International Journal of Engineering Innovation & Research
Volume 1, Issue 2, ISSN : 2277 – 5668

Survey of Routing Protocols in Vehicular Ad-Hoc Network

Karthikumar. P.
Research Scholar
Department of CSE
PSG College of Technology, Coimbatore - 641 004.
Tamil Nadu, India
karthikumarece@gmail.com
Mobile: +91 9655333397

Dr. V. Krishnaveni
Associate Professor
Department of ECE
PSG College of Technology, Coimbatore - 641 004.
Tamil Nadu, India
venimurthy@hotmail.com
Mobile: 91 9842075343

***Abstract* - Vehicular ad-hoc networks (VANETs) are a promising communication scenario. Several new applications are envisioned, which will improve traffic management and safety. In comparison to other communication networks, Vehicular Ad-hoc Networks (VANETs) have unique requirements with respect to applications, types of communication, self-organization and other issues. VANET-specific protocol layers, a staircase approach for interaction among layers and the use of an information connector for cross-layer information exchange using the publisher/subscriber pattern. The main goal of VANET is providing safety and comfort for passengers. Each vehicle equipped with VANET device will be a node in the Ad-hoc network and can receive & relay other messages through the wireless network.**

***Key Words* - Vehicular ad-hoc networks (VANET), Security, FSR, AODV, DSR, PGB, TORA, Geocast, BROADCOMM,**

I. INTRODUCTION

A Vehicular Ad-Hoc network is a form of Mobile ad-hoc Networks, to provide communication among nearby vehicles and between vehicles and nearby fixed equipment i.e. roadside equipment. Collision warning, Road signal arms and in place traffic view will give the driver essential tool to decide the best path along the way. VANET or Intelligent Vehicular Ad-Hoc Networking provides an intelligent way of using vehicular Networking.

Vehicular Ad Hoc Networks (VANETS) is one of its types. It deploys the concept of continuously varying vehicular motion. The nodes or vehicles as in VANETS can move around with no boundaries on their direction and speed. This arbitrary motion of vehicles poses new challenges to researchers in terms of designing a protocol set more specifically for VANETS. To evaluate VANET protocols and services, the first step is to perform an outdoor experiment. Many wireless technologies such as GPRS, IEEE 802.11p and IEEE 802.16 have been proposed for reliable traffic information.

A.Vanet Basics and Standards

In a VANET, each vehicle is equipped with the technology that allows the vehicle to communicate with each other as well as with the roadside infrastructure, e.g. Base stations also known as roadside units (RSUs), located in some critical sections of the road, such as traffic lights, intersections, or stop signs, to improve the driving experience and make driving safer. By using such communication devices, also known as on-board units (OBUs), vehicles can communicate with each other as well as with RSUs. A VANET is a self-organized network that enables communications between vehicles and RSUs, and the RSUs can be connected to a backbone network, so that many other network applications and services, including Internet access, can be provided to the vehicles

B. Wide Spectrum of Applications

VANETs can be used for many applications for vehicle-to-vehicle and vehicle-to-roadside communication, as opposed to networks tailored to specific applications like most of existing sensor networks.

C. Interaction with On-board Sensors

A VANET platform will most likely include on-board sensors like GPS to be utilized not only by applications, but also by network protocols, e.g., by position-based routing [9]. While there are even more facts that can be cited to describe the specific nature of VANETs compared to other wireless or ad-hoc networks, the above list appears to be sufficient to motivate the need for a specific VANET protocol architecture.

D. Self-organization & Management

As MANETs in general, a VANET requires a fully decentralized network control since no centralized entity could or should organize the network.

II. NETWORK ARCHITECTURE AND CHARACTERISTICS

The architecture of VANET consists of three categories: Pure cellular/WLAN, Pure Ad hoc and hybrid. VANET may use fixed cellular gateways and WLAN/WiMax 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.

A. Protocol Element Examples

Information flooding: The fundamental advantage in including application knowledge to VANET protocols is that it enables the network system to 'understand' the payload of the packet. With this knowledge, the system is able to detect redundancy in messages and since the medium is the bottle-neck resource the most important goal is to avoid redundancy.

International Journal of Engineering Innovation & Research
Volume 1, Issue 2, ISSN : 2277 – 5668

B. General Requirements

Application state database: The application part of the Protocol Element carries the complete application logic to assess the safety-related situation by evaluating sensor events gathered by the local information connector *and* by external messages. In addition, it initiates the sending of information or packets. To be able to decide if some received information is new, an application has to keep track of the messages received before and expire them if required.

III. Observations

We provide several observations from which we will derive our architecture.

A. Network Protocol Requirements

Among other things, the last observation directly leads to different requirements for multi-hop packet forwarding protocols. On one hand, traditional unicast and multicast protocols using ID-based addressing might still be needed for infotainment applications or the extension of hotspot access. On the other hand, the challenge for VANET network protocols lies in efficient geocasting and flooding. Additionally, there might be potential severe requirements concerning reliability and/or timeliness due to the safety purpose of some applications.

B. Information Sharing

In a VANET, the communication system generates information that is of high value for many protocol entities. E.g., beacon packets could be used to generate a list of neighbouring nodes, which could be used for both driver assistance *and* packet forwarding decisions. Thus, we observe the need for sharing information in an efficient and clean manner without creating complex control interactions. In addition, the integration of these events into protocol state machines demands for a standardized way to access these events, if implementation portability is desired.

C. Packets Vs. Information

Along the lines of the first observation, one therefore has to differentiate between 'packets' and 'information': In classical networks, the data payload of a packet is meant to be delivered unchanged to the addressed application instance(s). However, VANET applications will most likely evaluate the information contained in a packet, merge it with their own state and then decide how to communicate this updated information. This operation is known as 'in network' processing.

D. End-to-end Notion Revisited

In a traditional network, peer application and protocol entities are well-defined on all 'communication endpoints' — either by an ID or by a multicast group. However, the VANET communication entities might not only address specific peer entities, but also geographical or topological areas whose members are likely to change over time.

IV. Common VANET Entities

Several different entities are usually assumed to exist in VANETs. To understand the internals and related security issues of these networks, it is necessary to analyze such entities and their relationships.

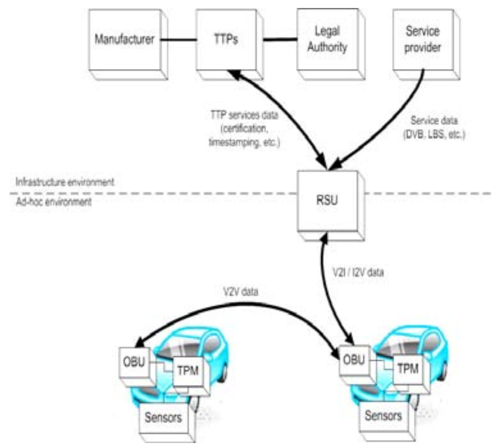

Fig.1 Simplified VANET model

A. Infrastructure Environment

In this part of the network, entities can be permanently interconnected. It is mainly composed by those entities that manage the traffic or offer an external service. On one hand, **manufacturers** are sometimes considered within the VANET model. As part of the manufacturing process, they identify uniquely each vehicle. On the other hand, the **legal authority** is commonly present in VANET models.

i) Ad-hoc Environment.

In this part of the network, sporadic (ad-hoc) communications are established from **vehicles**. From the VANET point of view[2], they are equipped with three different devices. Firstly, they are equipped with a communication unit (**OBU**, On-Board Unit) that enables Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I, I2V) communications. On the other hand, they have a set of **sensors** to measure their own status (e.g. fuel consumption) and its environment (e.g. slippery road, safety distance).

B.VANET Settings

Several applications are enabled by VANETs, mainly affecting road safety. Within this type of application, messages interchanged over VANETs have different nature and purpose. The four different communication patterns can be identified.

ii) V2V Warning Propagation:

There are situations in which it is necessary to send a message to a specific vehicle or a group of them. For example, when an accident is detected, a warning message should be sent to arriving vehicles to increase traffic safety In this cases, a routing protocol is then needed to forward that message to the destination.

4.2.2 V2V Group Communication

Under this pattern, only vehicles having some features can participate in the communication. These features can be static (e.g. vehicles of the same enterprise) or dynamic (e.g. vehicles on the same area in a time interval).

4.2.3 V2V Beaconing

Beacon messages are sent periodically to nearby vehicles. They contain the current speed, heading, braking use, etc. of the sender vehicle. These messages are useful to increase neighbour awareness. Beacons are only sent to 1-hop communicating vehicles,

4.2.4 I2V/V2I Warning

These messages are sent either by the infrastructure (through RSUs) or a vehicle when a potential danger is detected. They are useful for enhancing road safety. As an example, a warning could be sent by the infrastructure to vehicles approaching to an intersection when a potential collision could happen.

V. TRAFFIC LEVEL CRITERIA

The traffic level presents level of details that are concerned with streets, obstruction in communication paths, lights and vehicular densities. For the simulation to capture details at traffic level, it must include the following traces:

5.1 Movement Topologies

Movement topologies are key features for simulation and are used to calculate some important factors like speed and distances etc. The topologies are represented with the help of graphs and are classified into the following three types [2]: Custom graphs: Edges are connected by vertex.(Figure a). Random graphs: Using algorithms. (Figure b). Topologies from maps: Graphs from GDF (Geographical Data Files) [5] and TIGER database. (Figure c)

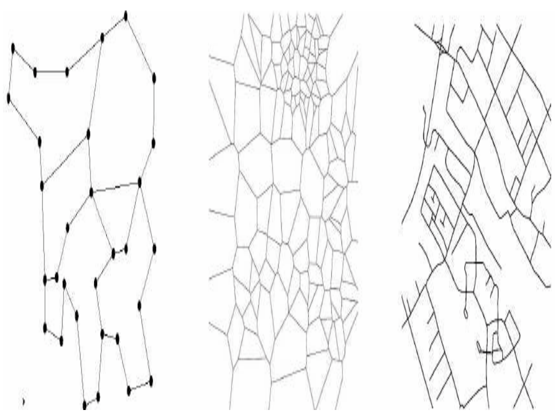

Fig.2 (a) Custom graphs (b) Random graphs (c) Maps graphs

5.2 Start and End position

The time a node starts its movement marks its initial position is referred to as repelling state, as the node traverses a certain path until it reaches its final position which can be referred to as its attracting point. These two points outline the start and end point for the vehicle. After the graphs are generated, the node's source and destination points are defined for simulation.

VI. ROUTING PROTOCOLS

These routing protocols use links information that exist in the network to perform packet forwarding. They are further divided into Proactive and Reactive.

6.1 Proactive Routing Protocols

The proactive routing means that the routing information like next forwarding hope is maintained in the background irrespective of communication requests. The packets are constantly broadcast and flooded among nodes to maintain the path, and then a table is constructed within a node which indicates next hop node towards a destination.

6.2 Position Based Routing Protocol

Position based routing consists of class of routing algorithm. They share the property of using geographic positioning information in order to select the next forwarding hops. The packet is send without any map knowledge to the one hop neighbor which is closest to destination. Position based routing is beneficial since no global route from source node to destination node need to be created and maintained.

6.3 Broadcast Routing

Broadcast routing is frequently used in VANET for sharing, traffic, weather and emergency, road conditions among vehicles and delivering advertisements and announcements. Broadcasting is used when message needs to b disseminated to the vehicle beyond the transmission range [1]. In VANET, it performs better for a small number of nodes. The various Broadcast routing protocols are BROADCOMM, UMB, V-TRADE, and DV-CAST.

Vehicular Collision Warning Communication (VCWC) Protocol

The VCWC protocol provides congestion control, service differentiation, and a method for propagating emergency message warnings. A communication collision warning protocol can be achieved by taking either a passive approach or an active approach. First, in a protocol that uses the passive approach requires each vehicle to frequently broadcast its state information to other neighbouring vehicles. Each vehicle then uses the collected state information from the surrounding vehicles to determine if it is in a dangerous situation[8]. The drawback of using a passive protocol is the network is always saturated with safety messages.

Second, the active approach only sends messages when an emergency event occurs. For instance, an emergency warning message (EWM) would be sent if a vehicle decelerates abruptly. The VCWC uses the active approach to achieve cooperative collision warning.

Position Based Greedy V2V Protocols

Greedy approach requires that intermediate node should possessed position of itself, position of its neighbor and destination position. The goal of these protocols is to transmit data packets to destination as soon as possible that is why these are also known as min delay routing protocols. Various types of position based greedy V2V protocols are GSR, GPSR, SAR, GPCR, CAR, ASTAR, STBR, CBF, DIR and ROMSGP

Geographic Source Routing (GSR)

Earlier GSR was used in MANET. Then it was improved to use in VANET scenario by incorporating in to it greedy forwarding of messages toward the destination. If at any hop there are no nodes in the direction of destination then GPSR utilizes a recovery strategy known as perimeter mode. The perimeter mode has two components one is distributed planarization algorithm that makes local conversion of connectivity graph into planar graph by removing redundant edges. Second component is online routing algorithm that operates on planer graphs.

Urban Multihop Broadcast protocol (UMB)

UMB is designed to overcome the interference, packet collision and hidden node problems during message distribution in multi hop broadcast. In UMB the sender node tries to select the furthest node in the broadcast direction for forwarding and acknowledging the packet without any prior topology information. UMB protocol performs with much success at higher packet loads and vehicle traffic densities.

Vector Based Tracing Detection (V-TRADE)

It is a GPS based message broadcasting protocols. The basic idea is similar to unicast routing protocols Zone Routing Protocol (ZRP). V-TRADE classifies the neighbors into different forwarding groups depending upon position and movement information. For each group only a small subset of vehicles is selected to rebroadcast the message.

V-TRADE improves the bandwidth utilization but some routing overheads are associated with selecting the next forwarding node in every hop.

Geocast Routing

Geocast routing is basically a location based multicast routing. Its objective is to deliver the packet from source node to all other nodes within a specified geographical region (Zone of Relevance ZOR). In Geocast routing vehicles outside the ZOR are not alerted to avoid unnecessary hasty reaction. Geocast is considered as a multicast service within a specific geographic region. It normally defines a forwarding zone where it directs the flooding of packets in order to reduce message overhead and network congestion caused by simply flooding packets everywhere.

In the destination zone, unicast routing can be used to forward the packet. One pitfall of Geocast is network partitioning and also unfavourable neighbours which may hinder the proper forwarding of messages. The various Geocast routing protocols are IVG, DG-CASTOR and DRG.

Fisheye State Routing (FSR)

FSR is similar to LSR, in FSR node maintains a topology table (TT) based upon the latest information received from neighbouring and periodically exchange it with local neighbours. For large networks to reduce the size of message the FSR uses the different exchange period for different entries in routing tables. Routing table entries for a given destination are updated preferably with the neighbours having low frequency, as the distance to destination increases. The problem with the FSR routing is that with the increase in network size the routing table also increases. As the mobility increases route to remote destination become less accurate. If the target node lies out of scope of source node then route discovery fails.

Temporally Ordered Routing Algorithm (TORA)

TORA belongs to the family of link reversal routing in which directed a cyclic graph is built which directs the flow of packets and ensures its reachability to all nodes. A node would construct the directed graph by broadcasting query packets. On receiving a query packet, if node has a downward link to destination it will broadcast a reply packet; otherwise it simply drops the packet.

A node on receiving a reply packet will update its height only if the height of replied packet is minimum of other reply packets. TORA Algorithm has the advantage that it gives a route to all the nodes in the network, but the maintenance of all these routes is difficult in VANET.

Position Based Routing Protocol

Position based routing consists of class of routing algorithm. They share the property of using geographic positioning information in order to select the next forwarding hops. The packet is send without any map knowledge to the one hop neighbour which is closest to destination. Position based routing is beneficial since no global route from source node to destination node need to be created and maintained. Position based routing is broadly divided in two types: Position based greedy V2V protocols, Delay Tolerant Protocols.

Protocols	**Proactive Protocols**	**Broadcast Protocols**	**Reactive Protocols**
Recovery Strategy	Multi Hop Forwarding	Carry & forward	Carry & forward
Prior Forwarding Method	Wire less multi hop Forwarding	Wire less multi hop Forwarding	Wire less multi hop Forwarding
Realistic Traffic Flow	yes	Yes	Yes
Scenario	Urban	Highway	Urban

Fig. 3. Comparison of Various Protocols

VII. CONCLUSION & FUTURE WORK

Comparison of these protocols Prior forwarding method describes the first routing decision of the protocol when there are packets to be forwarded. Digital map provides street level map and traffic statistics such as traffic density and vehicle speed on road at different times.

Each cluster can have a cluster head, which is responsible for secure communication between inter-cluster and intra cluster coordination in the network. Recovery strategy is used to recover from unfavourable situations. Recovery strategy is the criteria, which is used to judge the performance of protocol.

The Future Work for VANET Routing Protocols

¾ A major challenge in protocol design in VANET is to improve reliability of Protocols and to reduce delivery delay time and the number of packet retransmission.

¾ Develop an efficient geo cast routing protocol for comfort applications with delay tolerant capabilities with low bandwidth utilization.

REFERENCES

1. Kevin,Uichin Lee, Mario Gerla, Survey of Routing Protocols in Vehicular Ad Hoc Networks in Car 2 Car communication consortium.
2. Maxim Raya and Jean-Pierre Hubaux "Securing vehicular ad hoc networks", Journal of Computer security, IOS Press Amsterdam, The Netherlands,Volume 15, Issue 1(January 2007), pages 39-68
3. Chakkaphong Suthaputchakun, and Aura Ganz,"Secure Priority Based Inter-Vehicle ommunication MAC Protocol for Highway Safety Messaging",Proceedings of IEEE ISWCS 2007, October 16-19, 2007, Trondheim, Norway.
4. Yi Qian, and Nader Moayeri, "Design Secure and Application-Oriented VANETs", Proceedings of EE*VTC'2008-Spring*, Singapore, May 11-14, 2008.
5. James Bernsen, D. Mnivannan , Department of Computer Science, University of Kentucky, Lexington, USA "Unicast routing protocols for vechicular ad hoc "Dec2000.
6. J. J. Blum, A. Eskandarian, and L. J. Hoffman, "Challenges of Intervehicle Ad Hoc Networks," *IEEE Transactions on Intelligent Transportation Systems*, vol. 5, no. 4, pp. 347–351, Dec 2004.
7. A. Mahajan, "Urban mobility models for vehicular ad hoc networks," Master's Thesis, Department of Computer Science, Florida State University, 2006.
8. H. Wu, M. Palekar, R. Fujimoto, J. Lee, J. Ko, R. Guensler, and M. Hunter, "Vehicular networks in urban transportation systems," in *Proceedings of the 2005 national conference on Digital government research*, 2005.
9. C. Sommer, "Evaluation of Ad Hoc Communication in VANETs,"Master's Thesis, University of ErlangenNuremberg, November 2006.
10. Holger F¨ußler, Marc Torrent-Moreno, Matthias Transier, Andreas Festag, and Hannes Hartenstein, "Thoughts on a Protocol Architecture for Vehicular Ad-Hoc Networks," in *Proc. of WIT 2005*, Hamburg, Germany, March 2005, pp.41–45.
11. Sze-Yao Ni, Tseng Yu-Chee, Chen Yuh-Shyan, and Sheu Jang-Ping, "The Broadcast Storm Problem in a Mobile Ad Hoc Network," in *Proc. of ACM MobiCom '99*, Seattle, Washington, August 1999, pp. 151–162.
12. M. Fiore,"Vehicular Mobility and Network Simulation", to be published in *Handbook on Vehicular Networks*, S. Olariu and M. C. Weigle Eds.,Taylor and Francis, 2008
13. Aijaz, A., Bochow, B., Dötzer, F., Festag, A., Gerlach, M., Kroh, R., et al. (2006). Attacks on Inter-Vehicle Communication Systems - An Analysis. *International Workshop on Intelligent Transportation.* Hamburg, Germany: IEEE Communications Society.

AUTHOR'S PROFILE

KARTHIKUMAR. P. is a Research Scholar in Department of Computer Science and Engineering at PSG College of Technology, Coimbatore and currently working as Assistant Professor in Department of Computer Science and Engineering at Hindusthan College of Engineering, Coimbatore. His Research work focuses on Vehicular Ad hoc Networks and Renewable Energy.

Dr. V. KRISHNAVENI is working as Associate professor in Department of Electronics and Communication Engineering at PSG College of Technology, Coimbatore. She has more than 15 years of academic experience. Her area of research includes Medical signal processing, Digital signal processing and Digital image processing. She has published more than 24 book/papers. She is an active consultant for research projects.