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Review Article

A REVIEW ON VARIOUS DATA TRANSMISSION PROTOCOLS IN VANET

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A R T I C L E I N F O

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A B S T R A C T

VANET is a technology that is used in establishing a connection among moving vehicles and road side units with the help of a wireless medium called dedicated short range communication. VANET is a subpart of Mobile Adhoc Network (MANET). VANET provide applications like road safety, traffic notification and seamless communication between nodes. For these application VANET use different routing protocols. VANET uses wifi, Bluetooth for communication between source and destination nodes and also among intermediate nodes. This paper includes characteristics and challenges of VANET. Various data dissemination protocols are studied separately and their characteristics are observed and on the basis of that observation a tabular comparison of all the protocols is made.

INTRODUCTION

VANET is a technology that is used in establishing a connection among moving vehicles and road side units. It is a subpart of Mobile Adhoc Network (MANET). VANET have following applications: (i) road safety (ii) seamless communication between nodes. VANET uses wifi, wifmax, Bluetooth for communication between source and destination nodes and also among intermediate nodes. VANET is basically used to ensure the safety of a moving vehicle.

With the advancement in the field of wireless communications, its applications are being introduced based on car-to-car communication and uses standards such as Wireless Access in Vehicular Environments (WAVE) and Dedicated Short Range Communications (DSRC). Both the standards are defined in IEEE 1609.1-4 and 802.11p respectively.

With the increase in the advancement in the technology the interest area of students as well as automotive industries is increasing in this area. After all, with 60–100 embedded sensors with their corresponding microprocessors, the contemporary cars are the best mobile computing platforms that one could dream for. They are highly mobile and they have a tremendous amount of embedded computing power. For safety applications, car industries are also using VANET, at the present juncture the number of potential applications have quickly expanded beyond safety and now includes other types of applications as well. As all the nodes in vehicular ad hoc network are in moving state which lead to change in topology dynamically.

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Due to this dynamic change in topology some factors like end to end delay, packet delivery ratio, jitter increases which lead to bad connection.

Due to the importance of this problem, there have been several solutions, proposed to solve it. In this paper, we will describe some of the existing solutions and analyze each of these solutions, identify their strengths and limitations.

The rest of this paper is organized as follows. In Section II VANET architecture and its components are discussed. In Section III we provide a description of the some existing solutions to deal with VANET protocols. Section IV gives a comparison among existing solutions and Section V gives conclusion of this paper.

Architecture

Architecture includes the physical structure and style of design. VANET architecture can be classified into following three categories:

V2V

This is vehicle to vehicle architecture where vehicles act as both consumers and producers as vehicles receive information from other vehicles in the network and transmit it to other vehicles present in that network. So, both collection and distribution of data are done within the network for faster delivery of messages. v2v architecture uses following components for communication.

Application unit (AU): Application unit is a device which is embedded inside the vehicle. The main function of AU is that it uses the application provided by the sender with the help of OBU. This device is used to access internet facility in vehicle.

On board unit (OBU): It is used for exchanging information with either other OBUs or RSUs. OBU have resource command processor and its resources include a user interface which is used for establishing the connection with other OBUs, a read and write interface which is used to retrieve information and a network device which is used for short distanced wireless communication.OBS is connected to RSU thorough these short distanced communication devices. OBU is used for message transmission, data security and for geographical routing.

Roadside unit (RSU): Roadside units are the devices which are fixed along the road side and act as intermediate between sender vehicle and destination vehicle. These RSUs provide short range connectivity and is based on IEEE 802.11p radio technology.

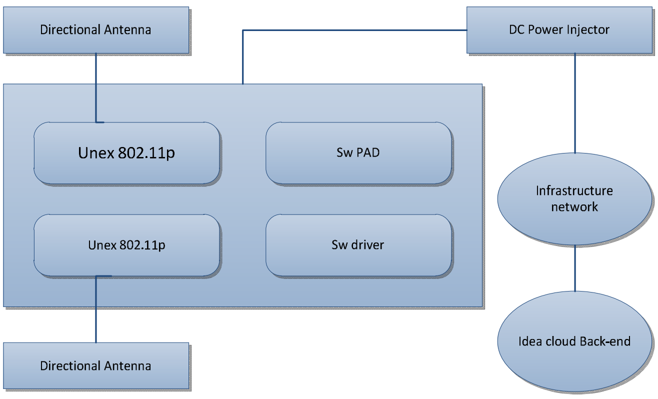

Figure 1 RSU architecture

V2I

This is vehicle to infrastructure wireless architecture in which infrastructure is used to collect information from vehicles and provide that information to other vehicles when necessary. It include vehicle to road side unit communication or vice versa.

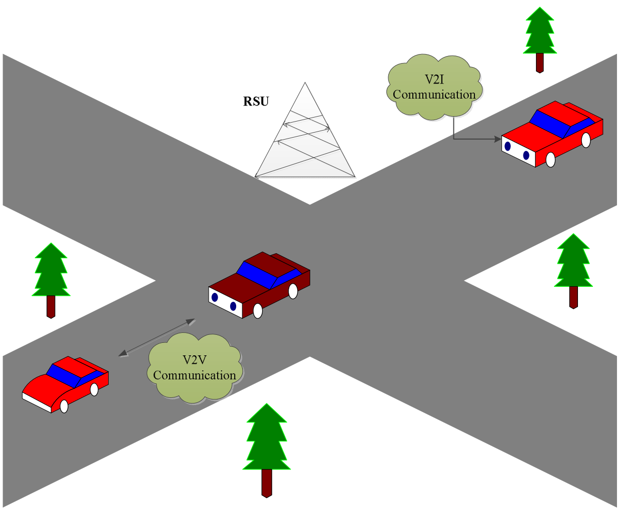

Figure 2 Communication among devices

Hybrid

This architecture is a combination of both V2V and V2I architectures. It includes communication between vehicle to vehicle and vehicle to road side units. It include the features of both v2v and v2i architecture which helps in improving the network performance. In hybrid networks we can easily detect and remove the faults/errors which occur during transmission of data. It can handle larger volume of nodes present in a network at a time.

Existing Solutions for Efficient Data Transmission

Recently, there have been several existing solutions to transmit the data packet from source to destination with minimum delay and maximum packet delivery ratio. However, most of them have drawbacks due to multiple reasons like poor connection among vehicles, bad internet connectivity etc. They are described below in compact form with their strengths and weaknesses as follows:

GPCR: Greedy Perimeter Cooordinator Routing

Lee *et al*. [1] presents a routing protocol for wireless datagram networks. This protocol use routers position and a destination address of packet to make decisions for forwarding data packets. It uses greedy forwarding algorithm to forward data packets from one hop to another.

GPCR uses the concept of junction nodes to control the next road segments that packets should follows. It contains two phases: a restricted greedy forwarding and a recovery phase. The first forwarding part uses nodes on the same road segment as potential relays, buildings and other obstacles blocks the radio signal between adjacent road segments. The only places where routing decisions are made are the junctions, packet must always be sent to the only node which is at a junction. Forwarding a packet across a junction may lead to bring GPCR to a local maximum condition. A greedy decision is made at junction, and the neighboring node which brings the maximum progress towards the destination is selected. If a local maximum is reached, the recovery mode is used.

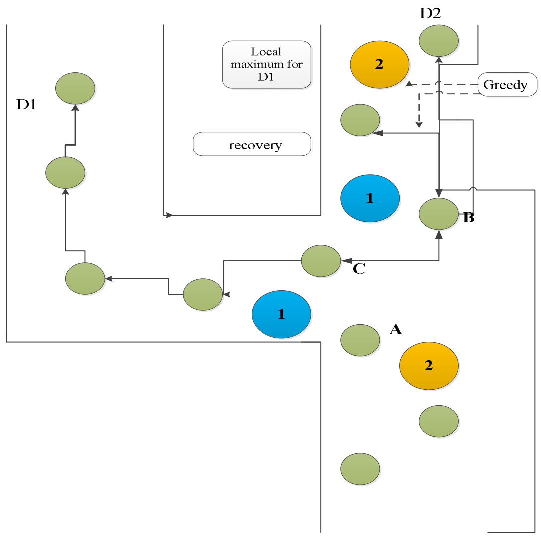

Figure 3 GPCR architecture

In recovery mode, packets are backtracked in a greedy manner to a junction node in order to find an alternate solution to return to the greedy mode. At the junction node, the right-hand rule is applied for finding the next road segment to forward the data packets.

There are three major weak points of GPCR. First, the junction nodes are selected initially and then accordingly the data transmission is done. Due to this the overhead of the protocol increases. Second, to recognize that junction node, which is faulty present inside GPCR, makes it very difficult to avoid the local maximums and consequent hop reduction. Third, although the junction node detection algorithm is very effective, but sometimes forwarding to a node at a junction is not necessary and counter-productive because many times junctions are not critical.

GSR: Goegraphic Source Routing

Lui *et al*. [2] proposed a multicasting protocol called geographic source routing. This protocol provides help for drivers in understanding the current traffic conditions for congestion avoidance and make optimal routing. GSR eliminate the broadcast storm problem by using modified directed broadcasting. The influence of traffic regulations is also analyzed and a packet forwarding strategy is introduced which is also attached with the protocol.

GSR is proposed to provide help for drivers to obtain real-time traffic conditions and possibilities in any designated areas. Initially, driver should tell its destination. After knowing the details of destination, the on-board system will calculate the valid route to reach the destination. Vehicular node will broadcast the querying packet to direct neighbor. The querying packets include the details of vehicle location, vehicle ID, destination name, destination point and a scale factor F. Scale factor F is initially 0 and the source distance from destination is denoted by R. When packet is received by direct neighbor the value of F is incremented by 1.

The advantage of GSR is that on the basis of binary selective flooding algorithm; enough road traffic status can be collected by vehicle and then it is displayed by using the on-board screen. This method does not cause broadcast storm whereas it is flexible to control the boundary of multicasting. However, DSR can be used when a given street does not have enough connectivity since it can find other routes.

The single point of failure in GSR is its frequent route breaks. This proposed protocol provides a slightly longer route to the destination node. The reason is that DSR chooses any node with the most progress, this leads in frequent route breaks. The main problem of DSR is that DSR consumes noticeably high bandwidth for routing overheads. It creates large packets because during the route discovery phase the source route is present in the headers, which leads in significant bandwidth overload. Another reason of DSR failure is the mobility of nodes.

CAR: Connectivity-Aware Routing

Naumov *et al*. [3] proposed a position based routing scheme which is designed for inter-vehicular communication in a city. In this protocol, all nodes contain information about their moving directions and speeds in the periodic HELLO beacons. When a node receives a HELLO beacon, it adds the sender information of that beacon in its neighbor table, then estimates its own and the neighbor's velocity vectors, and sets the expiration time for the entry in the neighbor table. The entry expires after a time when the positions of the current node is estimated and the neighbor become separated by more than 80% (configurable) of the average coverage range, or after two HELLO intervals (whatever is smaller). A new HELLO beacon from the neighbor updates the entry. At the same time, if the velocity vector information helps to estimate the availability of a node, the beaconing rate can be made adaptive.

CAR uses beacon signals for establishing connection with neighbor. For finding the active location of destination this protocol uses guards: standing guard and travelling guard here standing guard contains temporary state information and the later one contains information of velocity vector.

The advantage of CAR is that it is much more suitable for VANET than GPSR and GSR in terms of data delivery ratio and network throughput. In addition, CAR gives the lowest delay compared to the GPSR and GSR.

The disadvantage of using CAR is HELLO beaconing with a fixed period (with and even without jitter) may have several drawbacks such as: wasted bandwidth, delaying of data packet, increased network congestion.

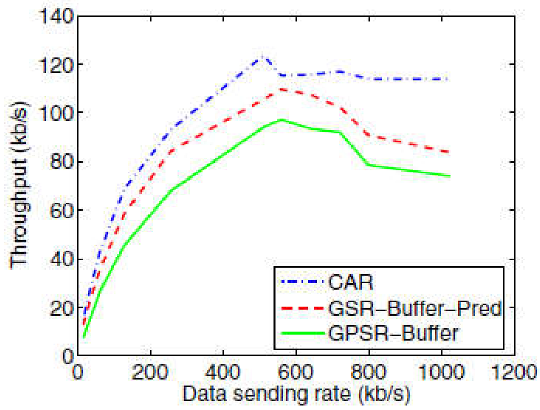

Figure 4 Throughput of networks with 100 nodes

GPRS: Greedy Paremeter stateless Routing

Karp *et al*. [4] have presented Greedy Perimeter Stateless Routing that uses geography to achieve small per-node routing state, small routing protocol message complexity, and extremely robust packet delivery on densely deployed wireless networks. GPSR generates routing protocol traffic in a quantity independent of the length of the routes through the network, and therefore generates a constant, low volume of routing protocol messages as mobility increases, yet doesn't suffer from decreased robustness in finding routes. GPSR keeps state proportional to the number of its neighbors, while both traffic sources and intermediate DSR routers cache state proportional to the product of the number of routes learned and route length in hops. GPSR's benefits all stem from geographic routing which use only immediate-neighbor information in forwarding decisions.

The advantage of using this protocol is that it can overcome the problem of local maximum by using the perimeter mode in this mode right hand rule is used for routing the path from source to destination.

The single point of failure is the maintenance of planar graphs at each node introduces a significant overhead. While all nodes need to maintain the planar graph all the time, this information is only used by nodes facing the local minimum phenomenon.

VADD:Vehicle assisted data delivery

Zhao *et al*. [5] introduce a protocol which adopted the idea of carry-and-forward for data delivery from a moving vehicle to a static destination. The most important issue is selecting a forwarding path with minimum delay in delivering the packet from one hop to another. VADD protocol attempts to keep the low data transmission delay by forwarding packets through wireless channel. In VADD, when a packet needs to carried through roads, the road with higher speed is selected. Highest speed indicates that there is less number of nodes present on the road which result in minimum delay. VADD assigns cost to edges between each two intersections by proposing delay model to estimate data delivery delay in different roads. VADD is equipped with digital map and traffic statistics such as traffic density and vehicle speed on roads at different times of the day. According to the information, VADD protocol proposed a delay model to assign cost to each edge. With these cost, VADD computes the shortest path from the source to the destination by a naive optimal forwarding path selection algorithm.

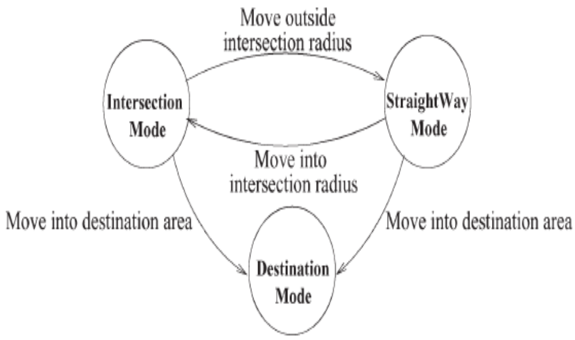

Figure 4 Transition mode in VADD[5].

The Disadvantage of VADD is that cannot freely select the outgoing road to forward the packet at each intersection.

ARBR: Adaptive Road Based Routing

Arzil *et al*. [6] proposed a novel routing protocol for VANETs, which is well adapted to continuously changing topology in such networks. ARBR includes a mechanism for tracking route-requesting vehicle when it leaves its expected location. The ARBR protocol uses two mechanisms to increase packet delivery ratio and to decrease the delay. Firstly, a high quality routing path between source and base station node is discovered and data packets are forwarded along that discovered path. After that Path maintenance is performed by updating routing information of route reply packet in intermediate nodes. The main advantage of this protocol is that ARBR outperforms GPSR and VADD in terms of both packet delivery ratio and average end-to-end delay of data packets. According to paper, the packet delivery ratio of ARBR is approximately 17% better than VADD and 55% better than GPSR*[5]. The single point of failure is also possible if the route discovery packet (RD packet) is lost because road segment quality is computed based on RD packet delivery delay.

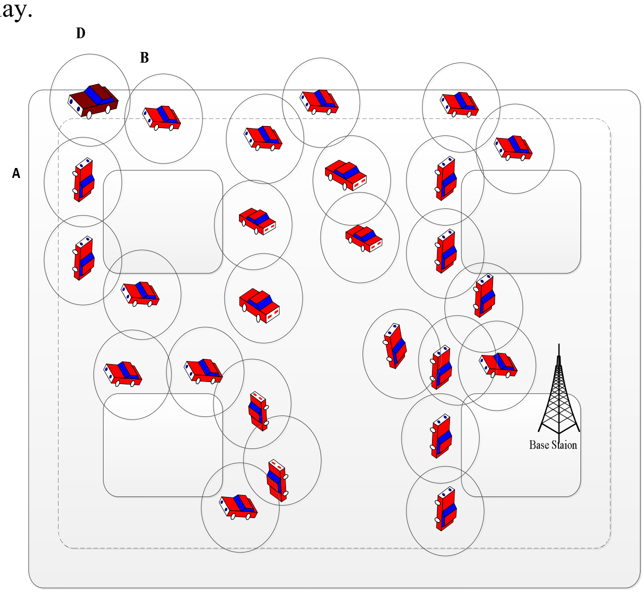

Figure 5 Route establishment in ARBR[6].

MIBR: Mobile Infrastructure Based VANET Routing Protocol

Luo *et al.* [7] presents a location based reactive routing protocol for improving packet delivery ratio and throughput. This protocol use buses, as a key component in route selecting and packet forwarding. The concept of using buses as the mobile infrastructure is to improve the network connectivity in VANET. MIBR assumes that source node know its destination point through GPS. After that road segments are chosen one by one. The transmission quality of each segment is considered and the next segment having minimum hop count to the destination is considered. For estimation of minimum hop count first estimate hop count of each road segment.

The traffic on the road is estimated according to the number of buses on road, more the number of buses more congestion will be present and more hop counts will be there. So the road with minimum number of buses is considered. So

the forwarding neighbor is selected according to the “bus first” which states that if the neighbor table contains any buses on the next road segment, choose the one which is nearest to the junction after the next junction else choose an ordinary car which is closest to the junction after next. If the neighbor table does not contains any vehicles on the next road segment, and packet is now on a bus: choose a bus with minimum distance to the next junction, else choose a vehicle which is closest to the next junction. If the neighbor table contains no vehicles on the next road segment, and packet is now on a car: choose a bus which is closest to the next junction. If not available, we should choose a vehicle which is closest to the next junction. If there are no better suitable forwarding nodes, drop the packet. The advantage of using MIBR is that it provides the highest packet delivery ratio when compared with GPSR protocol because the difference of bus and car is taken into account and buses are given higher priority to become the next hop node. Additionally, the algorithmic complexity of MIBR is very less, and the deployment is easy due to no need of static nodes or RSUs. The single point of failure can occur while estimating the number of buses present on the road because number of buses decides the traffic on the road.

DV-CAST: Distributed Vehiculer Broadcast

Tonguz *et al*. [8] proposed a distributed broadcast protocol that focuses on local topology information for handling broadcast messages in VANETs. DV-CAST can handle the broadcast flooding and disconnected network problem simultaneously. The algorithm relies only on GPS information of the one-hop neighbors and does not require any centralized node or maps. DV-CAST protocol consists of three major components: neighboring node detection, broadcast suppression, and store-carry and forward mechanisms.

The drawback occur due to the continuous transmission of hello packets because these hello packets can lead to network overhead when the nodes present in the network are more in number.

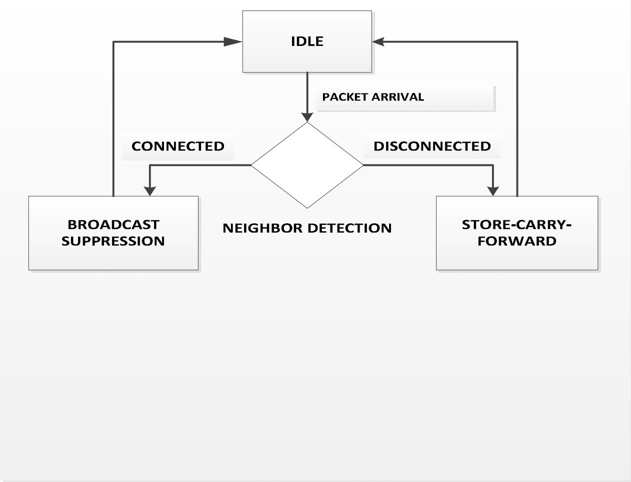

Figure 6 Route establishment in DV-CAST[7].

AODV:Adhoc Ondemand Routing Protocol

Pathak *et al*. [9] proposed improved AODV routing protocol which improve previously proposed AODV protocol in terms of throughput and link breakage. AODV is a reactive on demand routing protocol. Route discovery phase is responsible when a node wants to communicate with another node and then it reduces the overhead. Sequence numbers are used to make AODV a loop free protocol. AODV perform routing in three stages: Route discovery, data packet transmission and route maintenance.

This paper is based on improvement in existing AODV routing protocol through two step optimization in node selection and route selection for VANET. This paper includes speed and direction of vehicle for optimization. The first step is to forward RREQ request to selected nodes for route establishment. Nodes are selected on basis of their stability which also decreases overhead. Then most stable route among the possible multiple routes for transmission of packet are obtained. By this optimization, AODV finds the most stable route with minimum overhead.

Comparison of Existing Solution

From the description of each of the solutions presented in Section VI, we can easily notice that every routing protocol offers a feasible solution for the problem of packet delivery to destination in minimum time utilization.

Out of the all proposed solutions for data transmission in VANET, the solutions based on greedy approach [1, 2, 4] have caused increased overhead, frequent path breaks, the single point of failure is also possible. Naumov *et al*. [3] CAR uses HELLO beaconing with a fixed period (with and even without jitter) which leads to wasted bandwidth, delaying of data packet, increased network congestion. Zhao *et al*. [5] does not allow selecting freely the outgoing road to forward the packet at each intersection. Arzil *et al*. [6] provide comparison between the packet delivery ratio of ARBR, VADD and GPSR and ARBR is approximately 17% better than VADD and 55% better than GPSR. Luo *et al*. [7] MIBR achieves the higher packet delivery ratio when compared with GPSR protocol. Tonguz *et al*. [8] relies only on GPS information of the one-hop neighbors and does not require any centralized node or maps.

We have compared the requirements for different existing solutions and discussed about the mechanisms for each existing solutions as shown in table I. This comparison table provide efficient difference among the routing protocols and where we can use it and where not.

Table I Comparison Among Different Solutions

Protocols	Forwarding Strategy	Recovering Strategy	Mobility Model	Digital Map	QOS Parameters		
					Delay	*Packet Delivery Ratio*	*Scalability*
GPCR[1]	Greedy Approach	Flooding	VANETtMobsim	No	Less	Average	Good
GSR[2]	Greedy Approach	Flooding	M-Grid	Yes	Less	Average	Average
CAR[3]	Trajectory	Node Awareness	MTS	Yes	Less	Average	Good
GPSR[4]	Greedy Approach	Flooding	Ns-2	Yes	Less	Good	Good
VADD[5]	Opportunistic	Store and forward	Ns-2	Yes	More	Good	Good
ARBR[6]	Opportunistic	Node Awareness	Opportunistic Network Environment simulator	Yes	Less	Good	Average
MIBR[7]	Opportunistic	Store and forward	VANETMobsim	Yes	Less	Average	Good
DV-CAST[8]	Opportunistic	Store and forward	RWP	No	More	Good	Poor
AODV[9]	Greedy Approach		ONE	Yes	Less	Good	Good

CONCLUSION

This paper describe VANET, various data transmission protocol used in vanet such as Greedy parameter coordinator routing, Geographic source routing and some other routing protocols also. We discussed several currently available solutions; identify their strengths and limitations and provide comparison among them. For future work we will try to improve the efficiency of existing routing protocols and will try to reduce the transmission delay.

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