PERFORMANCE EVALUATION OF AD HOC ROUTING PROTOCOLS IN VANET USING NS-3 SIMULATOR

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ABSTRACT: A vehicular network or VANET, is a type of Mobile ad-hoc network(MANET).VANET is new and growing concept in the wireless network. The main objective of VANET is to build a secure and powerful network between mobile vehicles and road side equipment which are situated with wireless device. VANET has characteristics of high mobility and secure communication with the infrastructure along with comfort applications. The main objective of this paper is to make a comparison analysis of ad-hoc routing protocol, we have selected AODV,OLSR and DSDV in realistic urban senario. Impact of varying mobility and density on these above routing protocols. We study performance of these protocol under Packet delivery ratio , throughput and average delay metrics. We concluded in result section that AODV have better performance in terms of Throughput and PDR and OLSR gives best result in terms of Packet Delivery Time.
Keyword: Ad-hoc network, AODV, OLSR, DSDV, MANET, VANET, PDR, SUMO, NS-3

I. INTRODUCTION

Vehicular networks are emerging as a new promising field of wireless technology which aims to deploy vehicle-to-vehicle(V2V) and vehicle-to-infrastructure (V2I) for safety and non safety applications.A Vehicular Ad-hoc network is a subtype of Mobile ad-hoc Networks(MANET). VANET is characterized by very high node mobility and self organizing networks of vehicles which may not have prior knowledge of each other.Vehicular networks have wide range of applications area which include safety and traffic management, enhanced efficiency, traveller entertainment, decrease travelling time, conserve life and transportation properties besides these VANET have many more field of application.

VANET pose many challenges in respect of technology, protocols and security which increase the need for research in this field. VANET are expected to promise a large bunch of mobile distributed application like traffic alert dissemination and dynamic route planning and file sharing. In network there may be large number of nodes that take active role in these networks and their high mobility, so that challenge for feasibility of applications that use end to end multi hop communication still exist. The main objective is here whether the performance of VANET routing protocols satisfy or not the throughput and delay requirements of such applications.

In this paper, we have analyses the performance of three highly adopted adhoc routing protocols AODV, OLSR and DSDV in realistic urban scenario. To show performance analysis we use different types of performance parameter like such as Throughput, Packet delivery Ratio (PDR) and Average delay time. The performance of protocols tested at simulation tool Network Simulator (NS) and SUMO Traffic simulator.

Fig 1: VANET Enviornment

II. VANET SYSTEM ARCHITECTURE

In VANET system architecture each vehicle consists of two types of device : 1. On board unit(OBU) and 2. One and more application(s) unit(AUs) . An OBU is a communicating device which provide a short range wireless communication dedicated of road safety where as AU is a device which on which a single or set of application can be executed while making use of OBU's communication capabilities. AU can be portable device whether a laptop or PDA that can dynamically attach to(or detach from) OBU.OBUs from different vehicles node form mobile ad hoc network(MANET). OBU and road side situated equipments(RSU) together form ad hoc networks.RSUs can attach with network which further may be connected with internet. These RSUs can communicate with each other and with OBUs.

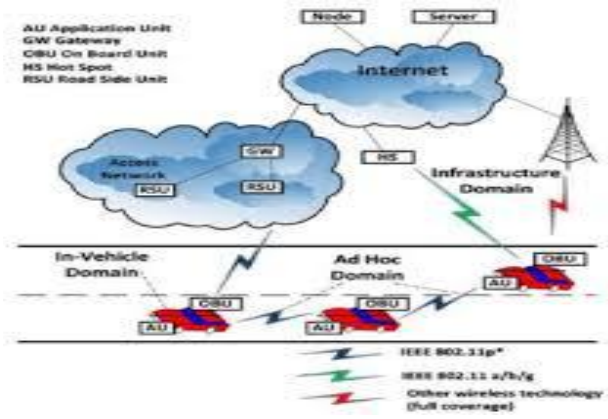

Fig 2: VANET System Archecture

III. APPLICATIONSIN VANET

There are various attractive feature of VANET that make difference from other networks. VANET have numerous applications which are as follows:

- Safety applications enhances the driving conditions and reduces the chances of accidents by providing enough time to the driver and to apply brakes automatically.
- Intelligent transport applications aim at providing faster delivery of traffic information, and improving the efficiency and accuracy of traffic detection by allowing collaborative processing of information between vehicles. These applications focus on observing the traffic pattern and managing traffic accordingly.
- Comfort applications are the applications of VANET related to comfort level of the passenger moving in the vehicle.
- Police service can be improve because in less traffic they can coordinate in better way while following criminals.

IV. AD HOC ROUTINGPROTOCOL

Classification of routing protocols in VANET can be done either depending on routing strategy and network structure. Where Table –driven and source initiated routing protocols which are based on routing strategy, while focused on the network structure these are categorised into flat routing ,hierarchical routing and geographic position assisted routing. Both routing protocol based on routing strategy comes under the Flat routing.

Our work focused on proactive(table -driven) and reactive (on -demand) routing protocols. AODV(Proactive routing),OLSR(Proactive routing),DSDV(Reactive routing).

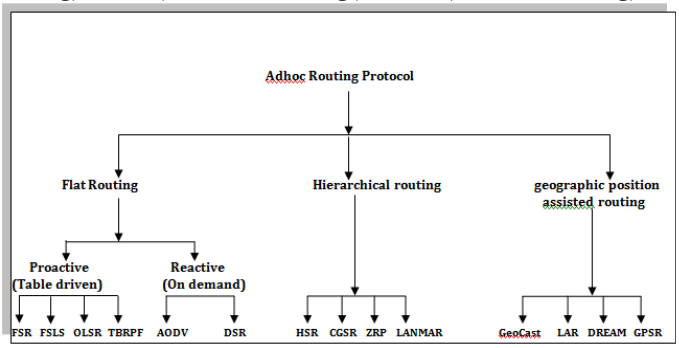

Fig 3: Adhoc Routing Protocols schema

Proactive (Table Driven) Routing Protocols

Proactive routing are also known as table driven routing protocols because in this every node keep maintain routing table information even they are required or not. Each node keep information of both network topology and route information in network. These routes information is periodically updated as any changes occurs in network topology. These protocols are not suitable for large networks as they need to keep track of routing table of each node in network. However this feature make it advent useful for datagram traffic.

Example: OLSR ,DSDV ,GSRR

Reactive(On Demand) Routing Protocols

Reactive protocols are also known as on demand routing protocols since they perform route information discovery only when needed. Which saves bandwidth of network. If a packet needed to send from source to destination node then routing protocol searches a route and establishes the connection between source and destination to send and receive packet. Example : AODV,DSR.

4.1 Ad hoc On-Demand Distance Vector(AODV) Routing Protocol

The Ad hoc On-Demand Distance Vector (AODV) algorithm is a pure reactive protocol that provides dynamic, self-starting, multi hop routing between participating numerous mobile nodes wishing to establish and maintain an ad hoc network. In AODV when a source node has require to send some data to destination node ,it found quickly a route by sending a Route Request(RREQ) packet and does not required each near by nodes to maintain routes which are not participate in communication. AODV allows mobile nodes to respond to link breakages and changes innetwork topology in a timely manner. When links break, AODV causes the affected set of nodes to be notified so that they are able to invalidate the routes using the lost link. One distinguishing feature of AODV is its use of a destination sequence number for each route entry. The destination sequence number is created by the destination to be included along with any route information it sends to requesting nodes.

4.2 Optimized Link State Routing (OLSR)Protocol

The Optimized Link State Routing Protocol (OLSR) is a table driven, proactive routing protocol which is developed for mobile ad hoc networks. This routing protocol inherits the property of link state routing protocol. In OLSR each node selects a set of its neighbour nodes as "multipoint relays" (MPR). In OLSR, MPRs are responsible for forwarding control traffic, intended for diffusion into the entire network. By use of MRP flooding of control traffic minimized and control retransmission in flooding and broadcast procedure.This protocol keeps routes for all destination in the network which make it useful for network system where number of nodes are communicating with each other or changing with time. Each node sends control messages periodically, and can therefore sustain a reasonable loss of some such message. The protocol also does not require an in-order delivery(Reliability) of message because all nodes keep sequence number of recent information which facilitate that re-ordering at destination end does not interpret old information as new one.

4.3 Destination –Sequenced Distance-Vector(DSDV)

The Destination Sequenced Distance Vector (DSDV) Routing Algorithm is an enhanced version of the Distributed Bellman Ford (DBF) Routing Algorithm with certain improvements. The primary concern with using a Distributed Bellman Ford algorithm in Ad Hoc environment is its susceptibility towards forming routing loops and counting to infinity problem. DSDV guarantees loop free paths at all instants.

Whenever a node B comes up, it broadcasts a beacon message ("I am alive message") stamping it with a locally maintained sequence number.
Each node maintains a routing table, which contains entries for all the nodes in the network. Each entry consists of:

- The destination's address
- The number of hops required reaching the destination (hop count)
- The sequence number as stamped by the destination.

V. SIMULATION MEHTODLOGY AND PERFORMANCE METRICS

5.1 Simulation Objective

The main objective of this paper is make performance comparison of VANET routing protocol (AODV,DSDV,OLSR) by using performance metrics such as Packet Delivery Ratio(PDR), Throughput and Average Time Delay. We performed this for varying speed and mobility .

5.2 Performance Metrics

There are several types of performance metrics at which routing protocols can be evaluated for network simulation result. In this dissertation following types of performance metrics are used:

Packet delivery Ratio

This is calculated as the ratio of the number of packet received by constant bit rate sink destination(CBR) and the number of sent by the CBR source node.Mathematically it is calculated as follows:

PDR(%) = S1÷ S2

Where S1= sum of data packets received at each destination in network

S2= sum of data packet sent by the each source in network

Throughput

The throughput of the protocols can be describes as percentage of total number of packets received by the destination among the packets transmitted by the source. It is the amount of data per time unit that is delivered from one node to another via a communication link. The throughput is measured in bits per second. Throughput can be calculated as follows :

$$\text{Throughput(mbps)} = \frac{\text{Total no of received packet at destination} * \text{packet size}}{\text{Total Simulation time}}$$

Average delay

This metrics define the overall delay, from packet transmission bythe application agent at the source node till packet reception bythe application agent at the destination node so that it includes the delays due to route discovery, packet propagation, transmitting time and the time of packet in queue. To calculate the average end-to-end delay the followingequation is used:

$$\text{Average Delay(second)} = \frac{\text{Total(PRT-PTT)}}{\text{Total (RP)}}$$

Where PRT = Time taken by data packets to received at destination node

PTT= Time taken by data packets sent from source node

RP= Received packet at destination

5.3 Simulation Tools

The result is carried out for the performance evaluation of routing protocol(AODV,DSDV,OLSR) under the operating system ubuntu 16.04 .For traffic simulation sumo 0.30.0 is used to generate mobility and openstreetmap is taken for this. Network simulation is done by using ns-3.26 simulator.

5.4 Simulation Scenario

Network Schema

In evaluation SUMO traffic simulator is used to generate network schema which is based on the"open street map". Following is real network schema shown in figure:

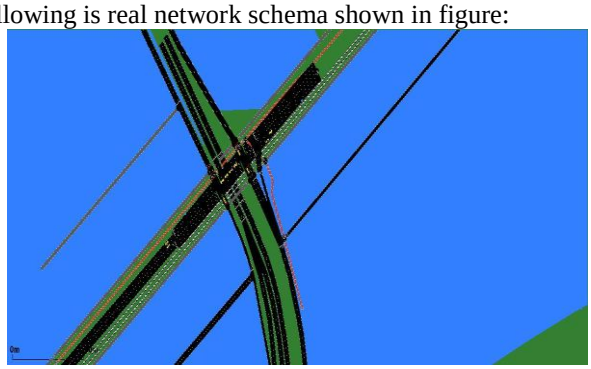

Fig 4:

Simulation Parameter

All test have been performed on different scenario having 50,100,150,200 nodes with 5 and 10 connection for each scenario. With the help of SUMO simulator a road map has been created which is shown in figure 5.1 with the area 650*750.

Table 5.1 Simulation Setup

Parameter	Value
Topology Area	650*750
Routing protocol	AODV,DSDV,OLSR
No of nodes	50,100,150,200
Node speed(m/s)	5,10,20,40,80
Traffic Type	UDP
Download file	Openstreetmap(in osm.xml format)
Speed	40kmh
Data rate	1mbps
Data Packet size	512 bytes
MAC protocol	IEEE 802.11a
Simulation time	200 sec
PropagationLoss Model	TwoRayGroundPropogationLoss Model
PropogationDelay Model	ConstantSpeedPropogationDelay Model
SUMO version	Sumo-0.30.0
NS3 version	Ns-3.26

5.5 Simulation Result

Case 1: Effect of varying no of nodes on the Average Delay,PDR and Throughput of AODV,OLSR,DSDV

In case1,by varying the no of nodes(density) we make performance analysis of AODV,OLSR,DSDV against the average delay, packet delivery ratio(PDR) and throughput.

While performing simulation we kept some parameter constant which are :Simulation time:200s and Speed of vehicles:40 m/s

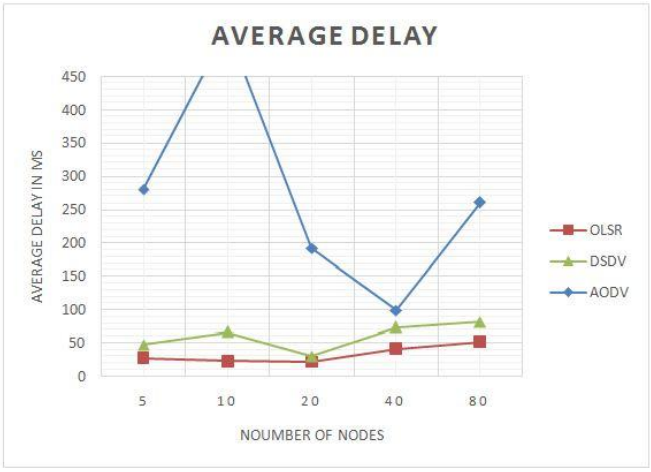

Fig 5: Node Density vs. Average Delay

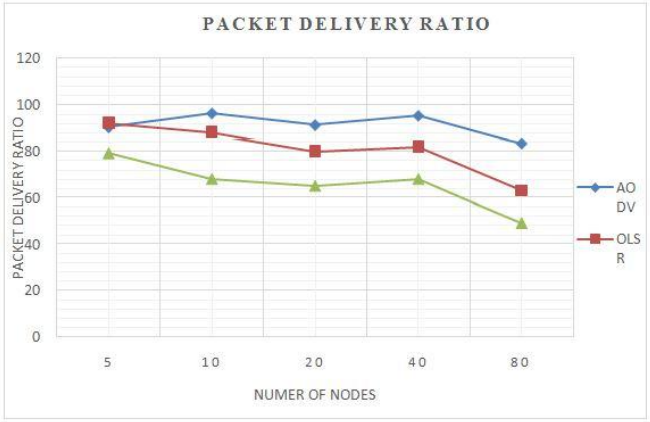

Fig 6: Node Density vs. PDR

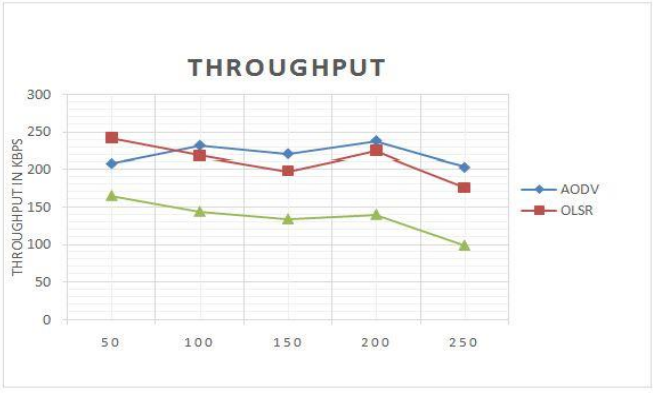

Fig 7: Node density vs. Throughput

As can be shown from above figure we can conclude following result:

Result 1: Above figure ,Fig. 5,shows that:

- The delay of OLSR routing protocol is the lowest among all these protocols.
- The average delay of DSDV is lower than AODV.

Result 2: Above figure ,Fig. 6,shows that:

- The packet delivery ratio of AODV routing protocol is the more than 90%among all these protocols regardless of network density.
- OLSR has better performance as comparative to DSDV protocol. In this case AODV performs best result among all protocols.

Result 3: Above figure ,Fig. 7,shows that:

- Throughput values of AODV routing protocol is higher than all these protocols regardless of network density.
- OLSR has better performance in terms of throughput as comparative to DSDV protocol. In this case AODV is the most efficient as compared to DSDV and OLSR.

Case 2: Effect of varying mobility on the Average Delay, PDR and Throughput of AODV,OLSR,DSDV)

Inthis case2, we vary the nodes speed and see how average delay, the packet delivery ratio(PDR) and the throughput changed accordingly. These all performance metrics are measured for AODV,OLSR,DSDV routing protocols. At this time we kept some parameter constant which are as: Simulation time: 200 secondsandNo of nodes :35

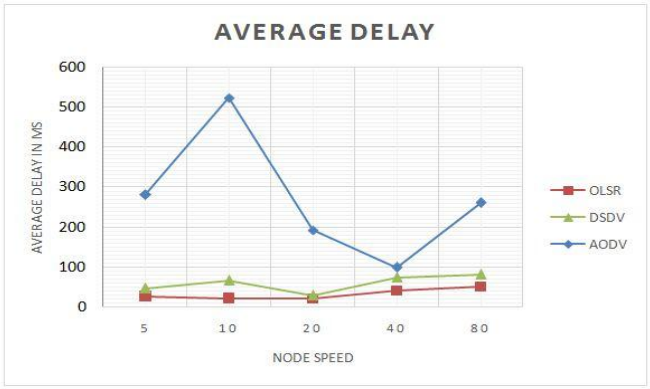

Fig 8: Varying Speed vs. Average Delay

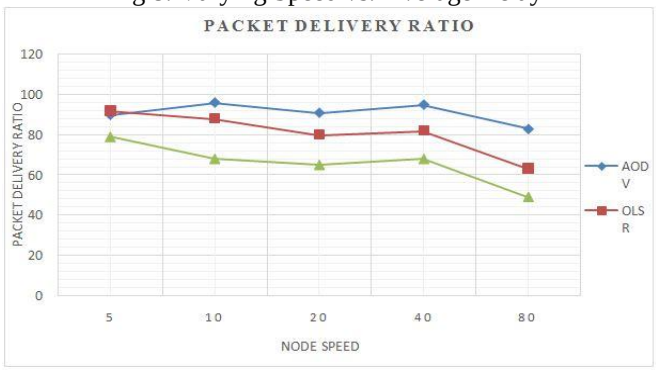

Fig 9: Varying Speed vs. PDR

Fig 10: Varying speed vs. Throughput

As can be shown from above figure we can conclude following results:

Result 1: Above figure ,Fig. 8,shows that:

- The delay of OLSR routing protocol is the lowest among all these protocols.
- The average delay of DSDV is lower than AODV. In this case OLSR records significantly efficient result from other protocols.

Result 2: Above figure ,Fig. 9,shows that:

- The packet delivery ratio of AODV routing protocol has significantly consistent delivery fraction values which are higher than DSDV and OLSR.
- OLSR has better packet delivery ratio as comparative to DSDV protocol. In this case AODV performs best result among all protocols.

Result 3: Above figure ,Fig. 10,shows that:

- Throughput values of AODV routing protocol has higher throughput values for all low and high mobility.
- OLSR has better performance in terms of throughput as comparative to DSDV protocol. In this case AODV is the most efficient as compared to DSDV and OLSR.

VI. CONCLUSION AND FUTURE SCOPE

In this paper a performance evaluation and comparison of AODV (Reactive routing protocol),OLSR(Link state proactive protocol), DSDV(Proactive protocol) is done in realistic scenario . All these protocols are simulated using NS-3.26 network simulator were compared in terms of performance metrics (Average Delay, Throughput and PDR) with varying number of nodes(50,100,150,200,250) and speed(5,10,20,40,80).Based on various result we can conclude that VANET protocol depends on a set of things that built the simulation environment such as mobility and density. In this paper three routing protocols(AODV,DSDV,OLSR) in VANET, we observed that further performance evaluation is required to compare performance of a routing protocol with other routing protocols for different scenarios. By comparison existing routing protocols can be enhance with different behaviour of VANET like high dynamic nature, huge velocity of mobile nodes, changing routing scenarios and routing feature and efficiency. In the future,extensive simulation could be used for other existing performance metrics. Existing protocols may be enhanced and design for new protocols in different more types of application.

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