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Performance Evaluation of AODV, DSR and ZRP Protocols for MANETs

Manjunatha D[1], S. Ravishankar[2]
[1]Department of Electronics, University College of Science, Tumkur University, Tumkur
[2]Department of Electronics and Communication, R V College of Engineering, Bangalore

Abstract: Mobile ad-hoc network (MANET) consists of wireless mobile nodes and they communicate with each other without any centralized control. The node mobility in such networks causes frequent changes in network topology. Hence, dynamic and reliable routing protocols are needed in MANETs. In this paper, performance evaluation studies of AODV, DSR and ZRP routing protocols are carried out using QualNet Network simulator. The performance metrics such as throughput, packet delivery ratio, total data bytes received, end-to- end delay and jitter are considered for simulation study.
Keywords: MANET, AODV, DSR, ZRP, QualNet

I. INTRODUCTION

Mobile ad-hoc network (MANET) is a network which contains mobile nodes. The nodes communicate with each other using wireless links. As there is no pre-existing infrastructure, each participating node will function as a host as well as a router. When the nodes are in the transmission range with each other, they can communicate directly; otherwise they depend on the neighbouring nodes to rely the messages [1]. The node mobility causes link breakages and network topology changes continuously and hence link re-establishment must be done very quickly. Therefore, dynamic and reliable routing protocols are needed in MANETs [2]. In this work, simulation studies of AODV, DSR and ZRP routing protocols have been done and their performance is compared.

II. ROUTING PROTOCOLS

The routing protocols paly vital role in route establishment and they must adapt quickly to the dynamic network topology. Ad-hoc routing protocols are categorized into following three types. They are, proactive, reactive and hybrid routing protocols.

Proactive routing protocols are also called as table driven routing protocols in which all the route information is maintained in the routing table. Routing tables contain updated list of destinations and their routes by exchanging their routing information time to time with nearby nodes [3]. The main drawback of proactive routing protocol is that every node maintains an updated table. Destination-Sequenced Distance-Vector Routing Protocol (DSDV) [4] and Optimized Link-State Routing (OLSR) [5] are proactive routing protocols.

In reactive or on demand routing protocols, all the nodes need not maintain up-to-date routing information. When a node wishes to send a packet to the destination node, the protocol initiates route search process in an on-demand manner and creates the link in order to send and receive the packets. Adhoc On Demand Distance Vector Routing (AODV) [6], Dynamic Source Routing (DSR) [7-8] and Temporally Ordered Routing Algorithm (TORA) [9] are the examples of reactive routing protocols.

Hybrid routing protocols have the merits of both reactive and proactive approaches. ZRP (Zonal Routing Protocol) is the example of hybrid routing protocol. In ZRP [10], the proactive routing approach is used inside the routing zones as IntrAzone Routing Protocol (IARP) and the reactive routing approach is used between the routing zones as IntErzone Routing Protocol (IERP).

III. RELATED WORK

In [11], performance evaluation of AODV, DSR, DSDV and OLSR protocols was done using the metrics end-to-end delay, PDR, throughput and control overhead with varying number of nodes, speed and network size. They showed that AODV and DSR protocols perform better with respect to packet delivery ratio with network size less than 600x600 sqm and OLSR protocol suitable for high mobility condition for network size more than 600x600 sqm. Authors in [12], studied the performance of AODV, DSR and DYMO with shadowing model, viz., Constant and Lognormal. The performance metrics used for the study are throughput, number of bytes received, average end-to-end delay. For constant model, AODV protocol performs better than other two protocols. For log-normal, the performance of DSR protocol is better than AODV and DYMO. Authors in [13] compared Adhoc on Demand Distance Vector (AODV), Dynamic Source Routing (DSR) and Temporary Ordered Routing Algorithm (TORA). The result shows that TORA has moderate throughput compared to AODV and OLSR. In [14], performance of routing protocols for MANETs was analyzed using the metrics such as throughput, end-to-end delay and network load by simulating multimedia (video conferencing) traffic. Simulation results show that proactive protocol OLSR which has readily available routing paths performs better than AODV and TORA.

IV. SIMULATION ENVIRONMENT

QualNet 6.1 Network simulator [15] has been used to evaluate the performance of routing protocols AODV, DSR and ZRP for IEEE 802.11b standard. The simulations are carried out for networks with varying density of 50, 100, 150 and 200. Simulation time was set at 300 seconds and CBR (Constant Bit Rate) application was used that maintains the same bit rate throughout the process. Simulations parameters configured for the scenario is shown in the Table I. Fig. 1 and 2 show the snapshots of Qualnet simulator for the scenario with 200 nodes.

TABLE I
Simulation Parameters

Parameters	Values
Terrain Area	1000 x 1000 m^2
No. of nodes	50,100,150, 200
Node Placement	Random
Network Simulator	Qualnet 6.1
Radio type	IEEE 802.11
Protocols	AODV, DSR, ZRP
Modulation	O-QPSK
Traffic Application	CBR
Packet size	512 Bytes
Simulation time	300 seconds
Mobility model	Random way point
Antenna model	Omni-directional
Energy model	Mica motes
Battery model	Linear model

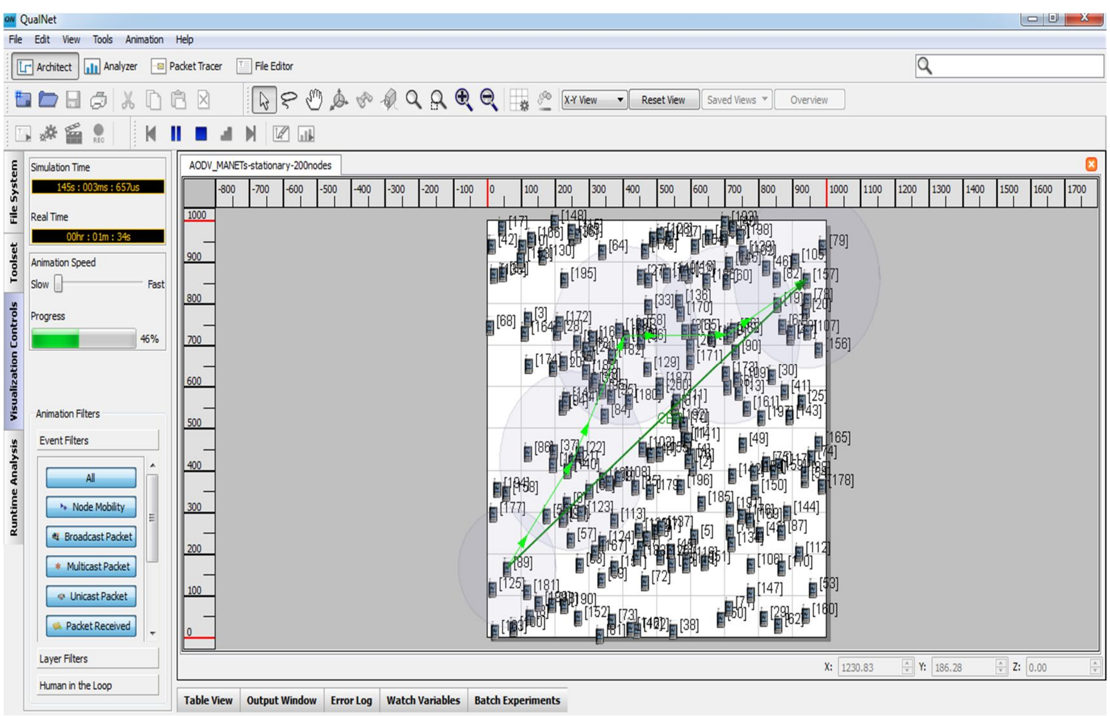

Fig. 1: Snapshot of the scenario for 200 nodes with AODV protocol

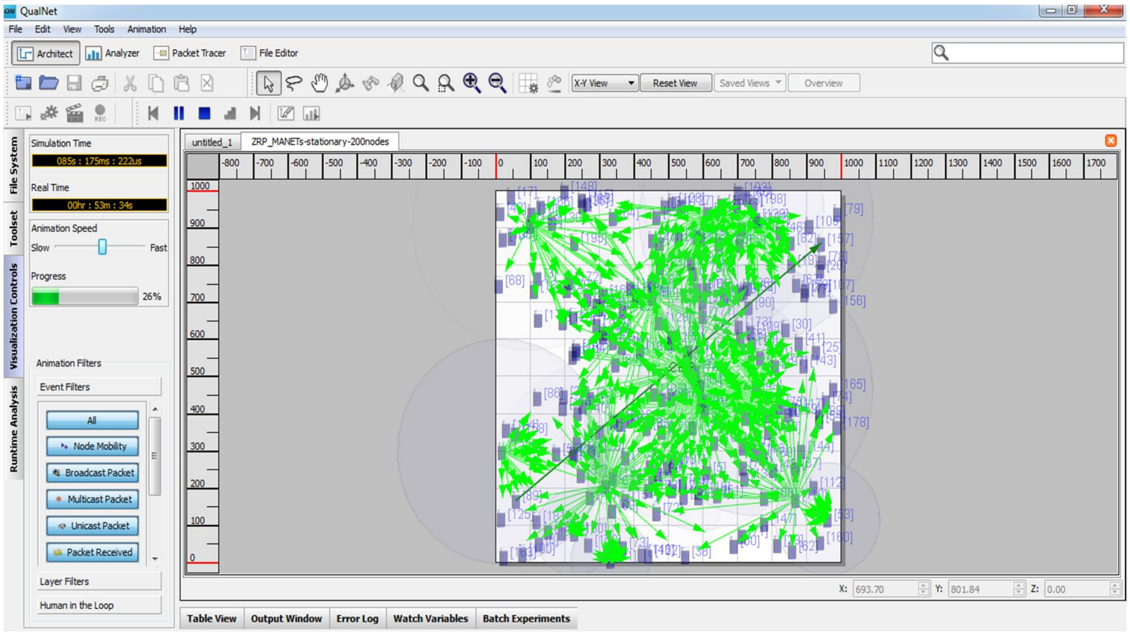

Fig. 2: Snapshot of the scenario for 200 nodes with ZRP protocol

V. RESULTS and ANALYSIS

Performance studies of the protocols are carried out with the help of metrics such as throughput, packet delivery ratio, total data bytes received, end-to- end delay and jitter. The results obtained from the simulations are compared.

A. Scenario with Stationary Nodes

To study the performance of routing protocols with IEEE 802.11b standard, various scenarios are deployed with different node density. In this case, simulation was done without mobility.

1) *Throughput:* Fig. 3 shows the variation of throughput as a function of number of nodes deployed in the scenario. From the Fig. 3, it is observed that the throughput for AODV and DSR protocols almost same for the scenarios. For ZRP, it is similar to AODV and DSR with 50 nodes and it is decreased with 100, 150 and 200 nodes.

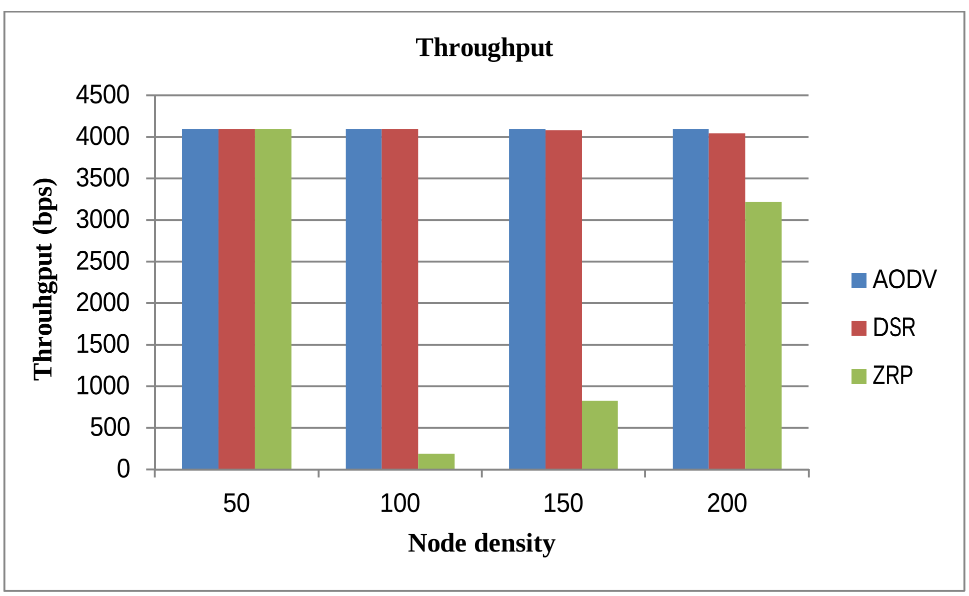

Fig. 3: Variation of Throughput with varying number of nodes

2) *Packet Delivery Ratio:* It is the ratio of data packets received by the receiver to those transmitted by the source. A high value of packet delivery ratio is preferred, which indicates better performance of the protocol. Fig. 4 depicts the packet delivery ratio for AODV, DSR and ZRP protocols. It is evident from the Fig. 4 that the packet delivery ratio is better with AODV and DSR protocols for all the tested scenarios. With ZRP, it is better for 50 nodes and is decreased with 100, 150 and 200 nodes.

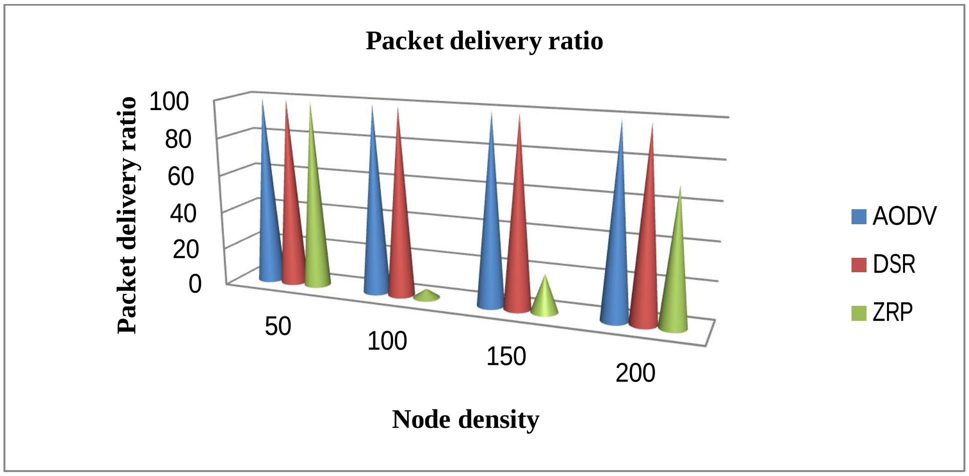

Fig. 4: Variation of packet delivery ratio with different node density

3) *Total Data Bytes Received:* The variation of total bytes received with varying node density for the AODV, DSR and ZRP protocols is shown in Fig. 5. It is evident from the Fig. 5 that data bytes received using AODV and DSR protocols almost same. For ZRP, it is same for 50 nodes and is reduced with 100, 150 and 200 nodes.

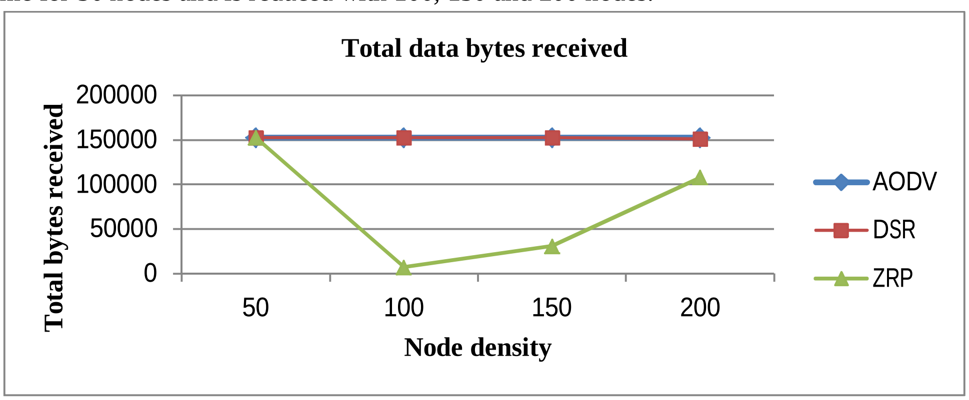

Fig. 5: Variation of data received with different node density

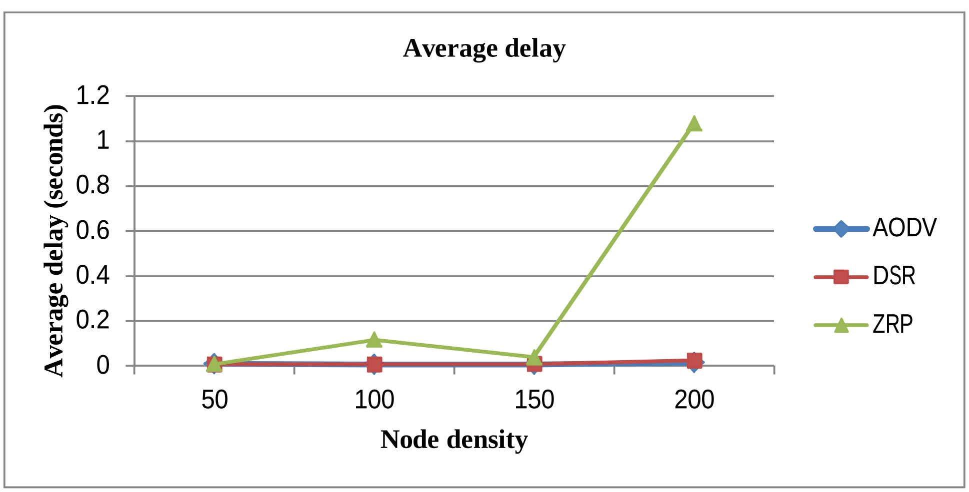

Fig. 6: Variation of delay with different node density

4) *End-to-End Delay:* The average end-to-end delay is the ratio of total delay in receiving all the packets to the total number of packets sent by the source. The graph of average delay for AODV, DSR and ZRP protocols is shown in Fig. 6. It is observed that end-to-end delay is almost same for the scenarios with 50, 100 and 150 nodes. For ZRP, it is increased with 200 nodes.
5) *Average Jitter:* The variation of delay in arrival of packets at the destination is referred to as jitter. This is due to network congestion, timing drift or changes in the route. A low value of jitter indicates batter performance. The plot for the variation of jitter with different network density is shown in Fig. 7. Jitter performance for both AODV and DSR protocols is low and for ZRP protocol, it is high.

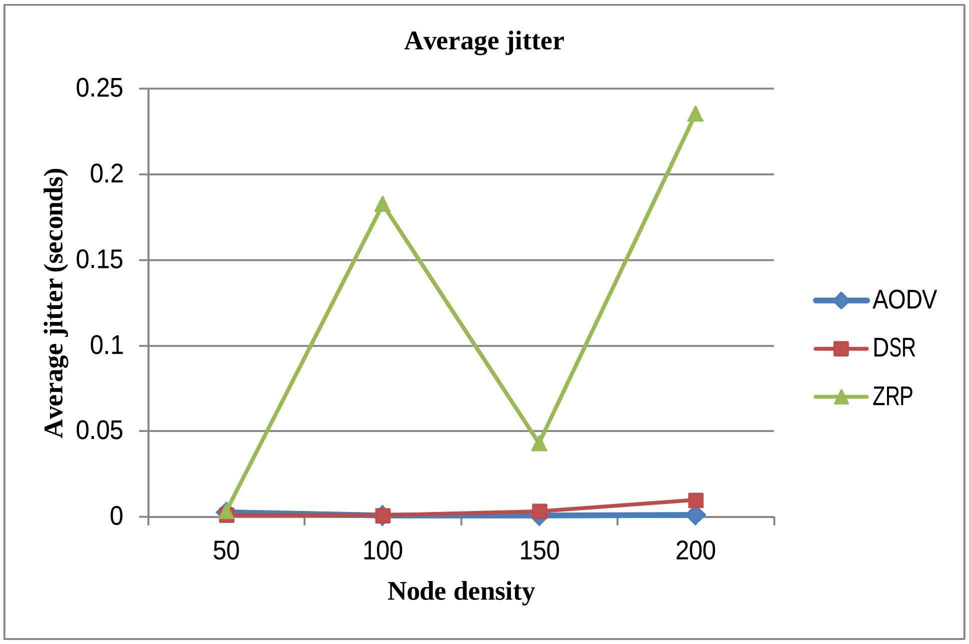

Fig. 7: Variation of jitter with different node density

B. Scenario with Mobile Nodes

Performance of the AODV, DSR and ZRP Protocols has been studied for the scenario in which mobility of the nodes is considered. Random way point mobility model has been applied to the nodes.

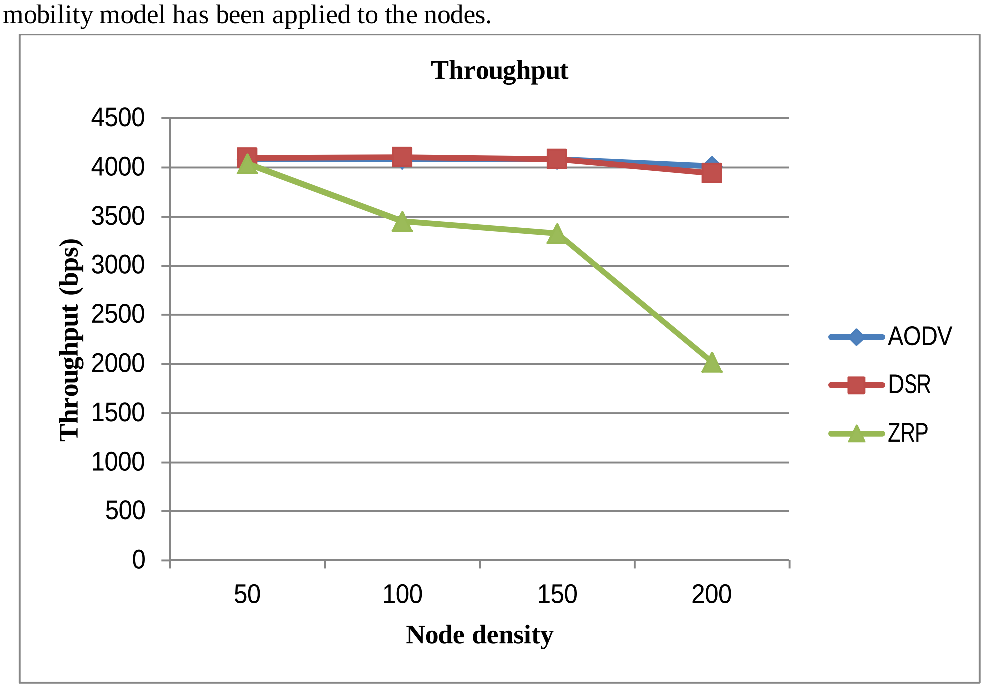

Fig. 8: Variation of throughput with node mobility

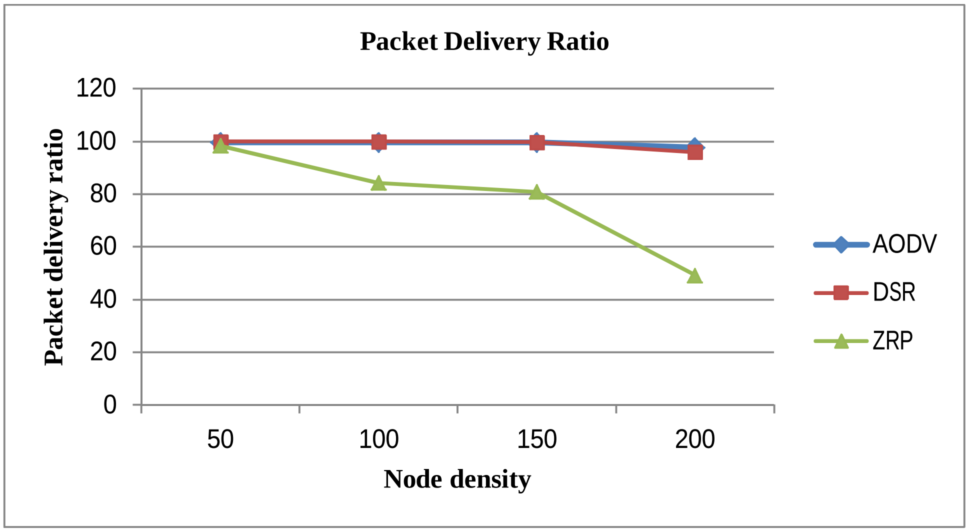

Fig. 9: Variation of packet delivery ratio with node mobility

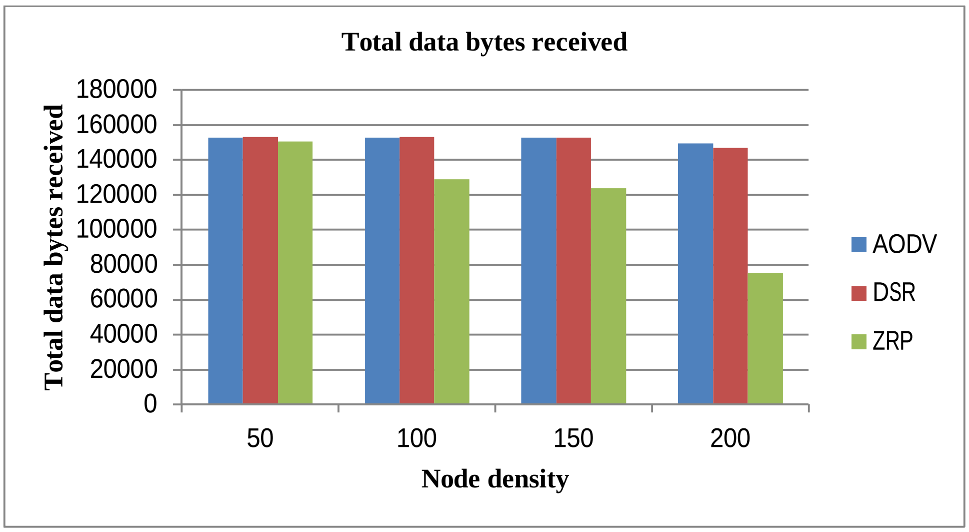

Fig. 10: Variation of data bytes received with node mobility

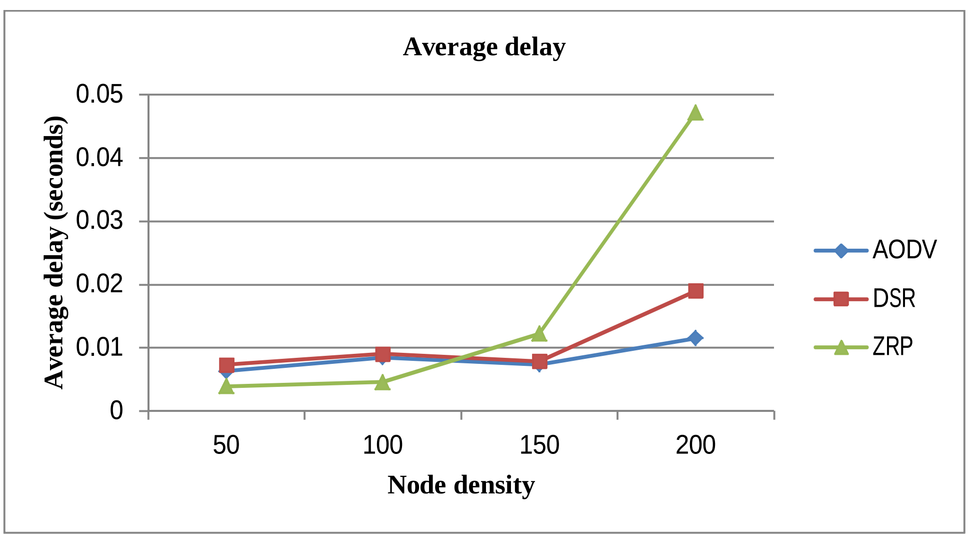

Fig. 11: Variation of delay with node mobility

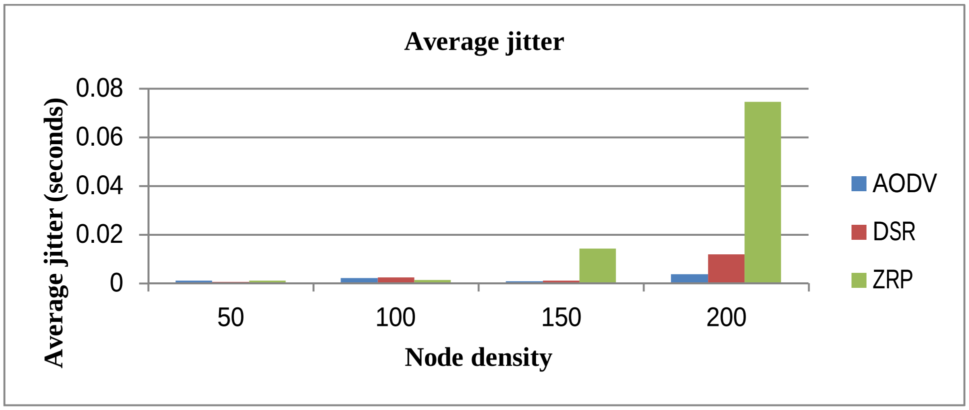

Fig. 12: Variation of jitter with node mobility

Figures 8, 9 and 10 represent the plot for throughput, packet delivery ratio and total data bytes received respectively. It is observed from the figures that the performance of both AODV and DSR protocols almost same for the scenarios with varying node density of 50, 100, 150 and 200. For ZRP, the performance is better with 50 nodes and reduced with 100, 150 and 200 nodes in comparison with AODV and DSR protocols. Figures 11 and 12 depict the average delay and jitter performance of the protocols. AODV and DSR protocols show same performance in all the scenarios. Whereas ZRP, performs better with 50 and 100 nodes, and it has more delay and jitter for the scenarios of 150 and 200 nodes in comparison with AODV and DSR protocols.

VI. CONCLUSION

In this paper, performance evaluation of AODV, DSR and ZRP protocols for the scenarios with stationary and mobile nodes has been done by varying the node density using Qualnet-6.1 network simulator. From the simulation results, it is observed that routing protocols AODV and DSR are performing well with respect to throughput, packet delivery ratio and average jitter. Whereas in ZRP protocol, establishing the path for data transmission involves much time during route discovery and route maintenance.

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