Various Routing Protocol for VANET

AkanshaBhati[1], Dr. P. K. Singh [2]
[1]*M. Tech. (Electronics &Communication Engineering),* [2]*Professor &Head of Department (Electronics & Communication Engineering)*
[12]*RadhaGovind Group of Institutions, Meerut.*

Abstract- Vehicular Ad Hoc Networks (VANET) is a subclass of Mobile ad hoc networks which provides a distinguished approach for Intelligent Transport System (ITS). The survey of routing protocols in VANET is important and necessary for smart ITS. This paper discusses the advantages / disadvantages and the applications of various routing protocols for vehicular ad hoc networks. It explores the motivation behind the designed, and traces the evolution of these routing protocols. Finally the paper concludes by a tabular comparison of the various routing protocols for VANET.

Keywords- VANET,Mobile ad hoc networks, Intelligent Transport System

I. INTRODUCTION

Vehicular networks represent a particularly new class of wireless ad hoc networks that enable vehicles to communicate with each other and/or with roadside infrastructure. Earlier, drivers were using their voice, gestures, horns, and observation of each other's trajectory to manage their behavior. When the drastic increase of vehicles made this not enough to manage, in the second half of the 19th century, traffic police took charge of controlling and managing the traffic using hand signals, semaphores and colored lights. The 1930s saw the automation of traffic signals and in the 1940s car indicators were deployed widely. Variable-message signs were introduced in the 1960s to provide information to the drivers to adapt according to the current circumstances. The information communicated via all of these means is, however, very less: road infrastructure typically provides the similar information to all cars, and the amount of information that the drivers can share directly with one another is restricted. Recently, drivers can exchange more information, such as traffic information and directions, to each other via car phones or citizen band radio.

Wireless communication supports more customized and complete information to be exchanged. VANET addresses all these issues related to the communications between vehicles and on-going research with wireless communication. It also covers the aspects of Wireless Access for the Vehicular Environment (WAVE) standards based on the emerging IEEE 802.11p specification. VANET basically enables *infrastructure-to-vehicle (I2V)*, *vehicle-to-infrastructure (V2I)*, and *vehicle-to-vehicle (V2V)* communications. In this paper, we use the term V2I to refer to both I2V and V2I communication.

II. NETWORK ARCHITECTURES

Wireless ad hoc networks generally do not rely on fixed infrastructure for communication and dissemination of information. VANETs follow the same principle and apply it to the highly dynamic environment of surface transportation. As shown in Fig.1, the architecture of VANETs mainly falls within three categories: pure cellular/WLAN, pure ad hoc, and hybrid.

VANETs may use fixed cellular gateways and WLAN / Wi-Max access points at traffic intersections to connect to the Internet, gather traffic information, or for routing purposes. The network architecture under this scenario is a pure cellular or WLAN structure as shown in Fig. 1(a). VANETs can combine both cellular network and WLAN to form the networks so that a WLAN is used where an access point is available and a 3G connection otherwise.

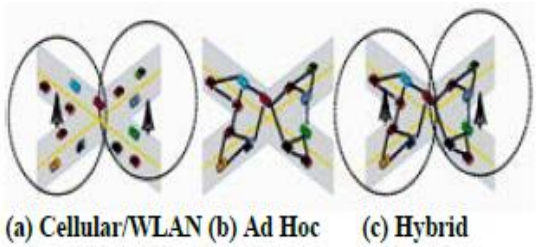

Fig.1: Network architectures for VANETs

Stationary or fixed gateways around the sides of roads could provide connectivity to mobile nodes (vehicles), but are eventually unfeasible considering the infrastructure costs involved. In such a scenario, all vehicles and road-side wireless devices can form a pure mobile ad hoc network (Fig. 1(b)) to perform vehicle to vehicle communications and achieve certain goals, such as blind crossing.

Hybrid architecture of combining infrastructure networks and ad hoc networks together has also been a possible solution for VANETs. Namboodiri et al. [2] proposed such a hybrid architecture, which uses some vehicles with both WLAN and cellular capabilities as the gateways and mobile network routers so that vehicles with only WLAN capability can communicate with them through multi-hop links to remain connected to the world. The hybrid architecture can provide better coverage, but also causes new problems, such as the seamless transition of the communication among different wireless systems.

III. MANET CHARACTERISTICS

a. Dynamic topologies: Nodes are free to move arbitrarily; thus, the network topology which is typically multihopmay change randomly and rapidly at unpredictable times, and may consist of both bidirectional and unidirectional links.

b. Bandwidth-constrained, variable capacity links: Wireless links have significantly lower capacity than their hardwired counterparts till date. In addition, the realized throughput of wireless communications after accounting for the effects of multiple access, fading, noise, and interference conditions, etc. are often much less than a radio's maximum transmission rate. One effect of the relatively low to moderate link capacities is that congestion is typically the norm rather than the exception, i.e. aggregate application demand will likely approach or exceed network capacity frequently. As the mobile network is often simply an extension of the fixed network infrastructure, MANET users will demand similar services. These demands will continue to increase as multimedia computing and collaborative networking applications rise.

c. Energy-constrained operation: Some or all of the nodes in a MANET may rely on batteries or other exhaustible means for their energy. The most important system design criteria for optimization may be energy conservation for these nodes.

d. Limited physical security: Mobile wireless networks are generally more prone to physical security threats than the infrastructure based networks. Hence, the increased possibility of eavesdropping, spoofing and denial-of-service attacks should be carefully considered. To reduce security threats some of the existing link security techniques are often applied within wireless networks. This provides the decentralized nature of network control in MANETs to be robust against the single points of failure of more centralized approaches.

IV. DIFFERENCE BETWEEN MANETAND VANET

Similar to mobile ad hoc networks (MANETs), nodes in VANETs self-organize and self-manage information in a distributed fashion without a centralized authority or a server dictating the communication. In this type of network, nodes engage themselves as servers and/or clients, thereby exchanging and sharing information like peers. Moreover, nodes are mobile, thus making data transmission less reliable and suboptimal. Apart from these characteristics, VANETs possess a few distinguishing characteristics [8], and hence presents itself as a particular class of MANETs:

a. Highly Dynamic Topology: The topology formed by VANETs is always changing as vehicles are moving at high speed. On highways, vehicles are moving at the speed of 60- 70 mph (25 m/sec) and vary for different vehicles. If the radio range between two vehicles is 125 m then the link between the two vehicles would last at most 10 sec.

b. Frequently Disconnected Network (Intermittent Connectivity):The highly dynamic topology results in frequently disconnected network since the link between two vehicles can quickly disappear while the two nodes are transmitting information. The problem is further worsened by varying node density where there are different frequency of nodes for different roads and highways. Moreover, disparate node density during non-rush hours results in dis-connectivity of nodes. A robust routing protocol is hence needed to recognize the frequent disconnectivity and to provide an alternate link quickly to ensure uninterrupted communication.

c. *Patterned Mobility:*Vehicles follow a trail or certain mobility pattern which is a function of the underlying roads, the traffic lights, the speed limits, traffic condition and driving behaviors of drivers. Because of the particular mobility pattern, evaluation of VANET routing protocols only makes sense from traces obtained from the pattern. There are several VANET mobility trace generators developed for the testing of VANET routing protocols in simulation. A realistic mobility traces were generated from vehicles to test the protocols.

d. *Propagation Model:*The propagation model in VANETs is usually not assumed to be free space because of the presence of buildings, trees, vehicles and other obstacles. A VANET propagation model should well consider the effects of static objects as well as potential interference of wireless communication from other vehicles or widely deployed personal access points.

e. *Unlimited Battery Power and Storage:* The nodes in VANETs are not subject to power and storage limitation as in sensor networks, another class of ad hoc networks where nodes are mostly static. Nodes are assumed to have ample energy and computing power and hence the optimizing duty cycle is not as relevant as it is in sensor networks.

f. *On-board Sensors:*In VANETs the nodes are assumed to be equipped with sensors to provide information for routing purposes. Many VANET routing protocols have assumed the availability of GPS unit from on-board Navigation system. Location information from GPS unit and speed from speedometer provides good examples for large amount of information that can possibly be obtained by sensors to be utilized to enhance routing decisions.

V. NETWORK ARCHITECTURE AND CHARACTERISTICS

Wireless ad hoc networks do not depend on fixed infrastructure for communication and dissemination of information. The architecture of VANET consists of three categories: Pure cellular/WLAN, Pure Ad hoc and hybrid. VANET may use fixed cellular gateways and WLAN/Wi-Max access points at traffic intersections to connect to the internet, gather traffic information or for routing purposes. This network architecture is pure cellular or WLAN. VANET can compile both cellular network and WLAN to form the network. Stationery or fixed gateways around the road sides also provides connectivity to vehicles. In such a scenario all vehicles and road sides' devices form a pure mobile ad hoc networks. Hybrid architecture consists of both infrastructure networks and ad hoc networks together. Nodes in VANET can self-organized and self-manage the information in a distributed fashion without any centralized authority. Since the nodes are mobile so data transmission is less reliable and sub optimal. Some of the distinguishing feature of VANET which make it more challenging class of MANET are:

High Dynamic Topology: Since vehicles are moving at high speed, Topology formed by VANET is always changing.
Frequently disconnected network: The highly dynamic topology results in frequently disconnected network. This problem is also caused by changing node density.

Unlimited Battery Power and Storage: Nodes in VANET are not subject to power and storage limitation as in sensor networks. Nodes have ample amount of energy and computing power.

On Board Sensors: Nodes consists of sensors which provide useful information for routing. Many VANET routing protocols consists of GPS unit which provides location information.

VI. BACKGROUND

Kumar & Dave (2011) Vehicular Ad Hoc Networks (VANET) is a subclass of Mobile ad hoc networks which provides a distinguished approach for Intelligent Transport System (ITS). The survey of routing protocols in VANET is important and necessary for smart ITS. This paper discusses the advantages / disadvantages and the applications of various routing protocols for vehicular ad hoc networks. It explores the motivation behind the designed, and traces the evolution of these routing protocols. Finally the paper concludes by a tabular comparison of the various routing protocols for VANET.

Tonguz et al. (2007) In this paper, we report the first complete version of a multi-hop broadcast protocol for vehicular ad hoc networks (VANET). Our results clearly show that broadcasting in VANET is very different from routing in mobile ad hoc networks (MANET) due to several reasons such as network topology, mobility patterns, demographics, traffic patterns at different times of the day, etc. These differences imply that conventional ad hoc routing protocols such as DSR and AODV will not be appropriate in VANETs for most vehicular broadcast applications. We identify three very different regimes that a vehicular broadcast protocol needs to work in: i) dense traffic regime; ii) sparse traffic regime; and iii) regular traffic regime. We build upon our previously proposed routing solutions for each regime and we show that the broadcast message can be disseminate efficiently. The proposed design of the Distributed Vehicular Broadcast (DV-CAST) protocol integrates the use of various routing solutions we have previously proposed.

Abedi et al. (2008)VANET is new generation of ad hoc networks that implement between vehicles on a road. Because of high mobility, routing in VANET has more problems than MANET. Thereby, in this paper we propose a modification on AODV as MANET routing protocol to make it adaptive for VANET. When a node is mobile, it has three mobility parameters: position, direction and speed. In our method, we have used direction as most important parameter to select next hop during a route discovery phase. With respect to mobility model, if nodes has same direction with source and/or destination nodes, our solution might selects them as a next hop. Position is another parameter that we used for next hop selection.

Ranjan&Ahirwar (2011)A Vehicular Ad-hoc Network (VANET) is a type of Mobile Ad-hoc Network (MANET) that is used to provide communications between nearby vehicles, and between vehicles and fixed infrastructure on the roadside. Though VANET is a type of MANET but the routing protocols of MANET are not feasible with VANET and if they are even feasible then they are not able to provide the optimum throughput required for a fast changing vehicular ad-hoc network. The difference between VANET and MANET is that in VANET, the nodes are moving on predefined roads, and their trails aren't too complicated and this is where the routing protocols have to be modified or changed. The differences in the architecture and characteristics have been studied in this paper to suggest the best out of the existing routing protocols. This paper presents the various protocols optimized for both the MANET and VANET. A protocol is analyzed from the existing reactive protocols which will be efficient for both the MANET and VANET.

Kohli et al. (2010) Vehicular Ad Hoc Networks (VANET) is a subclass of Mobile ad hoc networks which provides a distinguish approach for intelligent transport system (ITS). The survey of routing protocols in VANET is important and necessary issue for smart ITS. The chapter discusses the advantages and disadvantages of these routing protocols, it explores the motivation behind the designed and trace the

evolution of these routing protocols. Finally it concludes the chapter by comparing the various routing protocols.

Kumar & Dave (2012)VANETs (Vehicular Ad hoc Networks) are upcoming wireless network environment for Intelligent Transportation Systems (ITS). Most VANET applications are built upon the data push communication model, where information is disseminated to a set of vehicles. The diversity of the VANET applications and their potential communication protocols needs a systematic literature survey. In this paper VANET characteristics and challenges are discussed. Application based various broadcasting data dissemination protocols are surveyed separately and their fundamental characteristics are revealed. In the end a tabular comparison of all the protocols is given.

Singh & Mann (2019)VANET is a decentralized type of network in which vehicle acts like mobile nodes, can join together, and start communicating with each other. The reactive routing protocol is the type of protocol which establishes a path by gathering network information at the time of path establishment. The TDMA is the medium access control protocol, which assigns channels to each vehicle and vehicles can communicate with each other on the given time slots. Due to self-configuring nature of the network, clocks are weekly synchronized, which leads to packet collision in the network. In this research, time lay technique has proposed in which whole network has divided into zones and zone heads are selected from each zone, which are responsible to synchronize clocks of the mobile vehicle. The simulation of the proposed model has done in NS2, and it has been analyzed that proposed technique performs well in terms of NRL, route lifetime, and PDR.

Rehman et al. (2018)VANETs an application of MANETs, a fast growing, promising and emerging technology provides basis for ITS following IEEE 802.11p standard based on DSRC designed for WAVE. VANETs enable communication among vehicles (V2V) and road side infrastructure (V2I), disseminating alert messages regarding road conditions and any other critical situation to ensure safety and avoid losses of precious lives and property. Due to high velocity of moving vehicles and dynamic speedy topology change ultimate optimum routing protocols is still a challenging task in VANETs. It is cleared from the proposed results that there is no such protocol that is best for all kind of evaluation criteria. Infact, each routing algorithm conduct differently in sense of performance metrics. In VANETs timely arrival of data is much important to handle the security threats or any emergency efficiently. In this paper we focused and inspected various routing protocols including AODV, DSR and DSDV for the purpose to find out protocols best suited for all scenarios. The comparison and evaluation of various routing protocols is done on the basis of different performance metric criteria like data throughput, PDR, end to end delay or latency and network stability etc.

Kaur & Kaur (2018) the vehicular Adhoc network is the decentralized type of network in vehicle to vehicle and vehicle to road side units can communicate with each other. Due to such dynamic nature of the network routing, security and quality of the service are the major issues of VANETs. This paper is based on the analysis of routing techniques of VANETs. The routing techniques are analyzed in terms of description and outcomes.

Kumar et al. (2018) Vehicular Ad Hoc Networks (VANET) is a subclass of Mobile ad hoc networks. It is a developing new technology in which vehicles interchange the information from one vehicle to another vehicle within a network. VANET is responsible for providing an illustrated approach for Intelligent Transport System (ITS). The main use of VANET is to save life and prevent the accidents. This Paper describes a survey of routing protocols in vehicular ad hoc networks. The survey of routing protocols in VANET is significant and essential for smart ITS. The routing protocols are divided into two categories of topology-based and position-based routing for VANETs. This review discusses the advantages and disadvantages of these routing protocols

Protocols	**Proactive Protocols**	**Reactive Protocols**	**Position based Greedy Protocols**	**Delay Bounded Protocols**	**Cluster Based Protocols**	**Broadcast Protocols**	**Geo cast Protocols**
Prior Forwarding Method	Wireless multi hop Forwarding	Wireless multi hop Forwarding	Heuristic method	Carry & Forward	Wireless Multi hop Forwarding	Wireless multi hop Forwarding	Wireless multi hop Forwarding
Digital Map Requirement	No	No	No	No	Yes	No	No
Virtual Infrastructure Requirement	No	No	No	No	Yes	No	No

Realistic Traffic Flow	Yes	Yes	Yes	No	No	Yes	Yes
Recovery Strategy	Multi Hop Forwarding	Carry & Forward	Carry & Forward	Multi hop Forwarding	Carry & Forward	Carry & Forward	Flooding
Scenario	Urban	Urban	Urban	Sparse	Urban	Highway	Highway

Table 1: Comparison of Various Protocols (Source:

VII. CONCLUSION

This paper reviewed existing routing protocols. Table 1 gives a Comparison of these protocols. Various applications were highlighted and used to analyze a representative set of protocols, which were classified by their architectural as well as relevance. Additional details on selected protocols appropriate to each of the defined application types are presented. We have also discussed some important strengths and weaknesses of current research. Researchers designed different routing protocols for the purpose to improve the performance of VANETs by considering the above discussed parameters. VANETs is an essential key technology for ITS applications. However, Due to the rapid changing topology and high speed of moving vehicles, in VANETs specific and ultimate routing protocols are still required much research, still plenty of challenging issues are open and requires more vital research to resolve. Routing of collision avoidance or emergency related alert messages in VANETs required efficient on time delivery mechanisms to avoid critical tragedies. We studied that different routing protocols are implanted in different simulator like different vehicular driving environments: downtown, residential, and suburban areas. Each produced area is characterized by different driving environment parameters: different road obstacles, road lanes, and/or traffic light. From the collected results it is cleared that different routing protocols perform differently at different collection of transmission accesses, densities, and velocities of vehicles in VANETs. In our research we showed that some protocols has better stability period, minimum end-to-delay or latency, enhanced throughput over others, but there is no single routing protocol that has all these qualities individually. In future much research work is still possible to collect much qualities in a single routing protocol.

VIII. REFERENCES

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