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Comparative Study of AODV, DSR and DSDV in Vehicular Ad-Hoc Networks

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Abstract—Vehicular Ad-hoc network consists of wireless mobile nodes which form a temporary network having no centralized infrastructure. VANETs have dynamic topology because of higher node mobility. VANETs provide benefits like road safety, security etc of vehicles etc Therefore, reliable and efficient routing is one of the main challenges in VANETs. Many improved routing algorithms have been implemented for consummate this task and to achieve better results. Therefore, it is very tuff to figure out which protocol executes better results under different kinds of scenarios. At present, a lot of research work like security, entertainment, harmless driving etc in VANETs has been placed as popular issues in the network areas. VANET provides number of protocols for routing which all have unique nature, this unique nature of protocols differ them from the others. One can choose a specific protocol on the basis of features easily for their simulation work. Hence, this review paper presents some protocols and also comparison is evaluated by studying typical representatives of routing protocols structure for VANETs.

Keywords— VANET, Routing protocols, AODV, DSR, DSDV.

I. INTRODUCTION

A Vehicular Ad-hoc Network (VANET) is a special kind of Mobile Ad-hoc Network (MANET) in which the mobile nodes are independent on the other mobile nodes and moves arbitrarily throughout the network. Recently VANETs got success to divert the attention of researchers toward VANETs in the field of wireless networks; VANETs differ from MANET by their structure,compatibilities, challenges, characteristics and applications. In Vehicular Ad-hoc networks, each mobile noderepresents a vehicle acts which shares necessary information for a reliable routing. VANET network is not fixed because of the frequent nodes movement in the network and position of vehicles can be determined by using GPS. According to the movement of the nodes is resulted into the frequent topology changes. Vehicular Ad-hoc Networks are emerging ITS technologies integrating wireless communication to vehicles. Figure 1 shows the VANET Architecture.Communication between vehicles allows sharing different means of information, exemplified below:-

- Safety information regarding dangers for the purpose of accident prevention.
- Behind-accident investigation or traffic jams notifications.
- Some other sort of information can be dispersed such as traveller related information which is examined as non-safety information.

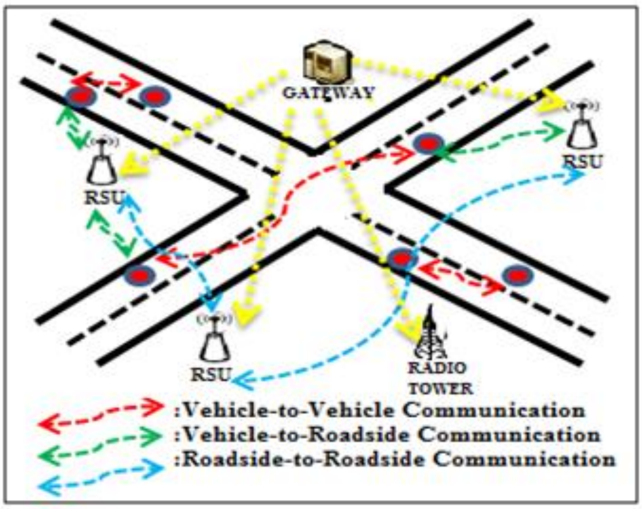

Figure 1: VANET Architecture

VANET supports three types of communication modes: first one is Vehicle-to-Vehicle (V2V), second is Vehicle-to-Infrastructure (V2I). V2V communication is for the direct and multihop communication which is efficient and cost effective due to low range bandwidth and dynamic nature. V2I refers to the communication between vehicles and road side unit and third is R2R communication, for in between roadside units.

VANETs are used in traffic control systems, safety activities, driver assistance and location based applications. In VANETs, energy sources and storage capacity are not an issue because these are not limited and fresh position status of the mobile nodes can be determined by using GPS (Global positioning system). Moreover, a number of researchers consider vehicular ad-hoc networks as one of the most prominent technologies for improving the efficiency, reliability and safety of modern transportation systems.

II. CLASSIFICATION OF ROUTING PROTOCOLS IN VANETs

A routing protocol governs the way that two communication entities exchange information; it includes the procedure in initiating a route, decision of choosing correct forwarding path and mechanism of maintaining the route or re-balancing from routing failure. Till now, a lot routing protocols have been developed for VANETs environment, which can be categorized in many ways, suitable to different aspects; for instance: protocols features, techniques used, routing algorithms, quality of functions, network configuration, accurate routing information, and so on. Many research papers classified VANETs routing protocols into five classes:

1. Topology-based
2. Position-based
3. Geocast-based
4. Broadcast, and
5. Cluster-based routing protocol

Moreover, they can be categorized into two classes according to routing strategies in vehicular ad-hoc network:

1. Proactive and
2. Reactive

On the other hand other papers classified them into two categories: geographic-based and topology-based, categorizes on the basis of the routing information used in packet transmission. As well, other papers classified VANETs routing protocols according to the network formation, into three classes:

1. Hierarchical routing
2. Flat routing, and
3. Position-base routing

2.1 Proactive Protocols

Proactive protocols permits the nodes in the network to use the routing table to maintain routes information for all other routing nodes, all the entries in the routing table consists the next hop node used in the path to the receiver, irrespective of whether the route is actually needed or not. It is mandatory to update the routing table frequently to reflect the changes in network topology, and must be broadcast periodically to the neighbor nodes. This systematic plan may cause more overhead particularly in the high mobility network. Moreover, routes to receivers will always be available when they required. Proactive protocols mainly depend on shortest path algorithms to examine which route will be chosen for better results; they usually use two routing techniques: Link state technique and distance vector technique.

2.2 Reactive Protocols

Reactive routing protocols are also called on-demand protocols which reduces the network overhead; by maintaining routes in the network. The sender node start a route discovery process, if the node requires a new route to a receiver node, this process continue by flooding a route request message in the network. Later on, when the message reaches the receiver node (or to the node which has a route to the receiver), then this node will send a route reply message back to the sender node using unicast conversation. Reactive routing protocols are applicable to the large scale of the vehicular ad-hoc networks which contains high mobility nodes and frequent topology mutations. Many reactive routing protocols have been developed till now, the following sections will illustrate features of some reactive protocols exists in VANETs.

III. ROUTING PROTOCOLS

This section portrays some basic and important routingprotocols. After the brief description, a comparison in the form of table is evaluated, Table 2.

3.1 AODV(Ad-Hoc On-Demand Distance Vector) Routing Protocol

AODV is an on-demand reactive routing protocol, which follows hop-by-hop structure. This protocol enables a dynamic mechanism, self-initiating, multi-hop routing between participating mobile nodes who wants to establish and maintain vehicular ad-hoc network. AODV protocol allows mobile nodes to procure routes rapidly for new required destinationand thenode does not need to maintain routes to destinations that are not active while packet transmission. Route Request (RREQ), Route Reply (RREP), Route Error (RERR) and Hello message are the message types used by AODV protocol.

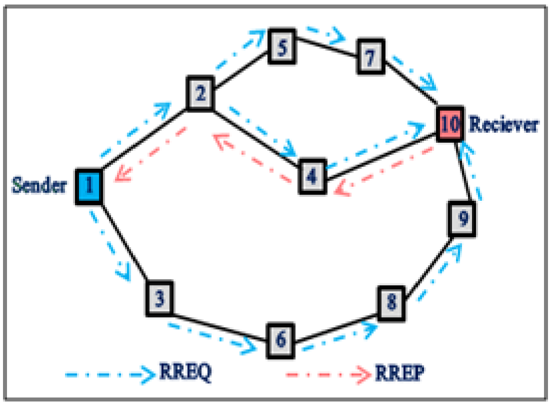

Figure2:AODV Protocol

In AODV routing, when the source node broadcast query (RREQ), then the receiver nodes record the address of the sender node in their routing table. This process of storing its previous hop is called *backward learning*. After receiving the RREQ, the receiver reply back by sending RREP through the complete same route obtained from backward learning to the sender node. At every stop of the path, the node would store its previous hop; by this it establishes the *forward path* from the sender. The flooding of query messages and sending reply back establish a full duplex path or route. When a reliable path is established, then it is maintained as long as the source wants to use it. If the link between sender and receiver fails then it will be reported recursively to the sender and will in turn generate another request-response procedure to find a new reliable route.

3.2 DSR (Dynamic Source Routing) Protocol

DSRis also an on-demand reactive routing protocol in which the primary goal is to maintain the whole path from sender to receiver in the routing table instead of storing the next hop like AODV routing protocol. Consequently, the packet header must contain all participating nodes through which the packettravels to be delivered to the receiver. Same as AODV, the RREQ and RREP messages are used to perform the route discovery by sending route request and delivering the reply message back to the sender.

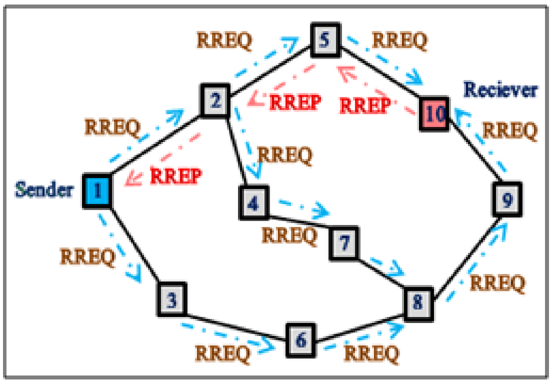

Figure 3: DSR Protocol

In DSR routing protocol, the RREQ message use rebroadcast method if the intermediate node receiving the RREQ message does not have the required destination information in its routing table. Furthermore, in DSR, cache route mechanism is also used in case of link failure.For exemplification, assume the source node 1 has a route <1, 2, 3, 4, 5> to destination node 5, and the link <4, 5> encountered a failure due to node`s movement. In such case, the source node 1 looks up in its cache route for any other route to destination node 5. It is necessary to note that other routes to destination node were stored in cache route due to overhearing the RREQ message by intermediate nodes through various routes in the network. Moreover, the cache route mechanism results in boosting up the data communication. After receiving the RERR message by the sender node, a new route discovery procedure will be started. The RERR message will be initiated and sent to the source node by the very first node which is closer to the source than others. Then, the message will be broadcasted to all the nodes used to deploy the broken link.

3.3 Destination Sequenced Distance Vector (DSDV) Routing Protocol

DSDV is a proactive, table-drivenrouting protocol which stores the route to the destination before it is needed to be established. In DSDV, each node stores a routing table including next hop like AODV, cost metric towards the destination node and asequence number produced by the destination node in the network. All the nodes exchange their routing tables dynamically after a short period or when it is needed to be exchanged. Therefore, every node is able to utilize the fresh list of nodes who wish to communicate. By having information of the neighbour`s routing table, the shortest possible path towards the destination could be examined.

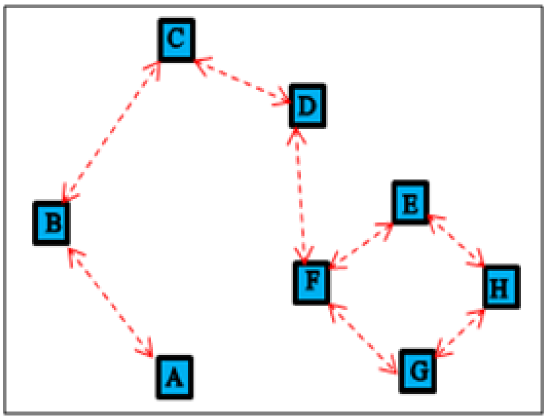

Figure 4: DSDV Protocol Structure

Figure 4 represents the structure of DSDV routing protocol and table 1 illustrate the DSDV's possible routing table according to the route mechanism.

Table 1: Possible Forwarded Routing Table

Destination	Next Hop	Metric	Sequence number
A	D	3	S400A
B	D	2	S300B
C	D	3	S450C
D	D	1	S200D
E	E	1	S210E
F	F	0	S800F
G	G	1	S220G
H	E,G	2	S350H

Furthermore, the DSDV routing mechanism incurs large quantity of control traffic in highly dynamic nature networks like VANETs which results in experiencing a significant amount of bandwidth consumption. Also, to overcome the described shortcoming, two update strategies have been proposed; (a). Full dump strategy, is that which infrequently broadcasts the whole routing table, and (b). Incremental dumpstrategyis that in which exchanging the minor modifications are requiredunlike the last full dump exchange.

IV. CHARACTERISTICS IN VANETs

VANET possess its own unique characteristics presenting itself a particular challenging class of MANETs, the unique characteristics of VANET include:

1. Predictable mobility: In VANETs, nodes move mostly in an ordered path, because vehicles are confined by road topology, structural arrangement and by the necessity to follow road signs, traffic lights and to communicate with other moving vehicles leading to predictability in term of their mobility.

2. Safe driving: In VANETs, a direct communication among moving vehicles and also with road-side units is done through the network. It helps the drivers travelling in the same direction by sharing warning messages concerned about accidents or any other critical situations like sudden hard breaking. It gives a broader frame of the road ahead. It improves the passenger comfort.

3. Unlimited battery power: The battery power in VANET is not a very critical issue as in MANETs, because vehicles have the capability to provide continuous power to the OBU via the long life battery. Vehicles are assumed to have sufficient energy and computing power.

4. Unpredictable traffic density: The traffic density in VANET changes depending on the number of vehicles in a particular area, density can be very high in the case of a traffic jam or it can be very low, as in suburban traffic.

5. Rapid changes in network topology: Due to high speeds of moving vehicles in the network, particularly at the highways leading to changes in network topology very rapidly. Moreover, driver behaviour is affected by the rapid disconnection between vehicles in short range of time

6. Large scale network: In the areas like at the entrance of big cities like at toll-tax centre and at highways etc, the network scale could be large in due to denser traffic.

7. High computational ability: In VANETs, the vehicles can be equipped with the sufficient required number of sensors and some other computational resources like large memory storage, enhanced antenna technology, processors and also the GPS (global position system). These resources boost up the computational capacity in vehicles, which help in sharing accurate information regarding its speed, up-to-time position and direction.

V. COMPARATIVE STUDY

This section provides comparative study between on-demand and table-driven routing protocols described in the previoussection. Table 2 refers difference between AODV, DSR and DSDV. Moreover, reactive routing protocols were proposed to overcome the traffic control overhead and improve reliability in the network. The DSR protocol is designed for networks in which the mobile nodes move at temperatespeed in respect of packet transmission latency.

As compared to the other on-demand protocols, DSR does not need of periodic routing updates like AODV, thus it save more bandwidth and reducing energy consumption. Moreover, DSR is not scalable to large networks because of small diameter assumption and the source routing requirement.

Same as DSR, AODV follow a route discovery procedure, but in DSR overhead is generally larger than in AODV. In AODV, the transmissionpacket only contains the destination address instead of the complete routing information of the routes. Another benefit of AODV is that it supports multicasting (MAODV).

AODV take advantage of both the distance vector used in DSDV protocol and source routing from DSR protocol. AODV has less traffic control overhead and highly scalable as compare to DSR and DSDV. However, nodes in AODVrequire hello message during communication periodically with their neighbor nodes to maintain link failures.

In AODV and DSR, a node informs the source node to initiate a new route discovery procedure when a routing link failure is detected and use flooding technique to inform nodes. Moreover, AODV and DSDV avoid the formation of route loops by using sequence numbers but in DSR the route loops can be avoided by checking addresses in route record field of data packets.

Table2:Comparison Table

	AODV	**DSR**	**DSDV**
Protocol type	Distance Vector & Source Routing	Source Routing	Distance Vector
Route nature	Reactive	Reactive	Proactive
Structure	Flat-hierarchical	Flat-hierarchical	Flat
Multiple paths	Yes	Yes	No
Loop-free	Yes	Yes	Yes
Latency	High	High due to flooding	Low due to routing tables
Routing metric	Freshest & Shortest path	Shortest path	Shortest path
Multi-casting	Possible	NP	NP
Updates transmitted to	Source	Source	Neighbor
Refresh period	Event-driven	Event-driven	Periodic
Hello message	Re-queried	No need	No need
Route main-tained in	Route-table	Route-cache	Route-table
Storage capacity	Low	Low	High
Sequence number	Required	Not-required	Required
Advantage	Adaptable to dynamic topology	Multiple Routes	Loop-free
Dis-advantage	High scalability	Flooding	High-overhead

VI. CONCLUSION

In this paper, an effort has been made to reveal the basic features andcomparative study of AODV, DSR & DSDV. Moreover, a single routing protocol can't perform best in all circumstances. So, the choice of routing protocol should be done attentively according to the requirements of the specific routing tasks. The focus of this review in our future research work is to propose new extensions in theexisting routing protocols in VANETs which will be better in terms of security, reliability, throughput, efficiency in terms of utilization of limited resources.

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