Analysis of DSDV,OLSR and AODV Routing Protocols in VANETS Scenario: Using NS3

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***Abstract*—VANET's is an emerging field in communication networks and has become a promising tool to provide safety and connectivity for an intelligent transport system. Choosing appropriate routing protocols is necessary for smooth communication. In this paper we use NS-3 to implement AODV, OLSR and DSDV routing on V-to-V, I-to-I and V-to-I nodes. Then we employ Qos (Quality of service) parameters like throughput, PLR (packet loss ratio) and packet overhead, as evaluation parameters to compare these routing protocols. We use IEEE 802.11p [2] and Nakagami-n fast fading propagation loss model for the simulations. The simulation results show that OLSR is the most optimum technique amongst AODV, DSDV and OLSR for our model.**

Keywords- VANETs,DSDV,OLSR,AODV,RSU,OBU

I. Introduction

Vehicular Networks is the new developing field in wireless networks. Vehicular Ad Hoc Network (VANET) is a kind of Mobile Ad Hoc Networks (MANET). VANETs provides us with the platform for developing new and improved systems for improving drivers' and passengers' safety and comfort. VANETs are network systems that distribute and organize [7] themselves, and are created among mobile vehicles that are equipped with wireless communication devices. These category of networks are created as component of the Automated Transportation Systems (ATS) in order to improve the performance of transportation systems. Each Vehicle Node is equipped with WAVE (IEEE 802.11p) which provides necessary frame structure to facilitate communication between mobile components known as OBUs (On Board Unit) and the stationary infrastructure units are called RSUs (Road Side Unit). There are three main types of communication areas in [7] vehicular networks: OBU-to-OBU, RSU-to-RSU and OBU-to-RSU or RSU-to-OBU. These Vehicular Networks are anticipated to expend variety of advanced wireless technologies such as Dedicated Short Range Communications (DSRC) that are an improved version of the WAVE (IEEE802.11p) technology apt for VANET environments. The DSRC is created in order to support the data transfer in rapidly fluctuating communication environments. The above mentioned technology also uses [2] the 5.9 GHz band in various propagation environments: vehicle, open, urban, and so on.

DSDV, OLSR and AODV are [6] optimized for MANETs but are also used for VANETs.

Model Vehicular Ad-Hoc Network (VANET) communication has recently become an increasingly popular research topic in the domain of wireless networking and the automobile industries. The main aim while researching in VANET is to create a quick and cost-efficient vehicular communication system to enable distribution of data for passengers' safety and comfort.

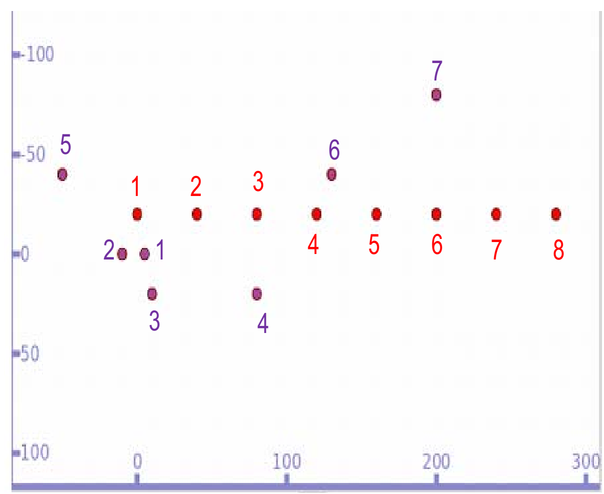

Figure 1. RSU's and OBU's [4]

This paper focusses on analyzing different routing protocols in the VANETS model as shown in the Figure 1[4]. The performance of different routing protocols between the different nodes in the models are compared and the results displayed. Depending upon the area of the model an appropriate loss model is chosen for this purpose. The model shows infrastructure nodes that are stationary and the mobile nodes that move in fixed lanes. The red stationary nodes are the RSU's (Road Side Units) and violet nodes are the mobile nodes which represent the vehicles or the OBU's (On Board Units). The model shows communication among the Vehicle nodes, the vehicle nodes and the infrastructure nodes and also amongst the infrastructure nodes. Payload from all the nodes in the model are broadcasted to all the other nodes. The above model is created in NS3 which is a simulation tool and models the real world scenario theoretically (i.e. Loss models and mobility of the nodes).The nodes have been

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programmed to follow a certain path due to limitations of random path model in NS3 to give a closer approximation to the real world scenario even after taking into account the limitations of NS3 simulation. SUMO and similar software can be integrated to give a more graphically/pictorially attractive representation.

II. ROUTING PROTOCOLS

Destination-Sequenced Distance Vector (DSDV) [1] [5] routing protocol is a pro-active, table-driven routing protocol. All nodes preserve a table, which lists all the other nodes they know either directly or through some of their neighbors. There are three fields in the DSDV update message; Destination Address, Sequence Number and Hop Count. Before sending out the update, [5] the node waits for the settling time to make sure that it did not receive that update from its old neighbor. For packets that have no routes to the destination, it also has a request queue to buffer those packets. By default, the buffer size is up to 5 packets per destination. The nodes in the topology, periodically update their table after every 15s (default). In this update every node broadcasts out its entire routing table. Optimized Link State Routing (OLSR) [2] is a pro-active routing protocol, and it keeps a [10] routing table inside every node of the network topology to build up a route for data transmission. The fundamental [11] concept used in this protocol is that, selected nodes forward, broadcast messages during the flooding process. OLSR [1] employs HELLO messages to discover its one hop neighbours and also its two hop neighbours through their responses. This technique substantially reduces the message overhead as juxtapose to a classical flooding mechanism, in which all the nodes retransmit each message when they receive the first copy of the message. Only the MPR nodes generate the link state information. A further optimization is accomplished by minimizing the number of control messages that are flooded in the network. Furthermore, [12] an MPR node could choose to report links that are only between itself and its MPR selectors of multipoint relays (MPRs). The protocol is especially appropriate for large and dense networks due to the usage of MPRs. Ad hoc On Demand Distance Vector (AODV) is a reactive protocol. It is an improvement of DSDV, because it minimizes the number of broadcast packets [1] generated by creating route only when required. All nodes in the network maintain the route information in a table and participate in sharing their routing tables. [1] The source node starts the route discovery process, when it wants to transfer data to the destination node. During this process, source node disseminates Route Request [1](RREQ) packet to its neighbours. If the neighbour nodes which receive RREQ, lack the information pertaining to the request, they forward the packets to their neighbour nodes. The following process goes on until RREQ reaches, the destination or the node who knows the path to the destination. Intermediate nodes set up a reverse path by recording the addresses of the neighbours in their tables when, they receive RREQ.[1] When the destination node or the node which has information about the path to the destination receives RREQ, it sends back Route Reply (RREP) packet to the source node. This RREP packet is sent through the reverse course. The source node assimilates the course to destined node and the discovered course information is placed in the routing table, when it receives the RREP packet.

III. SIMULATION SYSTEM DESIGN

NakagamiPropagationLossModel:

The Nakagami model is an approximation for Rician [8]model-it also includes the LOS (line of sight path).Nakagami is a stochastic model for wireless propagation anomaly induced by partial cancellation of a radio signal [8] by itself .In case of mobile nodes, the receiver obtains the signal by several disparate paths [5] (therefore exhibiting multipath interference), and minimum one path keeps changing (expanding or compacting). The Nakagami-n distribution is applied to the power level of the signal. Its probability density function is defined as:

$$\rho(a;n,\omega) = \frac{2n^n a^{2n-1} e^{-na^2/\omega}}{\Gamma(n)\omega^n} = 2a.\rho_{Gamma}(a^2, n, \frac{n}{\omega})$$

With 'n' as the fading depth parameter, 'a' as the distance and 'ω' the average received power. Nakagami-n model depicts the amplitude of received signal after maximum ratio diversity combining.

Table 1. Simulation Parameters

Network Simulator	NS3
Routing Protocols	DSDV, OLSR, AODV
Simulation Time	225s
Simulation Area	900 units x 100 units
Number of Mobile OBU's	7
Number of stationary RSU's	8
Speed of Mobile Nodes	1 unit/sec
Mobile Node Traffic type	Multi-lane unidirectional
Data Type	CDR(constant data rate)
Packet Size	100 bytes
MAC Protocol	IEEE 802.11p
MAC Rate	2 Mbps
RTS/CTS	None
Transmission Range	250 units
Radio Propagation Model	Nakagami
Network Simulation Time	1s - 225s
Packet generation Rate DSDV	7.36 packets/sec
Packet generation Rate OLSR	2.92 packets/sec
Packet generation Rate AODV	4.53 packets/sec

SYSTEM DESCRIPTION: In the simulation we have considered a multi-lane unidirectional model, in which 8 nodes are RSU's that are essentially stationary and 7 other nodes are randomly distributed in four lanes across the infrastructure. As we begin the simulation these RSU's move at a constant speed of 1unit/s. We used DSDV, OLSR and AODV protocols and sent multiple CBR flows over UDP. The simulation time is 225s.

Table 2. Packet Delivery Ratio and Packet loss Ratio per node for DSDV, OLSR and AODV

Mobility	Node Number	Packet Delivery Ratio(PDR)			Packet Loss Ratio(PLR)		
		DSDV	OLSR	AODV	DSDV	OLSR	AODV
Stationary Infrastructure	1	0.203294	0.265137	0.248977	0.796706	0.734863	0.751023
	2	0.235063	0.345776	0.34372	0.764937	0.654224	0.65628
	3	0.259332	0.431672	0.382436	0.740668	0.568328	0.617564
	4	0.25736	0.493226	0.467737	0.74264	0.506774	0.532263
	5	0.257431	0.524378	0.469311	0.742569	0.475622	0.530689
	6	0.260348	0.508737	0.469311	0.739652	0.491263	0.530689
	7	0.257542	0.468379	0.429021	0.742458	0.531621	0.570979
	8	0.238611	0.398318	0.369846	0.761389	0.601682	0.630154
Mobile OBU's	1	0.280959	0.520297	0.485049	0.719041	0.479703	0.514951
	2	0.279206	0.498527	0.469940	0.720794	0.501473	0.53006
	3	0.267875	0.477092	0.468366	0.732125	0.522908	0.531634
	4	0.120664	0.471528	0.432798	0.879336	0.528472	0.567202
	5	0.252449	0.451087	0.428706	0.747551	0.548913	0.571294
	6	0.19078	0.3305	0.340573	0.80922	0.6695	0.659427
	7	0.120605	0.173892	0.163401	0.879395	0.826108	0.836599

IV. SIMULATION RESULTS

We evaluate the simulation results for DSDV, OLSR and AODV protocols done by NS3. For performance evaluation, we use two metrics: Packet Delivery Ratio (PDR) and Packet Loss Ratio (PLR).
Corresponding statistics are stated in Table 2.These are node specific and are calculated as:

$$PDR = \frac{PacketsRecieved}{TotalPacketsTransmitted}$$

And,

$$PLR = \frac{TotalPacketsSent - PacketsRecieved}{TotalPacketsSent}$$

The simulation results of PDR (Packet Delivery Ratio) for mobile OBU's is not distributed uniformly ,whereas for RSU's it does not vary more than 10% for all the above routing protocols. This observation is consistent with the theoretical model. The refresh rate for OLSR and AODV is 2 sec where as for DSDV it is 15 sec i.e Packet generation and transfer happens after every 15 s. During the simulation, [2] protocols encounter disconnections, but the time that DSDV is disconnected is longer than OLSR and AODV. OLSR protocol can find a new route faster than DSDV, when there is a disconnection. DSDV detects a valid route after converging slowly. Myriad packets are dropped and the throughput is low during this time. The link duration and path stability is higher in OLSR than DSDV due to its MPR mechanism that reduces routing overhead. AODV has a smaller PDR than OLSR, and DSDV has the lowest PDR. This is related with the fact that AODV different from OLSR is not equipped with MPR nodes that facilitates the route discovery. But it provides better performance compared to DSDV as AODV has only one route per destination node

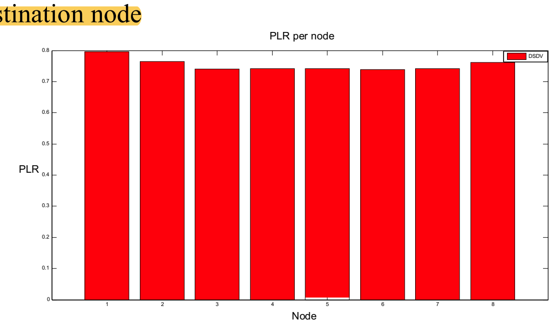

Figure 2. PLR of RSU's for DSDV

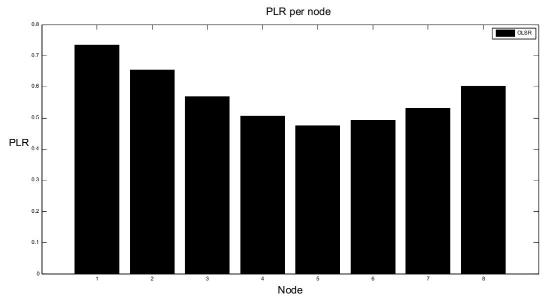

Figure 4. PLR of RSU's for OLSR

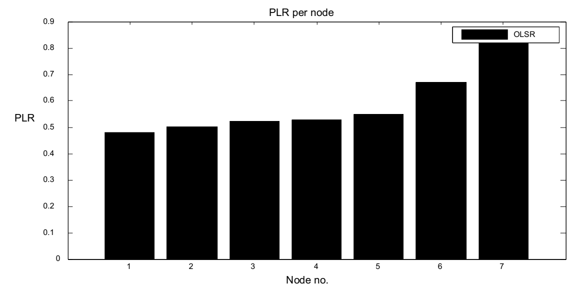

Figure 5. PLR of OBU's for OLSR

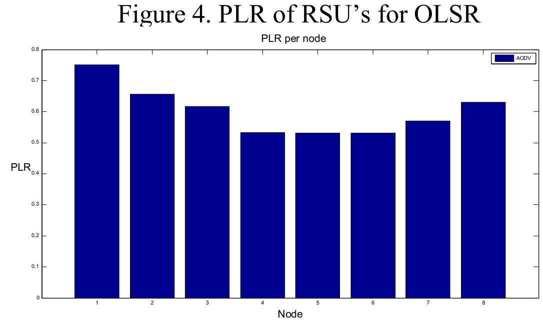

Figure 6. PLR of RSU's for AODV

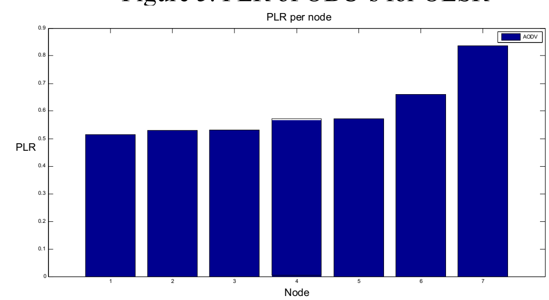

Figure 7. PLR of OBU's for AODV

in the routing table, which is constantly updated on the basis of sequence number and DSDV has to continuously update the whole routing table periodically and when needed, which leads to latency in delivery. The PDR for the stationary nodes 4, 5 and 6 higher than other RSU's as the only different functionality they do is to remain in contact with the mobile for a relatively longer period. Similarly the OBU nodes 1, 2, 3 and 4 have a higher PDR. According to the observations, PLR of these nodes is inversely proportional to PDR. These statistics are obtained after running the simulation for 225s.PLR and PDR have been calculated for DSDV, OLSR and AODV with periodic updates sent after default interval of 15s, 2s and 2s respectively. In case of DSDV, we observe from Figure 2, that PLR of OBU's on the far right side is more than that of those on left side. As per Figure 3, PLR for RSU's is almost uniform for DSDV. In case of OLSR, we observe from Figure 4, that PLR of OBU's on the far right side is more than that of those on left side. As per Figure 5, PLR for

Figure 3. PLR of OBU's for DSDV

RSU's at both edges is greater. In case of AODV, we observe from Figure 6, that PLR of OBU's on the far right side is more than that of those on left side. As per Figure 7, PLR for RSU's at both edges is greater. PLR of RSU's is highest and almost uniform when DSDV is implemented. PLR pattern is similar for RSU's, for OLSR and AODV, but OLSR has relatively lesser PLR.

The PLR for both RSU's and OBU's is the most for DSDV.OLSR relatively has the least PLR.

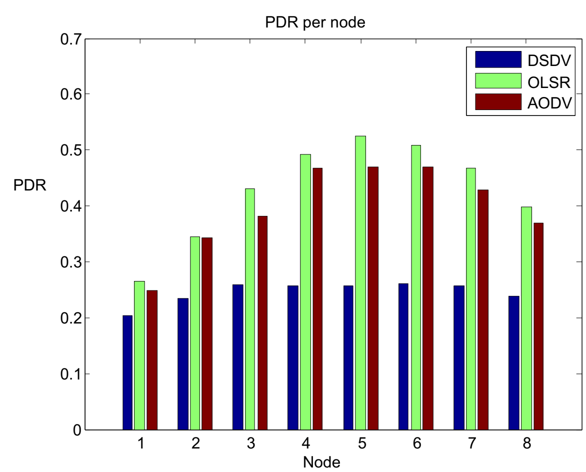

Figure 8. PDR of RSU's

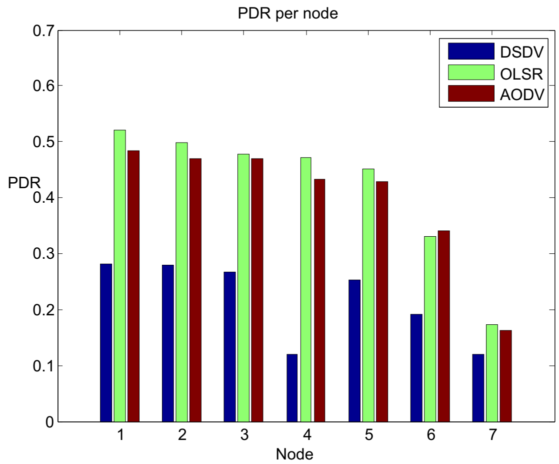

Figure 9. PDR of OBU's

According to Figure 8 and Figure 9, the PDR of OBU's on the right edge is greater and the PDR of RSU's in the middle is greater. Considering all the nodes (i.e. RSU's and OBU's) OLSR has the highest PDR and DSDV the lowest. The overall values of PLR seem high in this scenario as the connection between RSU's and OBU's (i.e. V-to-I) is broken when the distance between node 8 of RSU and node 5 of RSU in Figure 1[4], exceeds 250units(i.e.at 205s),however the nodes still try to communicate by sending packets over the duration of the simulation. These packets are lost and result in a lower overall PDR and higher PLR.

V. CONCLUSION

We compare DSDV, OLSR and AODV routing protocols, after implementing them in the model depicted in Figure 1 [4], and establish that among the routing protocol used OLSR proves to be the best in terms of highest PDR and lowest PLR for every node. Also, OLSR has the least overhead [1], so the buffer size required is less and the communication is faster and more efficient. We used NS3 for simulation and Wireshark to sniff packets in order to carry out the research. The analysis of all the parameters was carried out on every node using different routing protocols and the results were viewed using Wireshark to analyse and compare the outputs. The observations proved that whether it was RSU's or OBU's the PDR was highest and PLR was lowest in case of OLSR which shows that OLSR provides the best performance in the scenario considered. We plan to analyze the network security in the VANET models and determine the best course of action in order to enhance the security using OLSR as the established routing protocol for the research. The research would aim at using reconfigurable platforms as OBU's and testing of the new security algorithms to check the efficiency and feasibility of the algorithms and determine the best one for the scenario. The research would also involve a deep rooted study into the cryptographical algorithms to predict the best out of all which minimizes the resource and energy consumption of the device and provides satisfactory security results.

VI. ACKNOWLEDGEMENT

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