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Performance Evaluation of Proactive, Reactive and Hybrid Protocols by Varying Vehicle Nodes in Vehicular Ad-hoc Network

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***Abstract*—** Routing protocols govern a network to facilitate the communication easier under specific network topology. Network researchers have presented various routing protocols for VANETs having different categories. Among these, the proactive, reactive and hybrid protocols are mostly prominent. Performance analysis of these routing protocols for MANET has been proposed earlier. But the main motive of this paper is to analyze the different performance metrics (throughput, end to end delay, routing overhead, packet delivery ratio, dropped packet) individually by which these protocols are compared in VANET. We have carried out the performance evaluation of Destination-Sequenced Distance Vector (DSDV), Zone Routing Protocol (ZRP), Dynamic Source Routing (DSR) and Ad-hoc On-Demand Distance Vector (AODV) as proactive, hybrid and reactive routing protocols, respectively, using NS2 simulator. In this paper, for simulation a particular scenario has been discussed. On the completion of this simulation we could have a clear view in what conditions VANET can be operated in more efficient manner compared to present VANET network arrangements. The simulation is performed on each routing protocol for varying vehicle nodes with source nodes 10 and 20.

***Keywords**:* VANET, Routing Protocols, Throughput, End to End delay, Routing Overhead, Packet Delivery Ratio, Dropped Packet, NS2 (Simulator)

I. INTRODUCTION

Vehicular Ad-hoc Networks (VANET) is an arbitrary network without any fixed infrastructure. It's an advanced arrangement of Mobile Ad-hoc Networks (MANET). VANET has been developed to provide better service to the road side vehicle users. It helps in proper maintenance and advancement in the Intelligent Transportation System (ITS). With this work the road users could have enough safety and comfort. In VANET, the communication happens in two forms, either between vehicle to vehicle or between vehicles and central gateways known as roadside units [10]. When users in VANET communicate and coordinate with each other then there is reduction in road accidents, easiness in traffic jams, proper speed management of vehicles, determination of free passage for emergency vehicles and information on unseen obstacles [1].

In any network data dissemination occurs which means there is spreading of data and information over the distributed networks. For this there is employment of various routing protocols to increase the efficiency and reliability of VANET [2]. These protocols are targeted to be used for improving the throughput, reducing the amount of packet loss, increasing the security, minimizing interference and controlling the overhead. Now, in order to select the appropriate routing protocols we need to know their significance in various network conditions. In this paper we have evaluated various performance metrics to determine each protocol's usage. Main motivation of this research was to observe the behavior of different routing protocols in particular scenario. If we could determine how well these protocols behave in VANET under the discussed scenario then we could have a better understanding. This would be highly helpful in improving the VANET performance. The resultant output will provide a valid comparison to the present network arrangements and facilitate to use the appropriate one to meet our growing needs and ease out traffic condition.

The rest of the paper is organized as follows, Section I provides introduction to this paper. Section 2 provides some insight on related findings. The description of tools used and procedure is explained in Section 3. Section 4 describes results of this research and provides some discussion on them. Finally, Section 5 concludes research work with future directions.

II. RELATED WORK

In [3] the authors evaluated the performance of reacting protocols namely, AODV and DSR. This task was performed on mobile but high dense network. Throughput, End-to-end delay and Packet delivery ratio were the performance assessment metrics. The targeted protocols were compared with the newly developed protocol DYMO. And it was found that DYMO was better than other protocols. The throughput was greater and end-to-end delay was lowest. But AODV had better packet delivery ratio than DYMO and DSR.

Employment of security algorithm in VANET is done in [4]. Here private key encryption is used which enhances the performance of a VANET network and provides better security in data transfer.

There was a survey conducted [5] in which the performance is analyzed to determine the most suitable routing type to ensure the efficiency of VANET. This paper shows that the clustering protocols are effective to send a packet within a short time and without collision.

Performance analysis of VANET in Cloud computing by varying the highway traffic scenarios is done here [6]. As there is rise in vehicle density in any scenario then there has been rise in throughput and packet loss. The end-to-end delay has an inversely proportional with vehicle density.

III. METHODOLOGY

The practical implementation of VANET is a costly agenda so various simulators are employed for evaluation. In this case NS-2 tool has been used the executing the VANET and testing the protocols [7].

NS-2

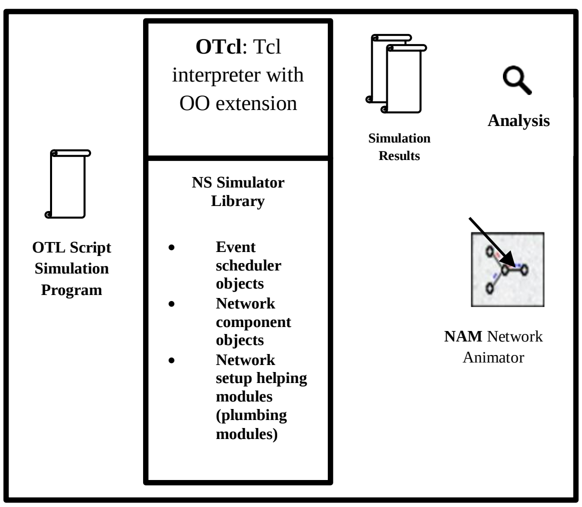

Figure 1: Architecture of NS-2

The network simulator is a very significant tool in implementing wired and wireless networks under various routing mechanisms over TCP and UDP traffic scenarios [8,9].

Here the protocols AODV, DSR and DSDV can be easily implemented in NS2 but ZRP requires a patch to be integrated in NS2 package. Utility named as cbrgen has been used for CBR and TCP traffic connections between nodes and traffic files have been generated at the rate of 4 packets/sec by varying number of nodes.

For mobility model, setdest utility has been used to create node positions and their movements. In order to perform simulation experiments, different scenario files have been generated by varying the number of nodes and pause time and keeping other values constant. Other scenario files have been generated by varying the number of nodes and maximum speed by keeping the pause value.

Based on routing protocols trace files are generated which is later parsed to measure the performance metrics. After obtaining the values of different metrics then MS-Excel has been used to plot graphs. Simulation can be visualized using network animator NAM.

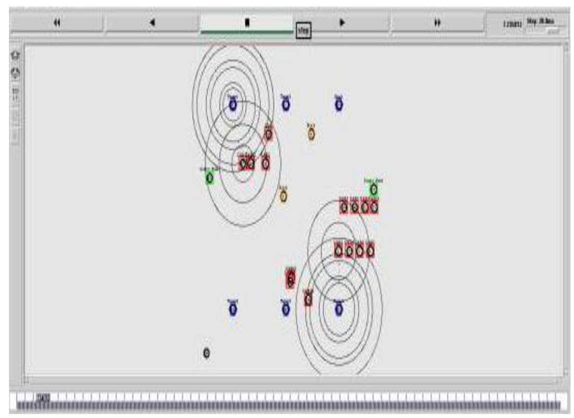

Figure 2: NAM generated for VANET

Above figure shows the output of the network animator after executing the .nam file obtained from the simulated .tcl file.

IV. RESULTS AND DISCUSSION

The analysis is being done on the basis of the results of *.tr file by executing TCL scripts. The TCL files were generated for 20, 40, 60, 80 and 100 vehicle nodes. Simulation has been performed on each protocol with 10 and 20 source nodes. Warm-up time for each simulation 10ms. The numerical and graphical representation of various performance metrics are shown below:

Throughput – It is defined as amount of data per unit time that has been delivered to one node from another. It is calculated in Kbps. Throughput include frequent topology changes, unreliable communication, limited bandwidth and limited energy. A high throughput network is desirable.

Table 1: Throughput (Source Node 10)

Throughput (Source Node 10)				
No of Nodes	***ZRP***	***AODV***	***DSDV***	***DSR***
20	7.0942	9.0942	9.2930	6.1373
40	7.2103	9.2103	9.8023	6.2249
60	7.1817	9.1817	9.4630	6.3167

80	7.1819	9.1819	9.4216	6.2343
100	8.1167	9.1167	9.4457	6.2848

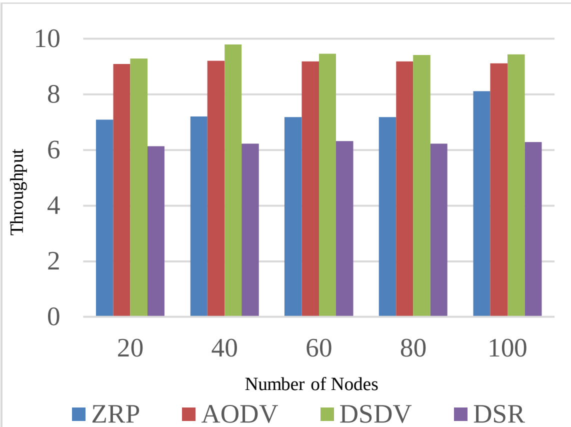

Figure 3: Throughput Vs. No. of Nodes (Source Node 10)

Table 2: Throughput (Source Node 20)

Throughput (Source Node 20)				
No of Nodes	***ZRP***	***AODV***	***DSDV***	***DSR***
20	27.1724	27.3724	25.3376	28.1004
40	27.4760	27.7760	21.1830	28.4609
60	26.1848	26.4848	23.3083	27.5721
80	21.0760	21.0760	17.6164	22.6148
100	25.2996	25.4996	23.5175	25.6173

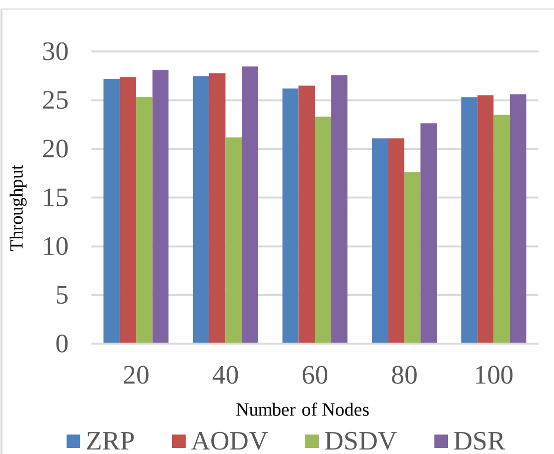

Figure 4: Throughput Vs. No. of Nodes (Source Node 20)

End to End delay - It explains the average time taken by data packet to reach its destination after being sent by the source. Route discovery time, queuing, propagation delay and transfer time are various delays.

Table 3: End-to-end Delay (Source Node 10)

End-to-end Delay (Source Node 10)				
No of Nodes	***ZRP***	***AODV***	***DSDV***	***DSR***
20	0.0218535	0.0128535	0.00865208	0.012483
40	0.0348020	0.0148020	0.00773136	0.0194127
60	0.0494470	0.0194470	0.0107141	0.0316153
80	0.0458308	0.0258308	0.0159825	0.0272573
100	0.0461063	0.0261063	0.0114511	0.0406396

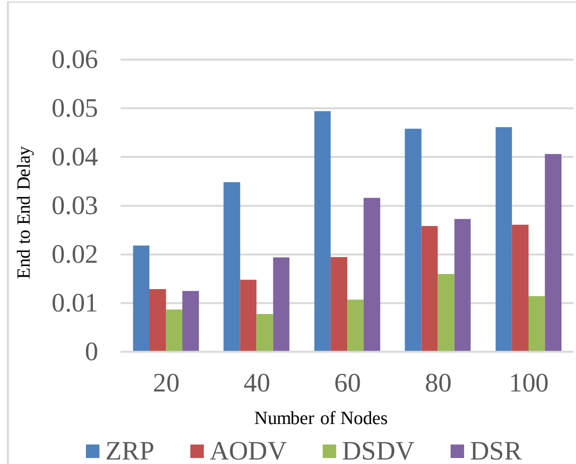

Figure 5: End-to-end Delay Vs. No. of Nodes (Source Node 10)

Table 4: End-to-end Delay (Source Node 20)

End-to-end Delay (Source Node 20)				
No of Nodes	***ZRP***	***AODV***	***DSDV***	***DSR***
20	0.0397085	0.0297085	0.0177660	0.0458507
40	0.0412786	0.0302786	0.0259119	0.095337
60	0.119220	0.15922	0.026536	0.158127
80	0.0748115	0.0848115	0.190815	0.260222
100	0.155814	0.175814	0.101016	0.34510

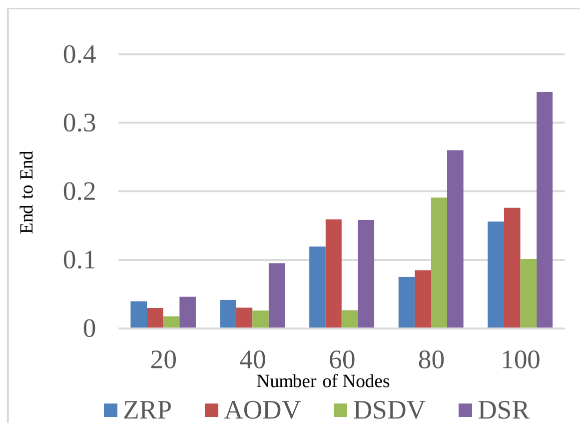

Figure 6: End-to-end Delay Vs. No. of Nodes (Source Node 20)

Routing Overhead - This can be obtained by dividing the total routing packets sent by the total data packets received. It gives knowledge about what amount of control packets are needed to transmit data packets to their destinations successfully.

Table 5: Routing Overhead (Source Node 10)

Routing overhead (Source Node 10)				
No of Nodes	***ZRP***	***AODV***	***DSDV***	***DSR***
20	2490	6490	11394	1394
40	8264	11264	12319	2319
60	5155	11155	12251	2251
80	4843	6843	11770	1770
100	9479	13479	12603	2603

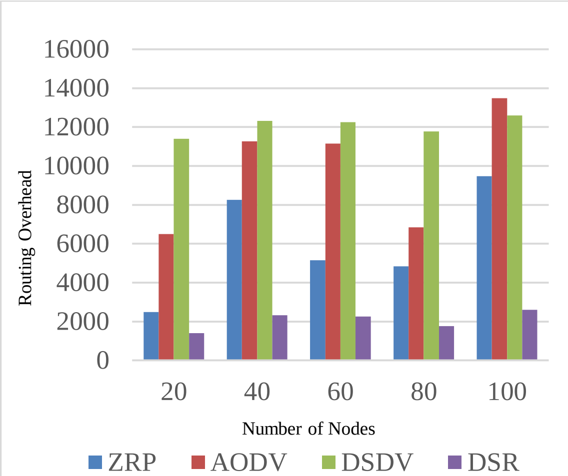

Figure 7: Routing Overhead Vs. No of nodes (Source Node 10)

Table 6: Routing Overhead (Source Node 20)

Routing overhead (Source Node 20)				
No of Nodes	***ZRP***	***AODV***	***DSDV***	***DSR***
20	8764	5764	2406	2106
40	4597	4597	5318	5118
60	6739	3739	6203	6003
80	5726	5026	6852	6652
100	6305	5305	5868	5568

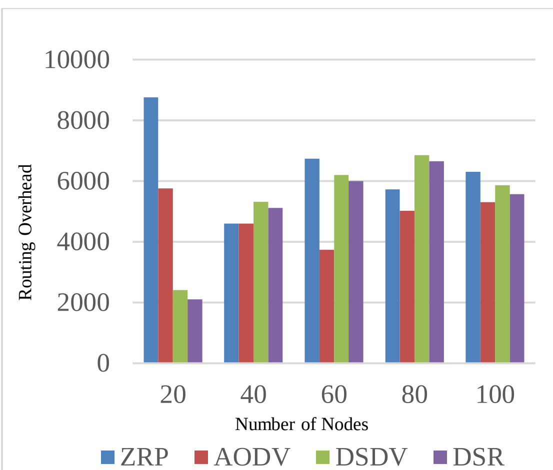

Figure 8: Routing Overhead Vs. No of nodes (Source Node 20)

Packet Delivery Ratio (PDR) - This defines the ratio of data packets received at destination to the data packets generated by the source. With the help of PDR one can understand how well a protocol can transfer packet from source to destination.

Table 7: Packet Delivery Ratio (Source Node 10)

Packet Delivery Ratio (Source Node 10)				
No of Nodes	***ZRP***	***AODV***	***DSDV***	***DSR***
20	0.9289	0.9989	0.8616	0.9986
40	0.9539	0.9939	0.7617	1.0834
60	0.9360	0.9960	0.8332	0.9957
80	0.9278	0.9978	0.7797	0.9989
100	0.9106	0.9906	0.8515	0.9996

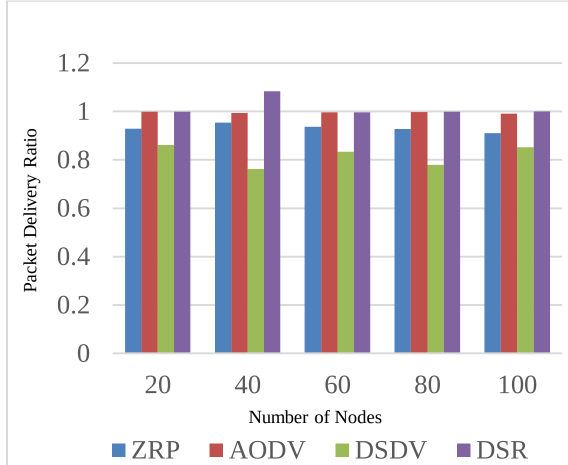

Figure 9: Packet Delivery Ratio Vs. No of nodes (Source Node 10)

Table 8: Packet Delivery Ratio (Source Node 20)

Packet Delivery Ratio (Source Node 20)				
No of Nodes	***ZRP***	***AODV***	***DSDV***	***DSR***
20	0.9517	0.9717	0.8880	0.9976
40	0.9334	0.9634	0.7403	0.9907
60	0.8574	0.8974	0.8010	0.9514
80	0.6800	0.6863	0.6526	0.8140
100	0.8456	0.8496	0.8444	0.8410

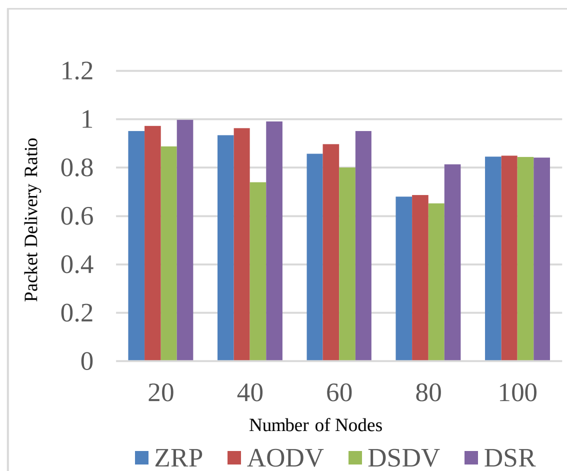

Figure 10: Packet Delivery Ratio Vs. No of nodes (Source Node 20)

Dropped Packet - Dropped Packet it is the number of packets lost by routers at the network layer due to the capacity of buffer or the packet buffering time exceeds the time limit.

Table 9: Dropped Packet (Source Node 10)

Dropped Packet (Source Node 10)				
No of Nodes	***ZRP***	***AODV***	***DSDV***	***DSR***
20	77	31	390	1
40	126	46	662	15
60	148	77	456	17
80	97	41	611	24
100	161	141	410	16

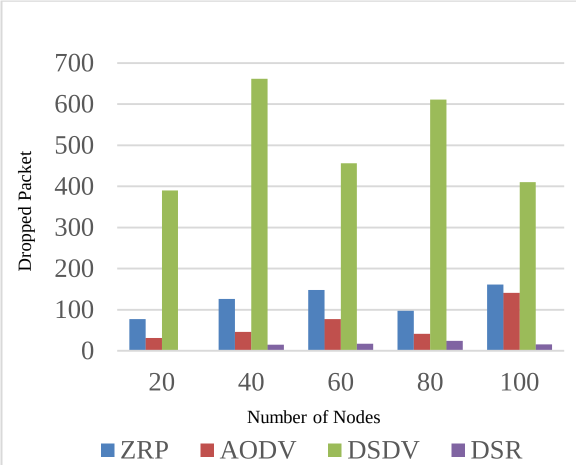

Figure 11: Dropped Packet Vs. No of nodes (Source Node 10)

Table 10: Dropped Packet (Source Node 20)

Dropped Packet (Source Node 20)				
No of Nodes	***ZRP***	***AODV***	***DSDV***	***DSR***
20	146	186	473	26
40	335	535	1076	31
60	1319	1619	829	123
80	2273	2573	1447	710
100	1116	1516	579	359

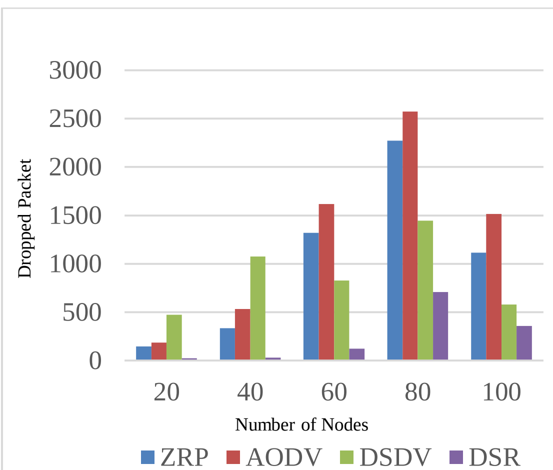

Figure 12: Dropped Packet Vs. No of nodes (Source Node 20)

After viewing the graphs, we could easily observe how well each of the protocols performed in the specified scenario. Reactive routing protocols performed far better than other protocols but DSDV showed least end-to-end delay.

V. Conclusion and Future Scope

In order to bring out the essential characteristics of the protocols as reactive (AODV, DSR), proactive (DSDV) and hybrid (ZRP) the evaluations were performed in this paper using a microscopic mobility model in VANET.

As the observation was proceeded it was found that reactive routing protocols performed well because their route discovery, route maintenance and elimination of periodic broadcasting mechanisms. DSDV had the least end-to-end delay due to their table-driven approach but this causes extra overhead in the network which conclusively degrades its performance. The performance of ZRP hybrid routing protocol was found considerably poor in the simulated scenario.

The analysis performed was based on offline simulation so if we could implement same scenario in a real-life environment by specifying various real time phenomena as acceleration, deceleration, speed and other characteristic under a real map then we could have a proper result with a different communication scenario which could be utilized in further practical purposes.

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