Survey on different approaches of GyTAR routing protocol in VANET

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Abstract—*Vehicular Ad hoc NETworks (VANETs) are special class of wireless Mobile Ad hoc NETwork (MANET). VANET allows forming a highly mobile, self- organized and fixed infrastructure-free network. Due to high traffic density and numerous obstacles in city environment, efficient routing protocols are required to provide communication between vehicle to vehicle (V2V) and vehicle to infrastructure (V2I). Routing decision becomes crucial at intersections on road. Intersection-based position routing protocol are well suited for such scenario. This paper compares different approaches of intersection based geographic routing protocol which are based on GyTAR routing protocol. GyTAR finds the intersections dynamically and then forwards the packet along that route. Finally the paper concludes with pros and cons of each approach, their motivation behind their design and a tabular comparison with their features.*

Keywords: VANET, GyTAR, E-GyTAR, V2V

I. INTRODUCTION

Vehicular Ad hoc NETworks (VANETs) are gaining extensive attention of researchers in the field of wireless networking and automotive industries. To provide safety and comfort to drivers, noteworthy efforts have been made to amalgamate the computing and communication technologies into vehicles. This gave rise to the development of Intelligent Transportation Systems (ITS). Vehicular communication is a major part of ITS which forms a network called VANET. VANETs are useful to provide safety applications, infotainment applications like searching for nearby restaurant, chatting, file sharing, gathering real-time traffic congestion and routing information, sharing of wireless channels for mobile applications, decrease travelling time, conserve energy etc.

Vehicles in VANET are equipped with wireless communication devices (also known as On-Board Unit (OBU)), GPS, digital maps and vehicle sensors. Vehicles move along roads and exchange information with other vehicles and roadside infrastructure called Road Side Units (RSU) within their radio range. Hence there are two types of communication in VANET: vehicle-to-infrastructure (V2I) communication and vehicle-to-vehicle (V2V) communication. V2I can provide real-time information on road traffic conditions, weather, and basic Internet service via communication with backbone networks. V2V can be used to provide information about traffic conditions and vehicle accidents based on wireless inter-vehicle communication.

In V2Vcommunication environments, vehicles are wirelessly connected using multi-hop communication without access to any fixed infrastructure [1]. RSU collect the real time traffic information, analyze it and then broadcast it to network so that drivers can select appropriate route. Also virtual traffic lights set their timings based on this collected information to help avoiding congestion. Vehicles can dynamically form infrastructure-free ad hoc and send messages (unicast, multicast, geocast and broadcast) to destination. Wi-Fi (IEEE 802.11n standard, DSRC (Dedicated Short Range Communications) (IEEE 802.11P standard), WAVE(Wireless Access for Vehicular Environment) which uses IEEE 1609 standard are the technologies used for V2I and V2V communication. Federal Communication Commission allocated 5.9 GHz band (5.850-5.925 GHz) for DSRC to be used by Intelligent Transportation Systems. Following Figure1 shows the representation of VANET. The remainder of this paper is organized as follows. The next section describes the characteristic of VANET, while section 3 overviews some routing protocols proposed so far, based on GyTAR. Basic comparison is shown between the presented protocols. Following Figure 1 represents the VANET.

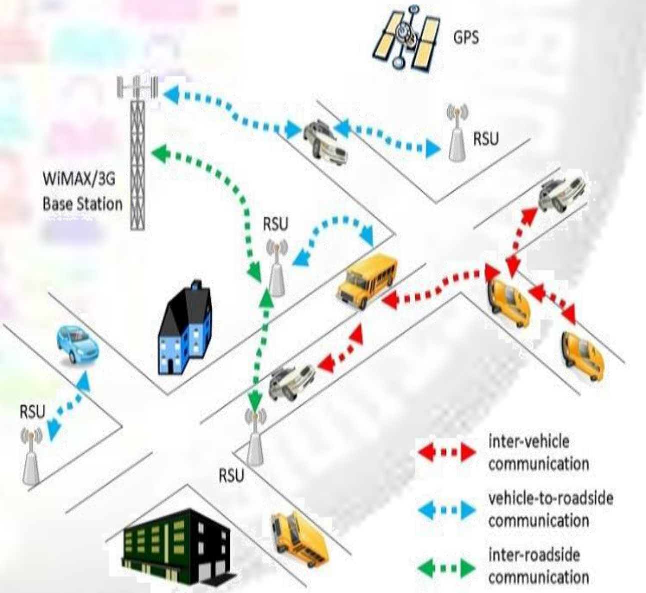

Fig. 1: Representation of a Vehicular Adhoc Network [2]

II. CHARACTERISTICS OF VANET

A. *High mobility and predictable road topology:*

The vehicles in VANETs move at high speeds and non-randomly. VANTEs differ from MANET in which nodes move in a random way, but because vehicles are constrained by road topology, predefined layout, traffic lights at intersections and movement of other vehicles leads to predictability in term of their mobility.

B. *Rapidly changes in network topology:*

Due to the highly variable speeds between vehicles, the network topology in VANETs tends to change frequently.

C. *Unbounded large network size:*

Especially in city area where the vehicles are highly dense, the network size increases as compared to highway scenario. Thus, the size of the network varies and becomes unbounded when several vehicles are present.

D. *Geographical type of communication:*

Most applications in VANETs require identification of the vehicles in a certain region, instead of the specific vehicles. Compared to other networks, VANETs often have a new type of communication which addresses a geographical area where packets need to be forwarded (e.g., in safety-deriving applications) [3].

E. *High computational ability:*

Vehicles can be equipped with sensors, large computational processors, a large memory capacity, advanced antenna technology, global position system (GPS) and digital maps. These resources help to increase the computational capacity and obtain accurate information regarding its current position, speed and direction.

F. *Abundant energy and storage:*

The VANET nodes have abundant energy and computation resources, since nodes are vehicles instead of small handheld devices.

III. ROUTING IN VANET

Routing in vehicular ad hoc networks is challenging due to exceeding number of vehicular nodes, high mobility, and large number of cross roads, uneven node distribution and radio obstacles in city areas. Various routing protocols have been designed for this purpose. VANET routing protocols are divided in three categories: unicast, multicast and broadcast. Further, unicasts are divided in two parts: topology-based and geographic/ position-based. In geographic routing, each node is aware of the positions of its direct neighbors. This is done by periodically sending out hello messages that indicate the current position of the node. To send a packet to destination node, sender needs the information of the current position of destination. This information is obtained through location service (LS). Main drawback of position-based routing is that during its greedy progress, it can get stuck in local maxima.
MoezJerbi proposed an intersection-based Greedy Traffic-Aware Routing (GyTAR) protocol to find best routes in urban environments. GyTAR creates routes from source to destination based on sequence of connectivity among intersections. All packets pass through these selected junctions to reach its destination. It considers vehicular density and the distance to the destination to determine the route.
Remaining section discusses different intersection based routing protocol which are based on GyTAR. Various protocols such as GyTAR, E-GyTAR, Reliable Routing Scheme(RRS) protocol and Urban Traffic Control Aware Routing Protocol (UTCARP) are discussed in next section.

A. *Greedy Traffic Aware Routing protocol (GyTAR)*

GyTAR is an intersection-based geographical routing protocol capable to find robust routes within city environments. It consists of two modules: (i) dynamic selection of the junction selection through which a packet must pass to reach its destination and an (ii) improved greedy forwarding mechanism between two junctions. Hence, using GyTAR, a packet will move successively closer towards the destination along streets where there are enough vehicles to provide connectivity. In junction selection process a value is given to each junction by comparing the traffic density between the current junction and the next candidate junction and the curvemetric distance to the destination. The junction with highest value will be chosen for packet forwarding. In second phase each vehicle maintains a table which contains position, velocity and direction of each neighbor vehicle and the table is updated periodically.
Thus, when a packet is received, the forwarding vehicle computes the new predicted position of each neighbor using the table and then selects the next hop neighbor which is closer to the destination junction which may cause packets in a local optimum. GyTAR efficiently uses the networkresources like wireless bandwidth by limiting thecontrol message overhead, and to route data packetsfrom sources to destinations in the vehicular networkwith a reduced end-to-end delay and low packet loss.
To overcome this problem GYTAR uses store and forward strategy. In this strategy packet will be stored at the intermediate node until another vehicle which is closer to the destination junction enters in its transmission range. Due to high mobility in VANET all greedy forwarding protocols can also cause routing loops problem and some packets may get forwarded to the wrong direction.
GyTAR also used an improved greedy forwarding mechanism to forward data packet on the road segments. If there is no node at intersection, then the packet cannot be forwarded and the performance of GyTAR affects as data packet dropped and higher end-to-end delay.

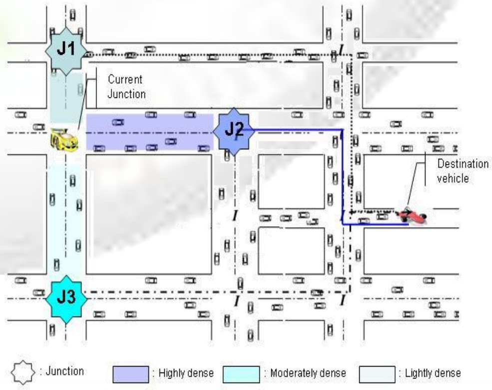

Fig. 2: Junction selection mechanism[4]

B. *Enhanced GyTAR (E-GyTAR)*

In E-GyTAR, the path is determined by considering the

traffic density in the direction of the destination. Hence it enables the packet to route which has the higher connectivity in the direction of the destination. It uses two parameters: vehicular speed and directional density for dynamic junction selection mechanism. It consists of two modules , which are same as GyTAR routing protocol. They are: (1) enhanced junction selection mechanism and (2) data forwarding. Each vehicle maintains a neighbor table which it records the speed, velocity, and direction of each vehicle. This table is updated periodically through hello messages. When the source vehicle needs to forward the data packets, it consults its neighbor table to find the new predicted position of neighboring vehicles [5].
Neighbor table is the database which is maintained by each vehicle which includes speed, velocity, and direction of each vehicle. This table is updated periodically through hello messages. The path is determined by considering the traffic density in the direction of the destination. This allows the packet to travel along the street which has the higher connectivity in the direction of the destination. The score is set for each junction by using the formula:
Score (Nj):= $\alpha\times[1\text{-Dp}] + \beta\times[\text{T}]$
where α and β are the weighting factors having wvalue0.5 each.[5]
When the source vehicle needs to forward the data packets, it consults its neighbor table to find the new predicted position of neighboring vehicles.

C. Reliable Routing Scheme (RRS) protocol

Another routing protocol based on GyTAR is reliable routing scheme (RRS) for VANETs [6]. It keeps two hop neighbor information in city environment where routing is almost difficult task because of the node distribution, constrained but high mobility patterns, obstacles causing blocking of signal transmission etc. It is proposed by applying position based routing strategy with the consideration of nodes moving direction, and predicable mobility in city environment. RRS adopts the anchored based routing approach with street awareness. It consists of two modules (1) Dynamically selecting the junctions through which the packets must pass to reach the destination and (2) applying efficient routing by keeping two hop neighbors information to forward packet between two junctions. Main focus of RRS is to route the data packets from source to destinations in Vehicular network with reduced end to end delay and low packet loss[6].

D. Urban Traffic Control Aware Routing Protocol (UTCARP)

UTCARP (Urban Traffic Control Aware Routing Protocol), a new V2V routing protocol is designed for VANETs associated with urban traffic control mechanism. The UTCARP is divided into two phases: (i) vertices selection and (ii) packet forwarding between two adjacent vertices. UTCARP considers the traffic control mechanism of traffic lights and stop signs. UTCARP performs the two key operations of the prediction of a sequence of vertices and the use of the predictive directional greedy routing to forward the data from a source vehicle to destination through the sequence of vertices. Intermediate vertices in UTCARP are chosen dynamically one by one, considering both distance to destination and the current traffic status. Each data-forwarding vehicle associated with the periodically updated traffic information determines involved intermediate vertices [7].Figure 2 shows the greedy forwarding mechanism of UTCARP.

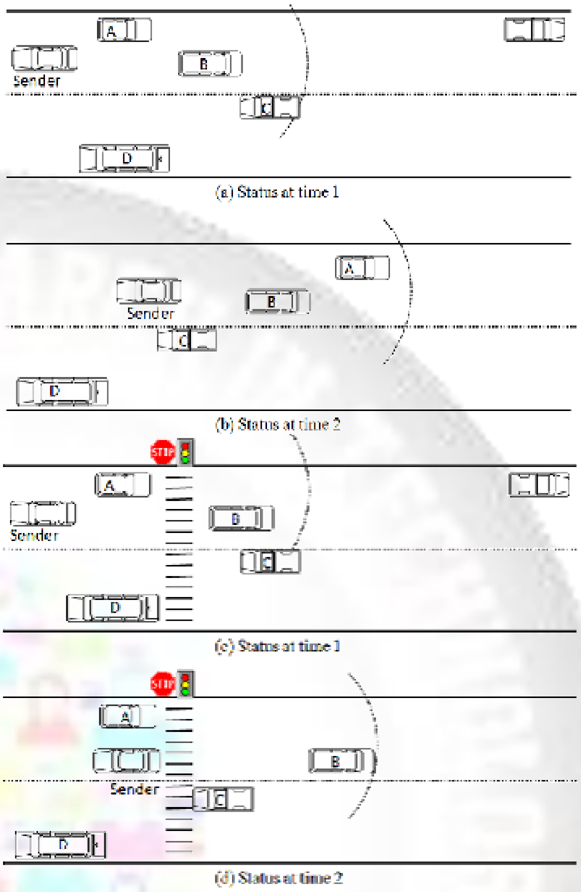

Fig. 2. Example of greedy forwarding[7]

E. Shortest-Time-based Traffic Light(STTL)

Shortest-Time-based Traffic Light routing (STTL) is for city vehicular communication with Traffic Light Considerations. It examines the VANET routing protocol in an city environment based on the turning probability of vehicles and traffic light, and analyzes the distribution of vehicles on road sections. In STTL, the data packets are chosen direction of road with the least time delay of transfer and best connectivity based on wireless link that is formed cyclically due to the control of traffic light. This protocol is divided into three stages: the first stage when the data packet is sent from the source node to that in the first intersection, the second stage from the first intersection to the last intersection, and the last stage from the final intersection to the target node.[8]

IV. COMPARISONS

Protocol	Feature	Traffic light and traffic signs used	Conclusion
GyTAR	IFTIS	no	PDR higher than GSR and LAR

			protocols[4]
E-GyTAR	Uses directional density for junction selection mechanism	no	E-GyTAR achieves higher packet delivery ratio and lower end-to-end delay than GyTAR[5]
RRS	keeps the two hop neighbors information.	no	Minimizes end to end delay and increases the Packet delivery ratio as compared to GyTAR.[6]
UTCARP	The data routing path is altered when routing holes occur due to traffic control mechanisms. Also considers the traffic control mechanism of traffic lights and stop signs.	yes	there is a low message re-transmitting rate that yields a low overhead plot than GyTAR.[7]
STTL	Data packets are chosen by direction of road with the least time delay of transfer and best connectivity based on wireless link that formed cyclically under the control of traffic light.	yes	Better performance in average delay and delivery ratio of data packets compared with VADD and GyTAR. It reduces the possibility of data packet loss due to collision during transmission through a wireless link[8].

Table 1: Comparison of Protocols

V. CONCLUSION

Different intersection based routing protocols based on GyTAR uses various approach for junction selection mechanism and packet forwarding. Better performance is achieved in terms of packet delivery ratio, and end to end delay as compared to GyTAR protocol by each protocol.

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