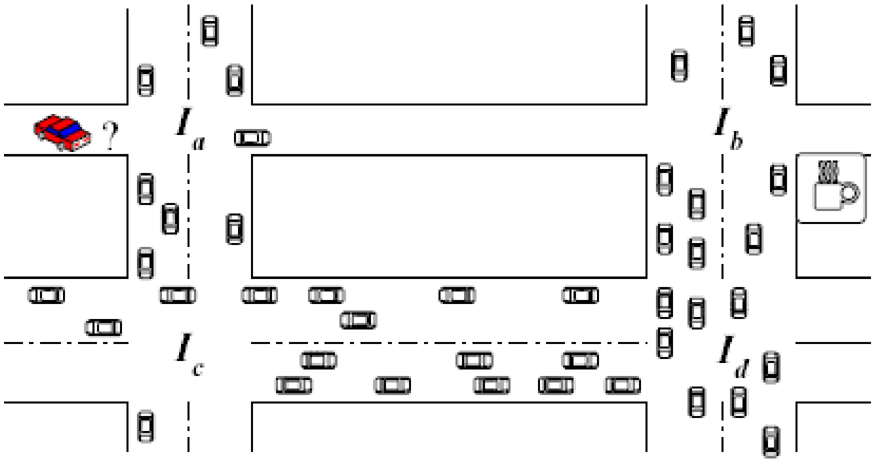

Figure 1.1: Find a path to the coffee shop

As shown in Figure, suppose a driver approaches intersection Ia and sends a request to the coffee shop (to make a reservation) at the corner of intersection Ib. To forward the request through Ia Ic, Ic Id, Id Ib would be As shown in Figure 1, suppose a driver approaches intersection Ia and sends a request to the coffee shop (to make a reservation) at the corner of intersection Ib. To forward the request through Ia Ic, Ic Id, Id Ib would be faster than through Ia Ib, 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.

- *Principles of VADD*

In sparsely connected networks, vehicles should try to make use of the wireless communication channel, and resort to vehicles with fast speed otherwise. Thus, our VADD follows the following basic principles:

- Transmit through wireless channels as much as possible.
- If the packet has to be carried through certain roads, the road with higher speed should be chosen.
- Due to the unpredictable nature of vehicular ad-hoc networks, we cannot expect the packet to be successfully routed along the pre-computed optimal path, so dynamic path selection should continuously be executed throughout the packet forwarding process.

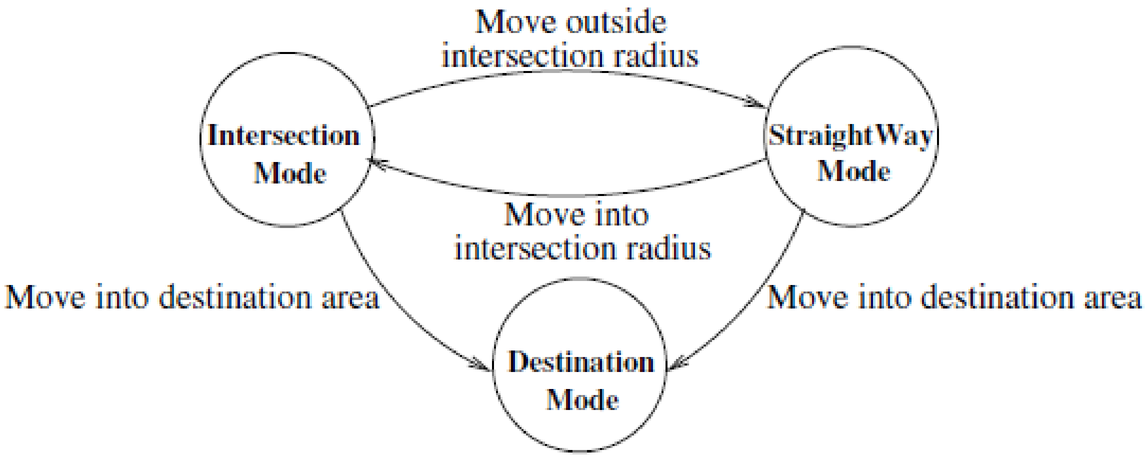

Figure 1.2: The transition modes in VADD

As shown in Figure , VADD has three packet modes: Intersection, Straight Way, and Destination based on the location of the packet carrier (i.e., the vehicle that carries the packet.) By switching between these packet modes, the packet carrier takes the best packet forwarding path. Among the three modes,the Intersection mode is the most critical and complicated one,since vehicles have more choices at the intersection.

1.5.3 The VADD Delay Model

To formally define the packet delivery delay, we need the following notations.

1. rij : the road from Ii to Ij .
2. lij : the Euclidean distance of rij .
3. ij : the vehicle density on rij .
4. vij : the average vehicle velocity on rij .
5. dij : the expected packet forwarding delay from Ii to Ij .

$$d_{ij} = \begin{cases} \alpha \cdot l_{ij}, & \text{if } \frac{1}{\rho_{ij}} \le R \\ \frac{l_{ij}}{v_{ij}} - \beta \cdot \rho_{ij}, & \text{if } \frac{1}{\rho_{ij}} > R \end{cases}$$

Figure 1.3: Equation 1

where R is the wireless transmission range, and alpha and beta are two constants used to adjust dij to a more reasonable value. Equation indicates that if the average distance between vehicles is smaller than R, wireless transmission is used to forward the packet. Otherwise, vehicles are used to carry the data. Even in this case, it is still possible to occasionally have wireless transmissions, and hence beta rho is used as a correction factor.

One way to view the VADD delay model is to represent the vehicular network as a directed graph, in which nodes represent intersections and edges represent the roads connecting adjacent intersections. The direction of each edge is the traffic direction. The packet forwarding delay between two adjacent intersections is the weight of the edge. Given the weight on each edge, a naive optimal forwarding path selection scheme is to compute the shortest path from source to destination by applying Dijkstras algorithm.[5] However, this simple solution does not work, since we cannot freely select the outgoing edge to forward the packet at an intersection. Only those edges with vehicles on it to carry packets can be the candidate path for packet forwarding. However we can not know for sure which direction the packet will go at the next intersection. In other words, it is impossible to compute the complete packet forwarding path.

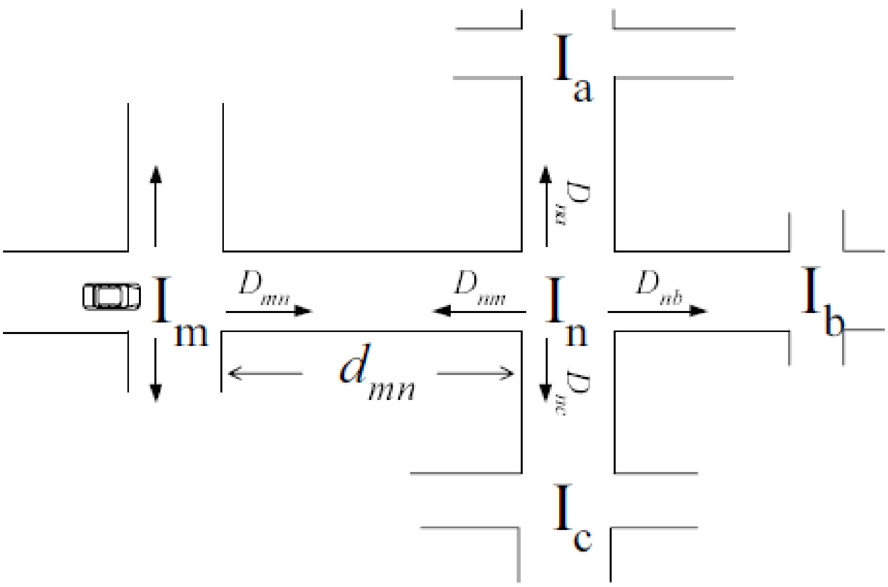

Figure 1.4: An example of VADD Delay Model

To address this problem, we propose a stochastic model to estimate the data delivery delay, which is used to select the next road(intersection). We first introduces the following notations:

1. Dij : The expected packet delivery delay from Ii to the destination if the packet carrier at Ii chooses to deliver the packet following road rij .
2. Pij : the probability that the packet is forwarded through road rij at Ii.
3. N(j): the set of neighboring intersections of Ij . As shown in Figure 1.3 , for a packet at Im, the expected delay of delivering the packet through road rmn is

$$D_{mn} = d_{mn} + \sum_{j \in N(n)} (P_{nj} \times D_{nj})$$

Figure 1.5: Equation2

Figure 1.4 illustrates how to apply Equation 2 to a simple triangle road, which only contains three intersections Ia, Ib,and Ic. Suppose a data packet reaches Ia, and the destination is Ic. The forwarding scheme needs to decide whether to forward the packet through the road to Ic or Ib. This is done by computing the value of Dac and Dab, and choosing the smaller one. By applying Equation 2, we have the following linear equations:

- Dac = dac
- Dab = dab + Pba Dba + Pbc Dbc
- Dba = dba + Pab Dab + Pac Dac
- Dbc = dbc
- Dcb = 0
- Dca = 0

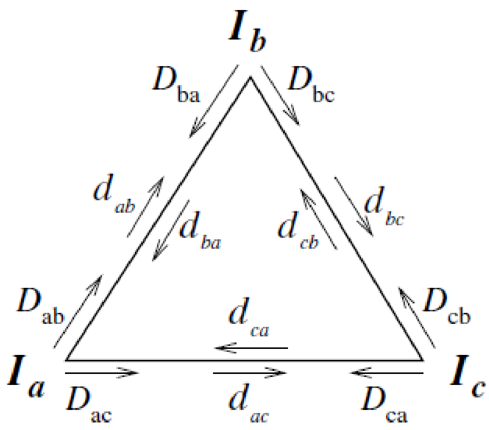

Figure 1.6: One Road Graph

Note that both dcb and dca are equal to 0, since the packet already arrives at destination Ic, and will not be forwarded anymore. We can easily solve Equation 3 and get Dac and Dab:

$$D_{ac} = d_{ac} \qquad D_{ab} = \frac{1}{1 - P_{ab} \cdot P_{ba}} \times (d_{ab} + P_{ba} \cdot d_{ba} + P_{ba} \cdot P_{ac} \cdot d_{ac} + P_{bc} \cdot d_{bc})$$

Figure 1.7: Equation3

Unfortunately, to find the minimum forwarding delay between two arbitrary intersections is impossible, since it involves unlimited unknown intersections. However, by placing a boundary including the source and the destination in a connected graph, we are able to find the expected minimum forwarding delay between them. Figure 5 shows one such boundary which includes the sender and the destination (hot spot). Certainly there are many other ways to place the boundary, as long as the destination is enclosed. Since only the roads within the boundary are used as available paths.[7] to compute the delay, a large boundary covering more high density streets can generally find more close-to-optimal paths, but with more computation overhead. Thus, there is a tradeoff between computational complexity and accuracy in delay estimation when selecting the boundary. Since this is not the major concern of and it does not affect the correctness of the algorithms.Since the number of intersections inside the boundary is finite, we can derive for each outgoing edge of every intersection within the boundary. In this way, a linear equation system is generated.

This chapter gives Introduction Of VADD with it's problem defination and it's Issues. and Next chapter gives the Literature Survey Of VADD.

Chapter 2

Literature Survey

2.1 Summary

In this chapter section 2.2 describes VADD Protocols Used in the Intersection Mode ,section 2.3 describes Data Forwarding in the Straight Way Mode and section 2.4 describes Protocols for Query Data Return.

2.2 VEHICLE-ASSISTED DATA DELIVERY PROTOCOLS

In this section, we present the VADD protocols. We first present the protocols used in the Intersection mode and the contact mode. Then we present protocols on the Straightway and protocols for data return.

2.2.1 VADD Protocols Used in the Intersection Mode

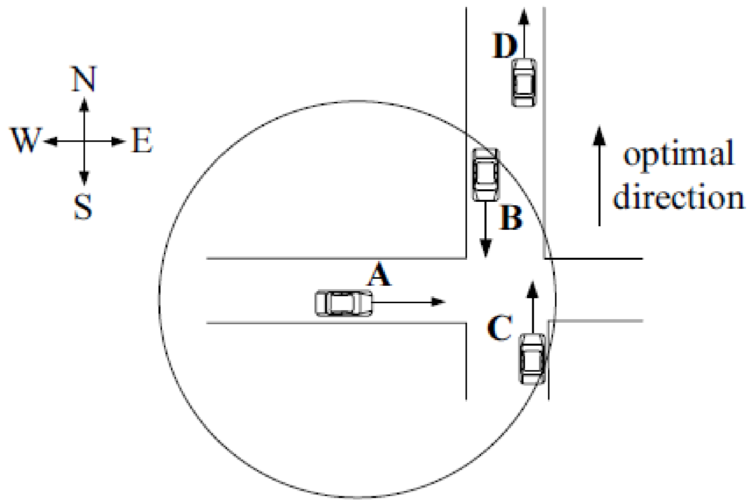

Figure 2.1: Select the next vehicle to forward the packet

By deriving and solving Equation at the intersection, the packet carrier can sort all the outgoing directions and check if there is a contact available to help forward through that direction. However, to determine the next hop among all available contacts and ensure a packet to go through the pre computed direction is not trivial. As shown in Figure, vehicle A has a packet to forward to certain destination. Assume the optimal direction for this packet is North. There are two available contacts for the packet carrier: B moving south and C moving north. A has two choices on selecting the next hop for the packet: B or C. Both choices aim at forwarding the packet towards North: selecting B because B is geographically closer towards North and provides better possibility to exploit the wireless communication (e.g. B can immediately pass the packet to D, but C cannot;) whereas selecting C because C is moving in the packet forwarding direction.[7] These two choices lead to two different forwarding protocols: Location First Probe (L-VADD) and Direction First Probe (D-VADD).

- *Location First Probe (L-VADD)*

Given the preferred forwarding direction of a packet, L-VADD tries to find the closest contact towards that direction as the next hop.

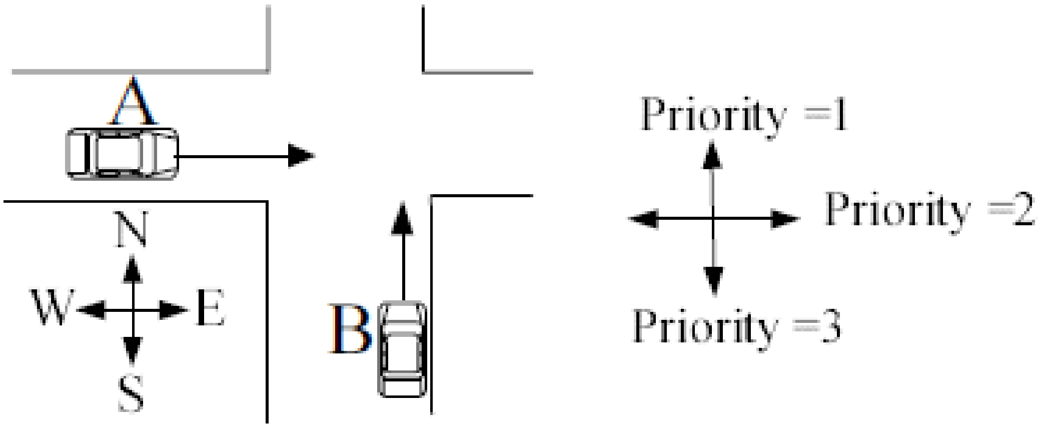

Figure 2.2: A scenario of routing loop

As shown in Figure, vehicle A forwards the packet to B. Seems like this is better than selecting C as the next hop, since B can immediately forward packet to D. Even if D does not exist, selecting B seems as good as selecting C, since B will meet C shortly and the packet can be passed to C anyway. However, L-VADD may result in routing loops. Figure shows one such scenario. Assume the North direction has the highest priority and East has the second highest priority. A first checks North and can not find any contact. Then, it checks East, and finds B which is closer towards East. Thus, it forwards the packet to B. Upon receiving the packet, B checks the North direction first and finds A is closer towards North, and then passing the packet back to A. There is a loop between A and B. A simple solution to break the routing loop is to record the previous hop(s) information. As in the above example, A records its own id as the previous hop before forwarding the packet to B. When B receives the packet, and decides to forward the packet to A, it checks the previous hop record and finds that A is the previous hop. To avoid a routing loop, B will not forward the packet to A, and look for the next available contact. A routing loop may involve n(n ¿ 2) nodes. To detect such a routing loop, all these previous n hops should be recorded. However, such loop detection mechanism dramatically degrades the forwarding performance, since the detection mechanism may prevent many valid nodes from being considered as the next hop. As shown in Figure , if A is the packet carrier after a routing loop has been detected, and there is no other contact available except B. Suppose after both A and B pass the center of the intersection, A continues going East and B to North. The packet should be forwarded to B since B will move towards the best direction, and the path between A and B becomes loop-free. However, as the packet records B as the previous hop, forwarding the packet to B is not allowed. Therefore, even though we can record previous hop information to detect routing loops, many valid forwarding paths cannot be used.

- ### *Direction First Probe (D-VADD)*

Routing loop occurs because vehicles do not have an unanimous agreement on the order of the priority, and then do not have an agreement on who should carry the packet. To address this issue, D-VADD ensures that everyone agrees on the priority order by letting the vehicle moving towards the desired packet forwarding direction carry the packet. In D-VADD, the direction selection process is the same as L-VADD. For a selected direction, instead of probing by location (in L-VADD), D-VADD selects the contacts moving towards the selected direction. Among the selected contacts, the one closest to the selected direction is chosen as the next hop. As shown in Figure , D-VADD selects C as the next hop when the selected direction is North. Since B is not moving North, it will not be considered. Therefore, D-VADD only probes vehicles moving towards the direction whose priority is higher than or equal to the moving direction of current packet carrier. As the probing strictly follows the priority order of the direction, D-VADD has the following property: Any subsequent packet carrier moves towards the direction whose priority is higher than or equal to that of the current packet carrier.

In D-VADD, if there are available contacts which can help forward the packet, the packet may pass through the intersection quickly (in milliseconds). However, most likely, a vehicle entering an intersection passes the packet to a contact moving towards a sub-optimal direction before it meets the contact moving towards the optimal direction. It would be better if the packet carrier can carry the packet a little bit longer and pass the packet to the optimal direction. Certainly, this packet carrier should not hold the packet longer than the packet delay of going through the sub-optimal direction.

- ### *Multi-Path Direction First Probe (MD-VADD)*

MD-VADD is inspired by this idea. In order to increase the chance of finding contacts to the optimal direction, the packet carrier does not delete the packet from its own buffer until it is forwarded towards the direction of the highest priority.More specifically, after a contact is selected as the next hop by D-VADD, the packet carrier passes a copy of the packet to the selected contact, and continues buffering the packet. In addition, it marks the packet as SENT, and record dsent as the moving direction of the contact to which the packet has just been passed. Later, if the packet carrier meets another contact at the same intersection moving towards the direction whose priority is higher than dsent, it sends another copy to the contact, and updates dsent accordingly. Only when dsent reaches the direction of the highest priority, the packet is deleted from the buffer. Immediately after the vehicle exits the Intersection Mode, it checks all buffer entries, and removes all packets that have been marked as SENT.

In MD-VADD, some packets may be forwarded through multiple paths and a vehicle may receive a packet which is already in its buffer. In this case, the vehicle simply discards the duplicated packet. MD-VADD is expected to have better packet delivery ratio and lower packet delay than D-VADD. In the worst case, it has the same performance as D-VADD, since at least one copy of the packet will use the currently available contacts as in D-VADD. However, MD-VADD may involve multiple paths and create duplicate packets, and hence it requires more buffer space and generates more network traffic.

- *Hybrid Probe (H-VADD)*

Comparing to other VADD protocols, L-VADD without loop detection can minimize the packet forwarding distance and hence the delay if there is no loop. However, the routing loop in L-VADD severely affects the performance and leads to a low packet delivery ratio. Loop detection mechanism can remove the routing loop, but may also increase the forwarding delay. D-VADD and MD-VADD are free from routing loops; however, they give priority to the moving direction and may suffer from long packet forwarding distance, and hence long packet delivery delay.

An ideal VADD protocol should minimize the geographic forwarding distance and does not have routing loops. To achieve this goal, we design a scheme called Hybrid Probe (H-VADD), which works as follows. Upon entering an intersection, H-VADD behaves like L-VADD with loop detection. If a routing loop is detected, it immediately switches to use DVADD (or MD-VADD1) until it exits the current intersection. In this way, H-VADD inherits the advantage of using the shortest forwarding path in L-VADD when there is no routing loop, and use D-VADD (or MD-VADD) to address the routing loop problem of L-VADD.

2.2.2 Data Forwarding in the StraightWay Mode

Data forwarding in the StraightWay mode is much simpler than the intersection scenario, since the traffic is at most bidirection. We can simply specify a target location and then apply the geographically greedy forwarding. To specify the target location, a simple scheme is to use the intersection ahead as the target. A better solution needs to identify whether taking the intersection ahead or the one behind as the target location. The intersection behind may have shorter delay in case the packet carrier fails to meet any contact in the previous intersection, and the chances to meet any one at the next intersection ahead is even less. In this case, we use Equation 2 to compute the expected delay of forwarding data to these two intersections, and pick the one with the smallest expected delay as the target. There is one minor modification when using Equation 2. Originally, dij is the expected forwarding delay between two neighbor intersections. Now it is the delay between the current location and the selected intersection: the one ahead or the one behind. dij can still be computed by applying Equation 1, using the distance between the current location and the selected intersection.

If the identified target intersection is the intersection ahead, the packet is forwarded to the target intersection by geographical routing. If there is no vehicle available to forward ahead, the current packet carrier continues to carry the packet. If the identified target intersection is the intersection behind, the packet carrier keeps holding the packet, and waits for a vehicle in the opposite direction. Upon meeting one, it immediately forwards the packet.

2.2.3 Protocols for Query Data Return

VADD for delivering packets from a moving vehicle to a fixed location (information server), which provides information and answers the query. Next, we discuss how to send the query data back to the moving vehicle. This is different from the previous data delivery protocol since the destination is moving. There are some previous studies on delivering data to mobile sinks in sensor networks. However, these studies implicitly assume a short round trip time since end-to-end connection normally exists in sensor network, and the mobile sink can not move too far away from its source in such a short time.

The solution is based on the predictable vehicle mobility. It is natural to assume the vehicle is moving with pre-specified trajectory, at least unchanged for a short time period due to the road layout. If GPS is used, the GPS system already knows the destination of the vehicle and can figure out the trajectory of the vehicle. These moving trajectory can be added to the query packet. After the information server receives the query, it attaches the moving trajectory with the query reply. Intermediate vehicles that delivering the query reply needs to calculate the destination position, and deliver the query reply to that position. To save computation overhead, the information server can calculate the expected position of the requester based on the moving trajectory. During the calculation, the information server can use the query delivering time to estimate the query reply delivering time. As this is only an estimate, and the requester may have changed its position, a broadcast can be used. To reduce the broadcast overhead, an expanding ring based approach where the number of flooding hops slowly increases from 1 to a threshold.[6]

This chapter describes Vehicle Assisted Data Delivery Protocols such as VADD Protocols Used in the Intersection Mode, Data Forwarding in the Straight Way Mode and Protocols for Query Data Return. and the next will contains the Performance Evaluation.

Chapter 3

Performance Evaluation

3.1 Summary

This chapter describes the Performance Evaluation of various protocols of VADD such as L-VADD, D-VADD, MD-VADD and H-VADD.

This chapter describes the Performance Evaluation .In this chapter section 3.2 describes The Data Delivery Ratio, section 3.3 describes The Data Delivery Delay,section 3.4 describes Data Traffic Overhead .

The L-VADD protocol may have routing loops, There are mainly two versions of L-VADD: L-VADD (with loop)and L-VADD (loop-free), where L-VADD (loop-free) records previous three-hop information to avoid intersection routing loops. The H-VADD protocol is a hybrid of the L-VADD protocol and the D-VADD protocol. Though by applying D-VADD in H-VADD for simplicity, it does not exclude the possibility of using MD-VADD in H-VADD. We compare the performance of the VADD protocols to several existing protocols: DSR protocol, the epidemic routing protocol and GPSR . Since GPSR is not proposed for sparsely connected networks, its performance is very poor in vehicular ad hoc networks. To have a fair comparison, we extend GPSR by adding buffers. In this way, GPSR (with buffer) can be considered as a simple carry and forward protocol.

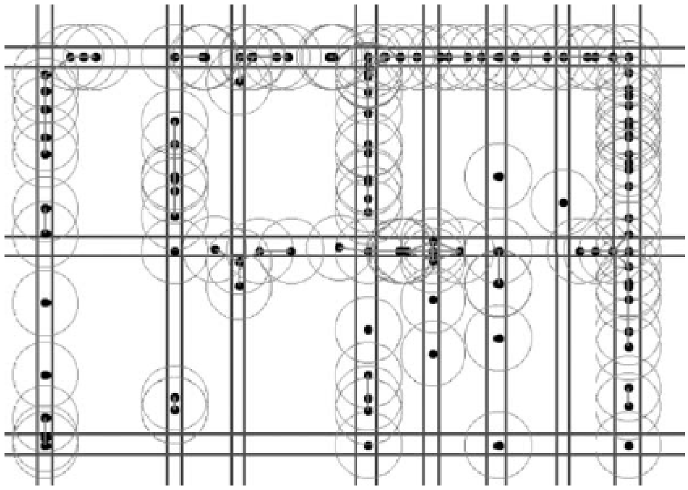

Figure 3.1: A snapshot of the simulation setup area

Different number of vehicles are deployed to the map, and the initial distribution follows the predefined traffic density. Then, each vehicle randomly chooses one of the intersection as its destination, and move along the road to this destination. The average speed ranges from 15 to 80 miles per hour, depending on the speed limit of the specific road it travels on, with a variance of 5 miles per hour. Figure shows a snapshot of the simulation area.

Certain roads are chosen to go through with higher probability to produce uneven traffic density. Among all vehicles, 15 of them are randomly chosen to send CBR data packet to fixed sites during the move. To evaluate the performance on different data transmission density, we vary the data sending rate (CBR rate) from 0.1 to 1 packet per second. For a packet to reach a certain destination, the priority ranking of the outgoing roads at the intersections are pre-computed and loaded to the vehicle as the simulation starts. The performance of the protocols are measured by the data delivery ratio, the data delivery delay, and the generated traffic overhead.

3.2 The Data Delivery Ratio

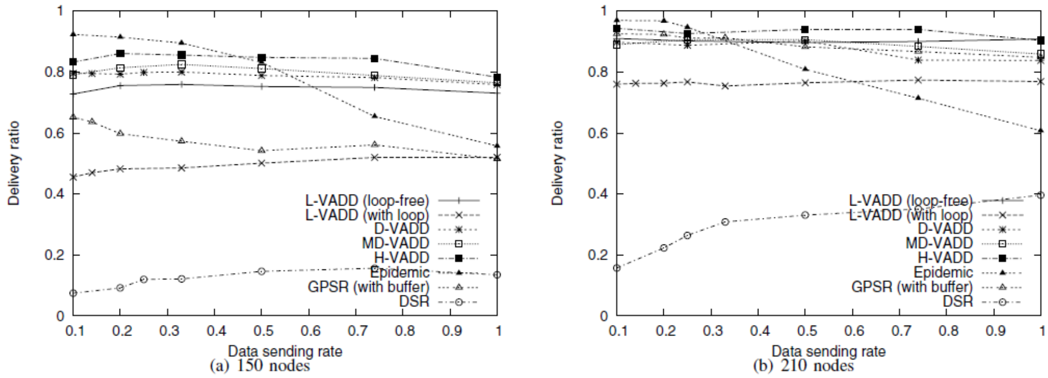

Figure 3.2: Data delivery ratio as a function of the data sending rate

Figure shows the data delivery ratio as a function of the data sending rate and compares the performance under different vehicle density settings. As shown in the figure, DSR has the lowest data delivery ratio and is not suitable for sparsely connected vehicular networks. Although GPSR (with buffer) is implemented in a carry and forward way, it is not a good choice since the geographical approach sometimes leads to void areas with few vehicles passing by, and it cannot make use of the traffic patterns. Therefore, its delivery ratio is poor when the vehicle density is low, as shown in Figure. However, when vehicle density is high where the connectivity is much better than the previous scenario, GPSR achieves very good delivery ratio, since the node mobility will help carry and forward the packets which temporarily reach the void zone. Intuitively, epidemic routing explores every possible path to the destination, and should represent the upper bound of the data delivery ratio. This is true when the data sending rate is low (e.g., when the data rate is 0.1 packet per second), and the node density is low.[7]

However, as the data sending rate increases, the epidemic routing protocol under performs most VADD protocols. This is due to MAC layer collisions. As the number of data requests increases, the network traffic dramatically increases in epidemic routing , thus increasing the number of collisions and reducing the packet delivery ratio. At more densely deployed network as Figure , the delivery ratio of the epidemic protocol drops even faster. While the epidemic routing is very sensitive to the data rate and nodes density, the VADD protocols, particularly H-VADD, steadily hold the close-to-optimum delivery ratio at different settings.

Figure also compares several VADD protocols. Among them, the H-VADD protocol has the benefits of both L-VADD and D-VADD, presenting the best delivery ratio. The MD-VADD protocol shows slightly better delivery ratio than the D-VADD protocol and the loop-free L-VADD at lower vehicle density, and approximately the same ratio at high vehicle density. As discussed in the previous section, loop detection prevents some packets from being sent to the loop vulnerable neighbors, which reduces the chance of using some valid good paths. However, with a high vehicle density, intersection routing loops do not occur frequently, and the L-VADD (loopfree) protocol does not need to exclude too many innocent nodes to recover from the loop, and its delivery ratio becomes higher.

3.3 The Data Delivery Delay

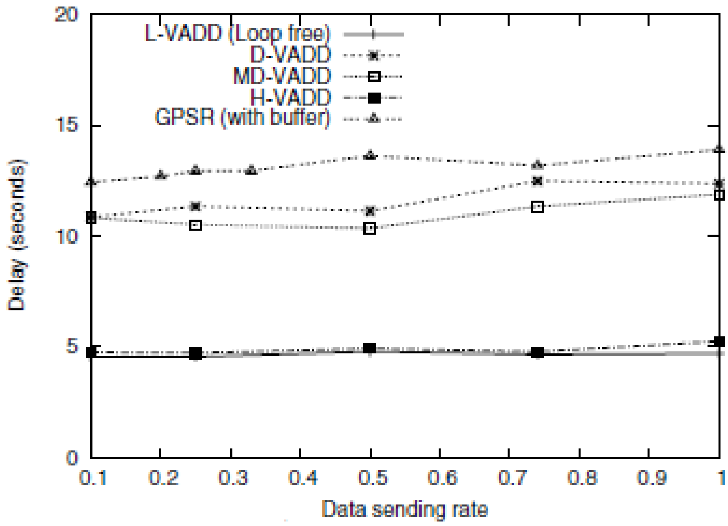

Figure 3.3: The lowest 75 delivery delay

In this section we compare the data delivery delay from moving vehicles to fixed sites using carry and forward schemes. Here, we do not consider DSR since its data delivery ratio is too low. Similarly, we do not consider the L-VADD protocol due to its low delivery ratio compared to the MD-VADD protocol and the D-VADD protocol. Note that a low delivery ratio may reduce the average data delivery delay since most undelivered packets may experience long delay. This is especially true in the DSR protocol, which only forwards packets through wireless communication whereas other carry and forward protocols also rely on the vehicle movement.

Figure shows the change of the data delivery delay by increasing the data sending rate. Epidemic routing presents the optimum delivery delay only when the data rate is very low.

As the data sending rate increases, the delay of the epidemic routing scheme also increases, because epidemic routing generates many redundant packets. As the traffic load increases, many packets may be dropped. Even though the redundant copies can help deliver the packet, the delay increases. GPSR has relatively low data delivery delay at low node density , but it is not meaningful simply because of its low delivery ratio. A valid comparison is when the GPSR protocol, the epidemic routing protocol, and the VADD protocols have similar delivery ratio, e.g., at data rate below 0.4 in Figure. In this case, GPSR shows much longer delivery delay because it does not consider the vehicle traffic pattern when making decisions.

The H-VADD protocol presents similar delivery delay as the MD-VADD protocol when the vehicle density is low, since it relies more on D-VADD for loop recovery because of more routing loops. When the vehicle density is high, the delay of the H-VADD protocol is lower than that of the MD-VADD protocol, but close to that of the L-VADD protocol. This shows that it behaves more like the L-VADD protocol, but has better packet delivery ratio than the loop free L-VADD. These results verify that H-VADD effectively captures the advantages of both L-VADD and D-VADD.The delivery delay is affected by the delivery ratio, and some extreme long-delay packets may greatly increase the mean value. MD-VADD shows slightly lower delivery delay than D-VADD since MD-VADD issues multiple copies to increase the chance of forwarding the packet through the best road.

3.4 Data Traffic Overhead

In this section, we evaluate the overhead of the carry and forward protocols by using the number of packets generated per second, which is a summation of individual packet-hops. For example, if a generated packet is forwarded 10 hops, the packet overhead is counted as 10 packet-hops. All results shown in this section are based on the 210-node deployment scenario.

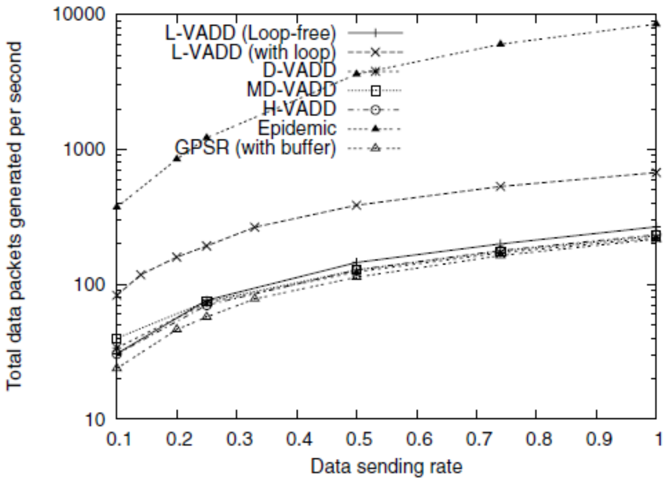

Figure 3.4: The number of packets generated

Figure shows the generated packet overhead as a function of the data sending rate. As the data sending rate increases, the number of packets generated by all protocols also increases. However, the increasing trend is different. The overhead of epidemic routing increases much faster than other protocols due to the redundant packets generated.

For the VADD protocols, L-VADD (with loop) has the highest overhead due to loops whereas all the other VADD protocols have about the same low overhead. Compared to D-VADD, MD-VADD generates a little bit more traffic since it sometimes probes multiple paths to find the best road.

This chapter describes the Performance Evaluation of various protocols of VADD such as L-VADD, D-VADD, MD-VADD and H-VADD. and the next will contains Discussion part of VADD i.e Advantages , Disadvantages and the Applications of VADD.

Chapter 4

Discussion

4.1 Summary

Comparing with GPSR (with buffer), epidemic routing and DSR , VADD performs high delivery ratio. In this chapter section 5.1 describes Advantages,section 5.2 describes Disadvantages and section 5.3 describes Application.

4.2 Advantages

- Packet delivery ratio of VADD - Comparing with GPSR (with buffer), epidemic routing and DSR , VADD performs high delivery ratio.
- VADD is suitable for multi-hop delivery.
- VADD protocols, the helper node technique is better than the other technique.
- Different from existing helper node solutions, predictable vehicle mobility is used , which is limited by the traffic pattern and road layout experiment results showed that the proposed VADD protocols outperform existing solutions in terms of packet delivery ratio, data packet delay and traffic overhead.
- VADD protocol share the property of using geographic positioning information in order to select the next forwarding hops.

4.3 Disadvantages

- VADD has the less end to end delay as compared to the existing approach.
- Dependent on GPS service.
- Reduces the network bandwidth.

4.4 Applications

- Co-operative Collision warning.
- Intersection Collision Warning.
- Work Zone Warning.
- Approaching Emergency Vehicle.
- Electronic Toll Collection.
- Data Transfer.
- Parking Lot Payment.
- Traffic Information.

This chapter describes Advantages,Disadvantages and Application of VADD in VANET and Next Chapter describes the Conclusion.

Chapter 5

Conclusions

VADD adopts the idea of carry and forward, and also explores the predictable vehicle mobility. VADD use a linear equation model combining with probabilistic method to compute the optimal forwarding direction. Four VADD protocols to forward the packet towards the optimal direction or path at the intersection. And Simulation results shows that the VADD protocols are better suitable for the multi-hop data delivery in VANET.

Many researchers and industry players believe that the benefit of vehicular networks on traffic safety and many commercial applications should be able to justify the cost. With such a vehicular network, many data delivery applications can be supported without extra hardware cost. However, existing protocols are not suitable for supporting delay tolerate applications in sparsely connected vehicular networks. To address this problem, we adopted the idea of carry and forward, where a moving vehicle carries the packet until a new vehicle moves into its vicinity and forwards the packet. Different from existing carry and forward solutions, we make use of the predicable vehicle mobility, which is limited by the traffic pattern and road layout.

As future work, we will consider using vehicles from nearby road, although this will be more complex. We will also address issues on designing protocols for query data return.

Bibliography

[1] Sandeep Kumar, Kantveer, "Vehicle Assisted Data Delievery Technique To Control Data Dissemination In Vehicular AD - HOC Networks (Vanets)" ,International Journal Of Scientific and Technology Research October 2015.

[2] Jing Zhao and Guohong Cao, "VADD- Vehicle-Assisted Data Delivery in Vehicular Ad Hoc Networks", Dec.2006 IEEE.

[3] J. Hubaux, "The Security and Privacy of Smart Vehicles," Workshop on Embedded Security in Cars (escar), Nov. 2004.

[4] J. Hubaux, The Security and Privacy of Smart Vehicles, Workshop on Embedded Security in Cars (escar), Nov. 2004.

[5] Ming-Chin Chuang and Jeng-Farn Lee, "TEAM: Trust-Extended Authentication Mechanism for Vehicular Ad Hoc Networks", IEEE 2013.

[6] M.Chitra1 and S. Siva Sathya2, Department of Computer Science, Pondicherry University, Pondicherry, "Efficient Broadcasting Mechanism for Data Dissemination in Vehicular Ad-Hoc Network", IJMNCT 2013.

[7] Fei Ye, Student Member, IEEE, Sumit Roy, Fellow, IEEE, Haobing Wang, Student Member, IEEE, "Efficient Data Dissemination in Vehicular Ad Hoc Networks", IEEE 2012.

[8] Albert Wasef and Rongling Lu, University Of Waterloo, Xiaodong Lin, University Of Ontario Institute Of Technology, Xuemin (Sherman) Shen, University Of Waterloo, "Complementing Public Key Infrastructure To Secure Vehicular Ad-Hoc Networks", IEEE 2010.

[9] Annu Mor Research Scholar, Deptt. Of Computer Science Applications, Kurukshetra University, Kurukshetra, Haryana, India, "Study of Different Type of Data Dissemination Strategy in VANET", IJESIT 2012.

[10] Sagarika Mohantya, Debasish Jenab, ”Secure Data Aggregation in Vehicular Ad Hoc Networks”: A Survey, ICCCS 2012.

[11] B.S.C. Lochert, J. Rybicki, M. Mauve, ”Scalable data dissemination for inter-vehicle-communication: aggregation versus peer-to-peer”, Inf. Technol. J. 50 (2008) 237242.

[12] Ismali salhi, Mohamed oussma and sidi mohammed ”A new architecture for data collection in VANET” 2009 IEEE.