International Journal of Advances in Computer Networks and Its Security– *IJCNS*
Volume 4 : Issue 3 *[ISSN 2250 – 3757]*
Publication Date : 30 September, 2014

Analysis of Routing Protocols over VANET through the Using Matlab Simulator

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***Abstract*—VANET is a Vehicular Ad hoc Network; it is a new network technology where the cars are used as mobile nodes to form a communication network. In VANET, routing protocols have a significant role in terms of the performance because they determine the way of sending and receiving packets between mobile nodes. In this paper, we examine and analyze the performance of Ad-hoc On-Demand (AODV), Dynamic Source Routing (DSR) and Destination-Sequenced Distance Vector (DSDV) routing in terms of Packet Delivery Ratio, Average End to End Delay, Latency and Throughput. The objective of this study is to find the best routing protocol over all circumstances. Based on our validated results, AODV performs the best among all evaluated protocols.**

Keywords—VANET; AODV; DSR; DSDV; MATLAB

I. INTRODUCTION

VANET is a Vehicular Ad hoc Network; it is a subclass of Mobile Ad Hoc Networks (MANETs). It is a new network technology where the cars are used as mobile nodes to form a communication network. VANET is an integral part of the intelligence transportation system architecture, which aims to improve road

Safety, optimizes traffic flow, and reduce congestion and so on. [1]. A Vehicular Ad-Hoc network provides communication among nearby vehicles and between vehicles and nearby fixed equipment i.e. roadside equipment as in figure 1.

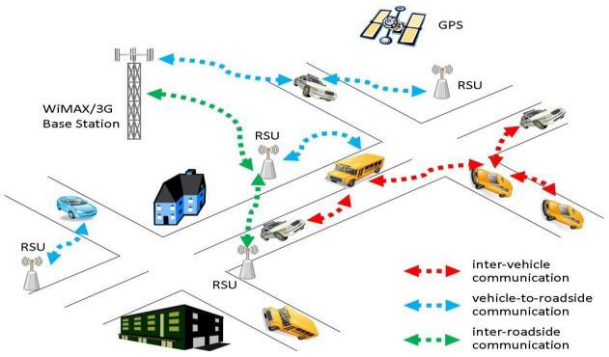

Fig. 1. Vehicular Ad Hoc Network

In VANETs, vehicles are represented as network nodes. Some vehicles are represented as senders and others are represented as receivers. Communications among vehicles are provided so that they transmit and receive information. The main goal of VANET is providing safety and comfort for passengers. Besides safety applications VANET also provide comfort applications to the road users.

This paper is organized as follows: section II introduces a brief summary about the routing protocols under, section III presents the proposed scenario, section IV includes the simulation environment, section V presents the results and last section includes the conclusion for our simulation results.

II. ROUTING PROTOCOLS

Routing is a process of sending a message from one mobile node to another in the network (it is also called unicast). Routing protocols for mobile ad hoc wireless networks normally call for mobility management and scalable design. The mobility management is done by exchange the information between moving hosts in the ad hoc wireless network. Generally, when the frequent information exchanges occur, the network maintains accurate information of host locations and other relevant information. However, frequent information exchanges consume communication resources including bandwidth and power, so that it can be costly. With less frequent information exchanges, these costs decrese but there is more uncertainty about the location of host. Scalable design which works for large size networks, requires both routing protocols and resource consumptions to be scalable. Routing in MANET poses special challenges because of its infrastructure-less network and its dynamic topology. Wired network uses traditional routing protocols, that generally use either link state or distance vector, but these protocols are not suitable for ad hoc wireless networks. In an environment, where mobile hosts work as routers, the network topology changes dynamically, hence the process could be expensiv due to low bandwidth.

A routing protocol is required, whenever a packet needs to be communicate via several nodes to arrive at its destination. A routing protocol is necessary to find a route for packet delivery and make the packet delivered to the correct destination. Routing Protocols in Ad Hoc Networks can be classified into

three types. The classification of routing protocols in MANET is described in figure 1.

A. Proactive routing protocol

These protocols are also called table-driven protocols and also comes under topology based routing protocol. In this, every node maintain routing table which contains information about the network topology. These protocols utilize information about links in the network to forward the packets. It follows the conventional routing scheme. Each node maintains one or more routing tables and for each new entry, routing table is updated periodically. They create the route before demand. So, there is no delay when a node wants to communicate to other node in the network. These protocols are not applicable for large networks. The major drawback of these routing protocols are more overhead and more bandwidth consumption as each node contain information about network topology even without requiring it. So, it incurs significant power consumption. Some of the proactive routing protocols are Destination sequenced distance vector (DSDV), Optimized link state routing (OLSR).

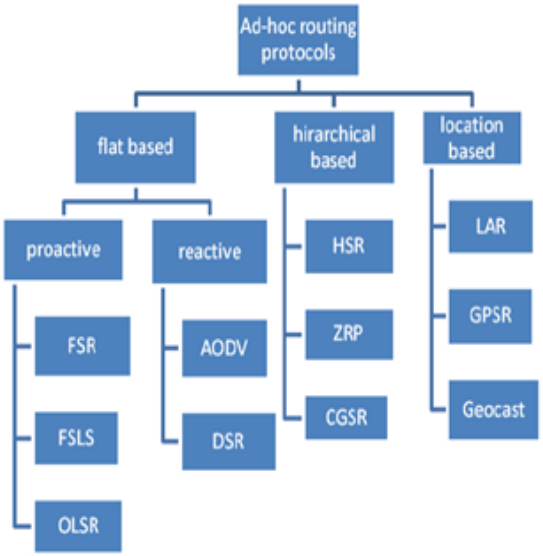

Fig. 2. Classification of routing protocols

B. Reactive routing protocol

Reactive routing protocols are also called on-demand routing protocols which comes under topology based routing protocol. These protocols take a lazy approach to routing. Every node maintains information only about active routes to the destination . These protocols will act on demand only. Discovery process is initiated whenever a node wants to communicate with other node. They were designed to overcome the disadvantage of proactive routing protocol to reduce the routing overhead by maintaining information only about active routes. It consists of two steps: route discovery and route maintenance. Route discovery is used to find out the path to the destination and route maintenance is used in case of any link breakage. Acknowledgment mechanism is used for notifying about any link breakage for route maintenance. Some examples of reactive routing protocols are Ad-hoc on demand distance vector (AODV), Dynamic source routing (DSR).

C. Hybrid routing protocol

The trade-off between proactive routing protocols and reactive routing protocols lead to the development of another class of protocols called the hybrid routing protocols. These protocols are the combination of both proactive and reactive routing protocols. Proactive protocols produce large routing overhead but with less latency whereas reactive protocols produce less overhead but with more latency. So, hybrid protocols presented the overcome of trade-off of both the protocols. In these protocols, network is divided into several zones. Inside the zone, proactive routing protocol is performed and outside the zone, reactive routing protocol is performed. Some examples of hybrid protocols are Zone routing protocol (ZRP) and SHRP.

In VANET, routing protocols have a significant role in terms of the performance because they determine the way of sending and receiving packets between mobile nodes.

D. Ad-hoc On–Demand Distance Vector Routing protocol

Ad-hoc on demand distance vector routing is a reactive protocol which is described in RFC 3561. It works in two steps: Dynamic Source Routing Protocol

- Route discovery:

Whenever a node wants to communicate to with another node, then it first check for a valid route to the destination. If it finds a valid route to the destination in its routing table, it forwards the packets on that route. If it does not find any valid route, it starts the route discovery process. In route discovery process, the node create a route request packet (RREQ) and send it to allits intermediate nodes. The RREQ message format consists of the varoius fields such as Type, hop count, destination IP address, destination sequence number, originator IP address, originator sequence number and reserved fields. The intermediate node on receiving that RREQ packet have the valid route to destination send a reply to the source othewise forwards RREQ to other intermediate nodes and so on. When the request reaches the destination, it replies with RREP packet to the destination containing type, hop count, destination IP address, destination sequence number, originator IP address and lifetime. Then source will start sending packets to the destination.

- Route maintenance:

The route maintenance process is initiated whenever there is a route failure in the network. When there is a route failure in the network, RRER message is send to the source so that the source will invalidate that route from its routing table and initiate a new route discovery process. The link failure can occur due to mobility or energy exhaustion of nodes. To check the connectivity of a route, HELLO messages are used periodically.

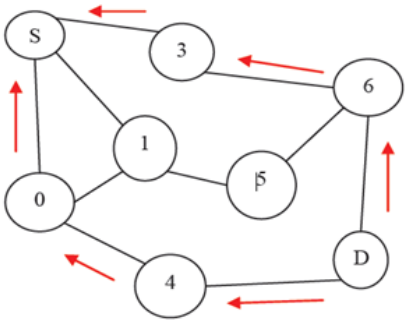

Fig. 3. RREQ broadcast.

E. Dynamic Source Routing (DSR)

Dynamic Source Routing (DSR) is based on the source-based routing in the Adhoc routing protocol. This protocol is source-initiated instead of hop-by-hop. This is particularly designed for use in multi hop wireless ad hoc networks of mobile nodes. DSR protocol is self organizing and configuring protocol so does not need any existing network infrastructure. It is composed of two essential parts: 1. Route discovery 2. Route Maintenance. To store recent discovered paths, every node maintains a cache in this protocol.

- Route Discovery:

In DSR before a node needs to send a packet to any node, it first checks its entry in the cache. If it is there in that, then it uses that path to transmit the packet and also attach its source address on the packet. If it is not there in the cache or the entry in the cache is expired because of long time idle, the sender broadcasts a route request packet to all of its neighbors asking for a path to the destination. The sender will be waiting till the route is discovered. The sender can perform other tasks such as forwarding other packets during waiting time. As the route request packet arrives to any of the nodes, they check from their neighbor or from their caches whether the destination asked is known or unknown. If route information is known, they send back a route reply packet to the destination otherwise they broadcast the same route request packet. When the route is discovered, the required packets will be transmitted by the sender on the discovered route. Also an entry in the cache will be inserted for the future use.

- Route Maintenance

The node will maintain the age information of the entry so as to know whether the cache is fresh or not. When a data packet is received by any intermediate node, it first checks whether that intermediate node is mentioned destination node. If the intermediate node is the destination node, then the packet is received otherwise that node will be forwarded using the path attached to the data packet. Any link might fail anytime on Adhoc network. Therefore, route maintenance process will regularly monitor and will also notify the nodes if there is any failure in the path. Subsequently, the nodes will change the entries of their route cache. The Figure 4 shows an example of DSR protocol.

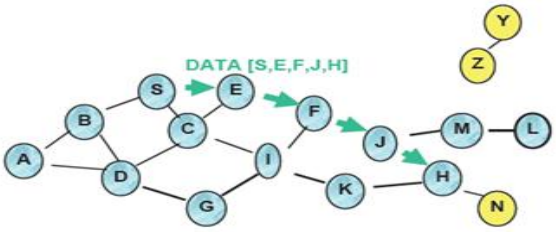

Fig. 4. Example of DSR

F. Destination-Sequenced Distance-Vector Routing (DSDV)

In DSDV, each node maintains a next-hop table, which it exchanges with its neighbours. There are two types of next-hop table exchanges: periodic full-table broadcast and event-driven incremental updating. The relative frequency of the full-table broadcast and the incremental

Updating is determined by the node mobility. In each data packet sent during a next-hop table broadcast or incremental updating, the source node appends a sequence number. This sequence number is propagated by all nodes receiving the corresponding distance-vector updates, and is stored in the next-hop table entry of these nodes. A node, after receiving a new next-hop table from its neighbour, updates its route to a destination only if the new sequence number is larger than the recorded one, or if the new sequence number is the same as the recorded one, but the new route is shorter. In order to further reduce the control message overhead, a settling time is estimated for each route. A node updates to its neighbours with a new route only if the settling time of the route has expired and the route remains optimal [3].

III. PROPOSED SCENARIO

The proposed scenario of vehicular ad hoc network is shown in fig. 5. In this RSU indicates the Roadside units, which are static in nature. H1 indicates the servers which controls the roadside units across the overall network. A red line shows the packets that are delivered from source to destination and Server is a central server which controls the all over network. Figure 5 shows a real scenario using VANET.

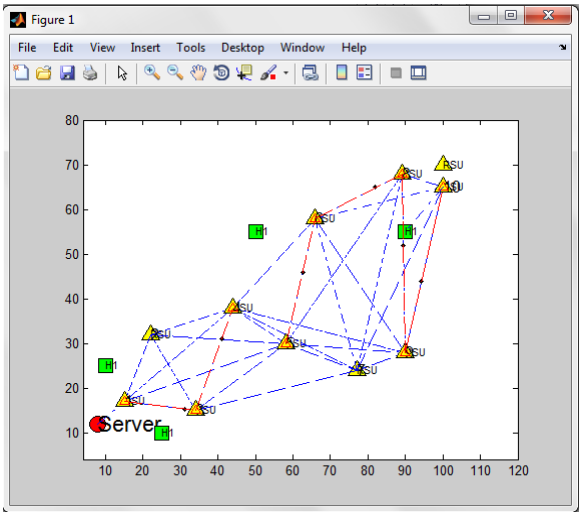

Fig. 5. Proposed Scenario of VANET

IV. SIMULATION ENVIRONMENT

A. *Simulation Set Up*

In our simulation, we have taken 11 RSU's that are static in nature. The simulation area of 80 m × 120 m is used. Different packet sizes in the range from 50 byte to 400 bytes are used. Three routing protocols are examined; AODV, DSR and DSDV. Table 1 shows the input parameters that we have used in our simulation using mat lab.

TABLE I. INPUT PARAMETERS

Parameter	Value
Protocols	AODV, DSR, DSDV
Number of RSU's	11
Packet size	50 to 400 bytes
Node type	Highly mobility nodes (vehicles)
Environment size	80 m × 120 m
Performance metrics	Throughput, Latency, E2E Delay, PDR

B. *Simulator Used*

Matlab is a technical computing language used mostly for high-performance numeric calculations and visualization. It can be widely used to analyze data, modelling, simulation and statistics. The language, tools, and built-in math functions enable you to explore multiple approaches and reach a solution faster than with spreadsheets or traditional programming languages, such as C/C++ or Java. MatLab 7.10 has been used for the implementation of routing protocols. It provides the real time environment to the vehicular ad hoc network.

V. RESULTS

In this section, we analyze the performance of the selected routing protocols; AODV, DSR, and DSDV. In this analysis, we consider the following measured parameters: Packet Delivery Ratio, Average End to End Delay, Latency and Throughput with respect to different packet size.

A. *Throughput:*

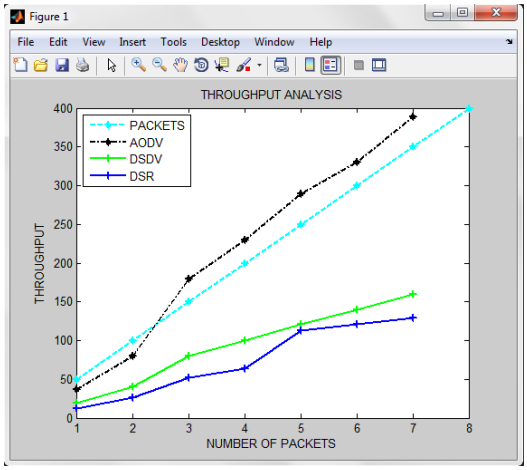

Fig. 6. Throughput of AODV, DSDV and DSR

Fig 6. shows the comparison of AODV, DSDV and DSR routing protocols in terms of throughput. More is the throughput of sending and receiving packets, better is the performance. With the increase in packet size of vehicular nodes, throughput is also increases in all cases of AODV, DSDV and DSR routing protocol. But in case of AODV, throughput varies in high as compare to DSR and DSDV. So, the performance of AODV routing protocol is better.

B. *Latency:*

It is the time taken for the packets being created at the source to the being received at the destination. VANET needs a small latency to deliver quick messages.

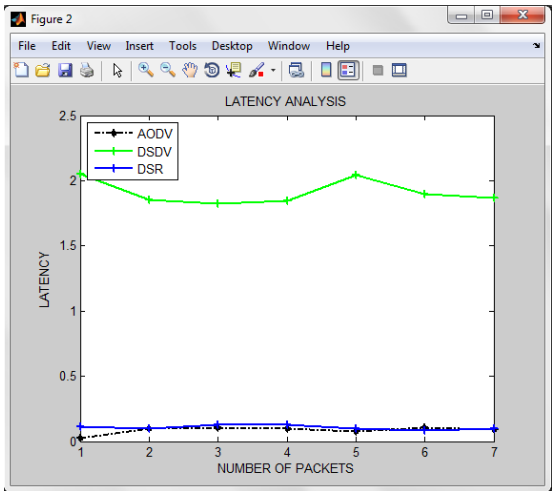

Fig. 7. Latency of AODV, DSDV and DSR

In fig 7, AODV occupy small latency as compared to both DSDV and DSR, so it delivers packets more quickly as compare to both of them. So, the result shows that AODV is best protocol. And latency of DSR is small as compare to DSDV, so DSR routing protocol is best then DSDV to deliver packets more quickly.

C. Packet Delivery Ratio:

It is the ratio between the number of packets delivered to the receiver and the numbers of packets sent by the source. Higher the percentage, more privileged is the routing protocol. In fig.8, PDR of AODV, DSDV and DSR is increases as the packet size increases, but in case of AODV, it increases in large number than DSDV and DSR. In case of DSR, it increases in small value than AODV and DSDV, and PDR of DSDV is increases in small value than AODV but large value than DSR. So, AODV is more suitable routing protocol than DSDV and DSR.

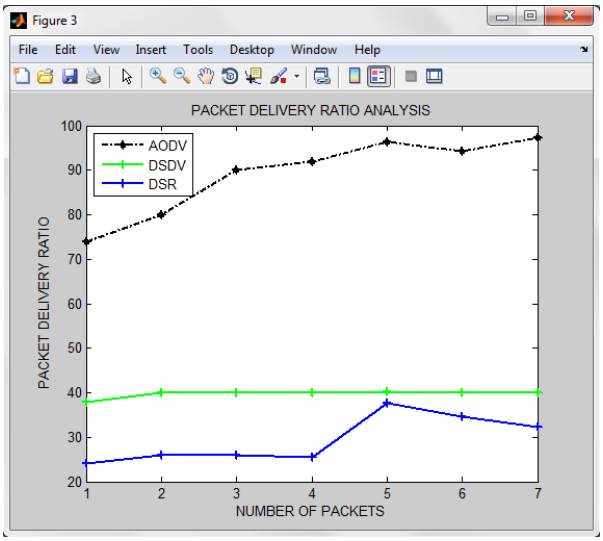

Fig. 8. Packet Delivery Ratio of AODV, DSDV and DSR

D. End-to-End Delay:

This metric gives the overall delay, from packet transmission by the application agent at the source node till packet reception by the application agent at the destination node. Lower the time taken, more privileged the routing protocol is considered. In Fig.9, End-to-End delay is less in case of AODV as compared to DSR and DSDV, so AODV is more suitable for VANET. In case of DSR and DSDV, end-to-end delay of DSDV is less than DSR, so from DSDV and DSR, DSDV is better.

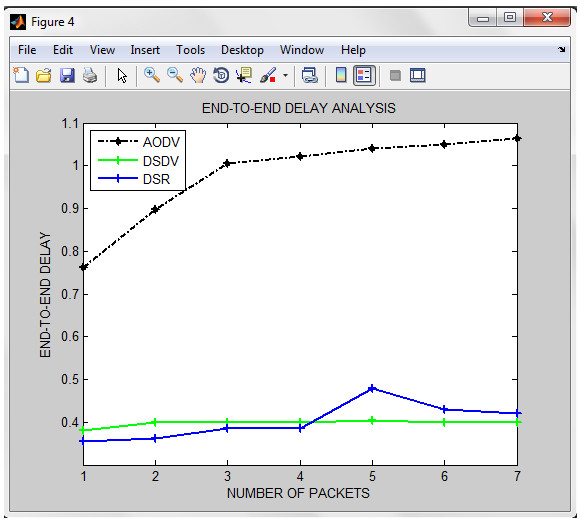

Fig. 9. End-to-End Delay of AODV, DSDV and DSR

VI. CONCLUSION

VANET is an active research field these days. This paper has been carried out the simulation of AODV, DSDV and DSR routing protocols in VANET as in more realistic manner. The simulation is done in Mat lab with respect to various parameters like throughput, packet size, end-to-end delay etc. The simulation result shows that AODV performs better than DSDV and DSR in terms of throughput, end-to-end delay, latency and packet delivery ratio. And from DSR and DSDV, DSDV is best.

In future, the simulation can be done for integrated protocol and compared with existing routing protocols with more performance metrics like delivery cost, normalized routing load, packet drop etc. Here the implementation has been done by using matlab. Further, the implementation can be done using Qualnet, NS2, NCTUns, GlomoSim etc.

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