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Comparative Analysis Of AODV, DSR Routing Protocols In Mobile Ad-Hoc Networks

Rahul Kulkarni
CSE Dept., GNDEC Bidar

Asha S.
CSE Dept., GNDEC Bidar

Nitin Kulkarni
ECE Dept., GNDEC Bidar

Abstract

A mobile ad hoc network (MANET) is a group of wireless mobile nodes dynamically forming a network topology without the use of any existing network infrastructure or centralized administration. The main procedure for evaluating the performance of MANETs is simulation. The on-demand protocol performs better than the table-driven protocols. Different methods and simulation environments give different results. One protocol may be the best in one network configuration but the worst in another. Here an attempt is being made to compare the performance of on demand reactive routing protocols i.e. AODV and DSR. Always the network protocols were simulated as a function of mobility, but not as a function of network density. Here the performance of AODV and DSR is evaluated by varying network density and traffic pairs. These simulations are carried out using the NS-2 which is the main network simulator, NAM (Network Animator) and Java program for trace file analysis.

Keywords: AODV, DSR, Network density, Traffic pairs, NS-2

1. Introduction

Nowadays, there is a huge increase of handled devices. Indeed, laptops, mobile phones and PDAs take an important place in the everyday life. Hence, the challenge is now to make all these devices communicate together in order to build a network. Obviously, this kind of networks has to be wireless. Indeed, the wireless topology allows flexibility and mobility. Mobile Ad hoc Network (MANETs) are characterized by multi-hop [2] wireless connectivity, frequently changing network topology and the need for efficient dynamic routing protocols. Each node in the network also acts as a router, forwarding data packets for other nodes. A central challenge in the design of ad hoc networks is the development of dynamic routing protocols that can efficiently find routes between two communicating nodes. In this paper a systematic performance study of on demand routing protocols AODV [10] and DSR [3] is carried out. Moreover our performance analysis is based on varying number of nodes in the Mobile Ad Hoc Network. Generally the network protocols were simulated as a function of pause time, but not as a function of network density. The rest of the paper is organized as follows: The AODV routing protocol Description is summarized in section 2. The DSR routing protocol Description is summarized in section 3. The simulation environment and performance metrics are described in Section 4. The simulation results and observation in section 5 and the conclusion is presented in section 6.

2. AODV Routing Protocol Description

Ad hoc On Demand Distance Vector (AODV) [1][8][10] is a reactive routing protocol which initiates a route discovery process only when it has data packets to send and it does not know any route to the destination node, that is, route discovery in AODV is "on-demand". AODV uses sequence numbers maintained at each destination to determine freshness of routing information and to avoid the routing loops that may occur during the routing calculation process. All routing packets carry these sequence numbers.

2.1. Route Discovery Process

During a route discovery process, the source node broadcasts a route request (RREQ) packet to its neighbors. If any of the neighbors has a route to the destination, it replies to the query with a route reply packet. Otherwise, the neighbors rebroadcast the route query packet. Finally, some query packets reach to the destination. "Fig. 1" shows the initiation of route discovery process from source node 1 to destination node 10.

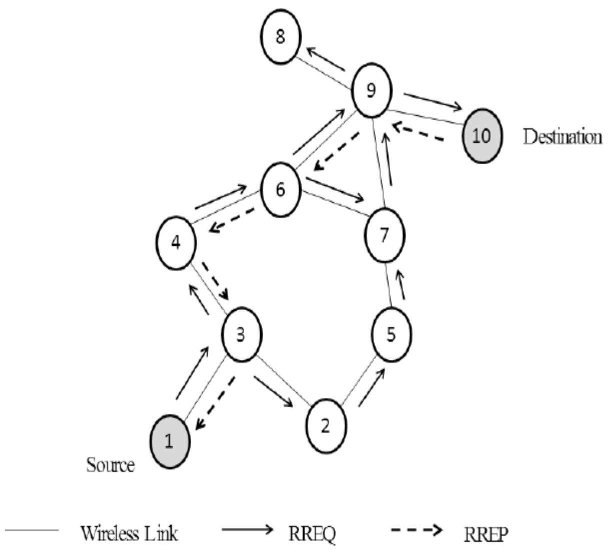

Figure 1.Source node 1 initiates the route discovery process.

At that time, a reply packet (RREP) is produced and transmitted tracing back the route traversed by the route request (RREQ) packet as shown in "Fig. 1".

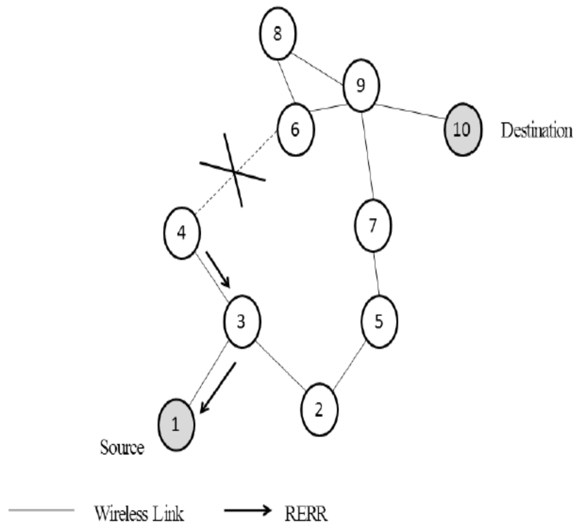

Figure 2. AODV Route Error message generation

2.2. AODV Route Error Message Generation

The route error message generation in AODV is as shown in fig 2. When the link in the path between node 1 and node 10 breaks the upstream node i.e. node 4 that is affected by the break generates and broadcasts a RERR message. The RERR message eventually ends up in source node 1. After receiving the RERR message, node 1 will generate a new RREQ message.

2.3. AODV Route Maintenance Process

Finally, if node 2 already has a route to destination node 10, it will generate a RREP message and if adjacent node do not have route in its routing table it will re-broadcast the RREQ from source node 1 to destination node 10. "Fig. 3" shows the AODV Route Maintenance process.

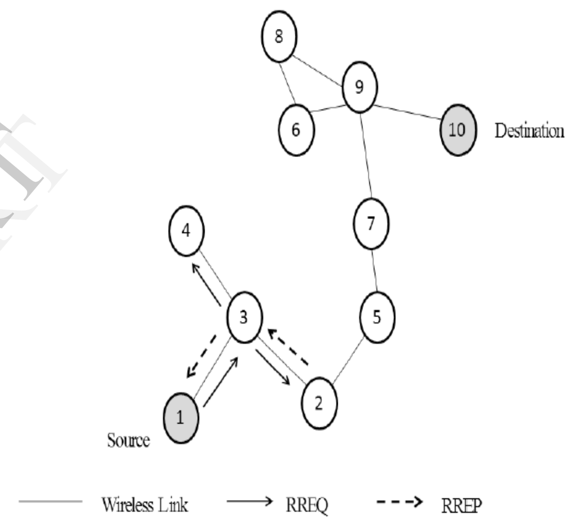

Figure 3. AODV Route Maintenance.

3. DSR Routing Protocol Description

The Dynamic Source Routing (DSR) protocol is also reactive routing protocol but is based on source routing [1][2][4]. In the source routing, a source determines the perfect sequence of nodes with which it propagate a packet towards the destination. The list of intermediate nodes for routing is explicitly stored in the packet's header. In DSR, every mobile node needs to maintain a route cache where it caches source routes. When a source node wants to send a packet to some other intermediate node, it first checks its route cache for a source route to the destination for successful delivery of data packets. In this case if a route is found, the source node uses this route to propagate the data packet otherwise it initiates the route discovery process. Route discovery and route maintenance are the two main features of the DSR protocol.

3.1. Route Discovery Process

For route discovery, the source node starts by broadcasting a route request packet that can be received by all neighbor nodes within its wireless transmission range. The route request contains the address of the destination host, referred to as the target of the route discovery, the source's address, a route record field and a unique identification number (Figure 4). During the route discovery process, the route record field is used to contain the sequence of hops which already taken. At start, all senders initiate the route record as a list with a single node containing itself. The next intermediate node attaches itself to the list and so on. Each route request packet also contains a unique identification number called as request_id which is a simple counter increased whenever a new route request packet is being sent by the source node. So each route request packet can be uniquely identified through its initiator's address and request_id. When a node receives a route request packet, it will process the request so that no loops will occur during the broadcasting of the packets.

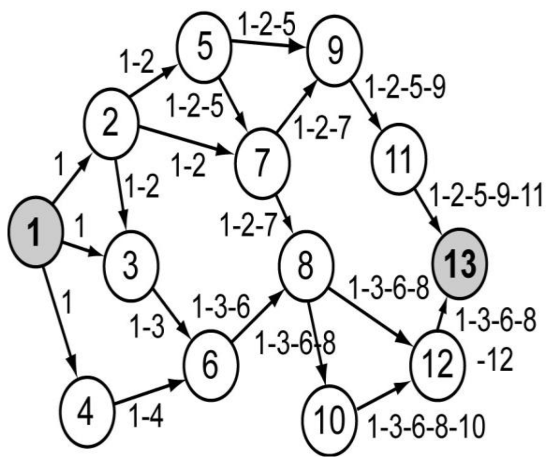

Figure 4.Building of the record during route discovery in DSR [3].

A route reply is sent back either if the request packet reaches the destination node itself, or if the request reaches an intermediate node which has an active route to the destination in its route cache. The route record field in the request packet indicates the sequence of hops which was considered. If the node generating the route reply is the destination node, it just takes the route record field of the route request and puts it into the route reply. If the responding node is an intermediate node, it attaches the cached route to the route record and then generates the route reply (Figure 5).

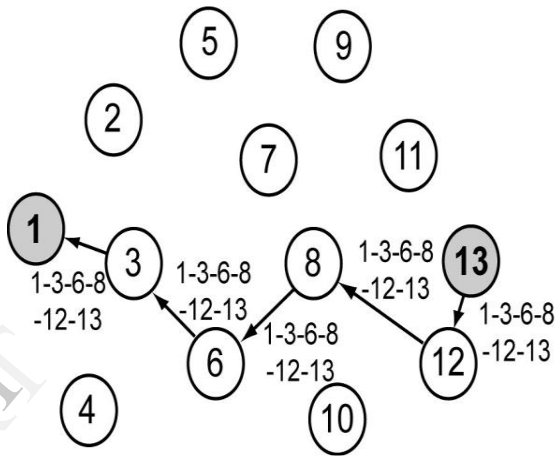

Figure 5.Propagation of the route reply in DSR [3].

Sending back route replies can be processed with two different ways: DSR may use symmetric links. In the case of symmetric links, the node generating the route reply just uses the reverse route of the route record. When using asymmetric links, the node needs to initiate its own route discovery process and back the route reply on the new route request.

3.2. Route Maintenance Process

Route maintenance can be accomplished by two different processes [3]:

- Hop-by-hop acknowledgement at the data link layer
- End-to-end acknowledgements

Hop-by-hop acknowledgement is the process at the data link layer which allows an early detection and re-transmission of lost packets. If the data link layer determines a fatal transmission error, a route error packet is being sent back to the sender of the packet. The route error packet contains the information about the address of the node detecting the error and the host's address which was trying to transmit the packet. Whenever a node receives a route error packet, the hop is removed from the route cache and all routes containing this hop are truncated at that point. When wireless transmission between two hosts does not process equally well in both directions, end-to-end acknowledgement may be used. As long as a route exists, the two end nodes are able to communicate and route maintenance is possible. In this case, acknowledgements or replies on the transport layer used to indicate the status of the route from one host to another. However, with end-to-end acknowledgement it is not possible to find out the hop which has been in error.

4. Simulation Environment

4.1 Simulation Model

Here we give the emphasis for the evaluation of performance of Ad Hoc routing protocol AODV and DSR with varying the number of mobile nodes and traffic pairs (connections). The simulations have been performed using network simulator NS-2 [9]. The ns-allinone-2.28 simulator is used which supports simulation for routing protocols for ad hoc wireless networks such as AODV [1], OLSR [5], TORA [2], DSDV [6][7], and DSR [3]. Ns-2 is written in C++ programming language and Object Tool Common Language (OTCL). Although ns-2.28 can be built on various platforms, we chose the platform as cygwin on windows. NS-2 can simulate the physical, MAC and data link layer of a multihop wireless network. The distributed coordination function (DCF) of IEEE 802.11 for wireless LANs is utilized as the MAC layer. Lucent's WaveLAN is used as the radio model, which is a shared-media radio with a nominal bit rate of 2Mbps and a nominal transmission range of 250 m.

We generate CBR traffic with the "cbrgen" tool and scenario with the "setdest" tool in ns-2. To run a simulation with ns-2.28, the user must write the simulation script in OTCL, get the simulation results in an output trace file and here, we analyzed the experimental results by using the java program. The performance metrics are graphically visualized in XGRAPH 12.1(Fig.7, 8, 9, 10, 11, 12, 13, 14, 15). Ns-2 also offers a visual representation of the simulated network by tracing nodes movements and events and writing them in a network animator (NAM) file.

4.2. Simulation Parameters

We consider a network of nodes placing within a 1000m X 1000m area. The performance of AODV and DSR is evaluated by keeping the network speed and pause time constant and varying the network density (number of mobile nodes).Table 1 shows the simulation parameters used in this evaluation.

TABLE I
PARAMETERS VALUES FOR AODV AND DSR SIMULATION

Simulation Parameters	
Simulator	**ns-2.28**
Protocols	**AODV, DSR**
Simulation duration	**200 seconds**
Simulation area	**1000 m x 1000 m**
Number of nodes	**20,25,30,35,40,45,50**
Transmission range	**250 m**
Movement model	**Random Waypoint**
MAC Layer Protocol	**IEEE 802.11**
Pause Time	**100 sec**
Maximum speed	**20 m/s**
Packet rate	**4 packets/sec**
Traffic type	**CBR (UDP)**
Data payload	**512 bytes/packet**

4.3. Performance Metrics

Three performance metrics which are Packet Delivery Fraction (PDF), Average End-to-End Delay and Normalized Routing Load (NRL) have been considered:

Packet delivery fraction: The fraction of all the received data packets successfully at the destinations over the number of data packets sent by the CBR sources is known as Packet delivery fraction.

Average End to end delay: The average time from the beginning of a packet transmission at a source node until packet delivery to a destination. This includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC, and propagation and transfer times of data packets. Calculate the send(S) time (t) and receive (R) time (T) and average it.

Normalized Routing Load: The normalized routing load is defined as the fraction of all routing control packets sent by all nodes over the number of received data packets at the destination nodes.

5. Simulation Results & Observation

The performance of AODV and DSR based on the varying the number of nodes is done on parameters like packet delivery fraction and average end-to-end delay and normalized routing load. "Fig. 6" shows the calculation of send, received packets, routing overhead, normalized routing load, PDF, average end-to-end delay for AODV and DSR simulation with 50 nodes by running java program for it.

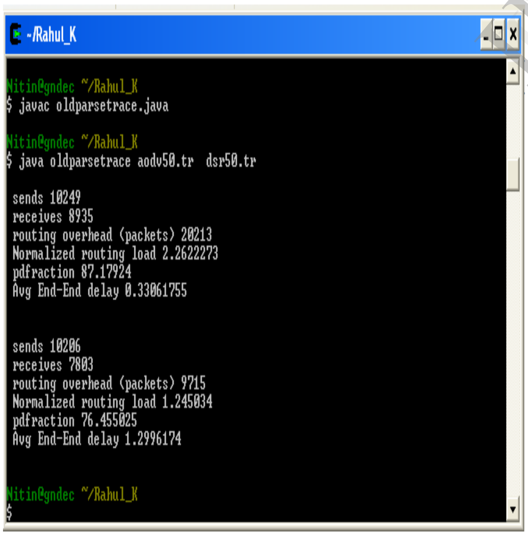

Figure 6. Result for 50nodes

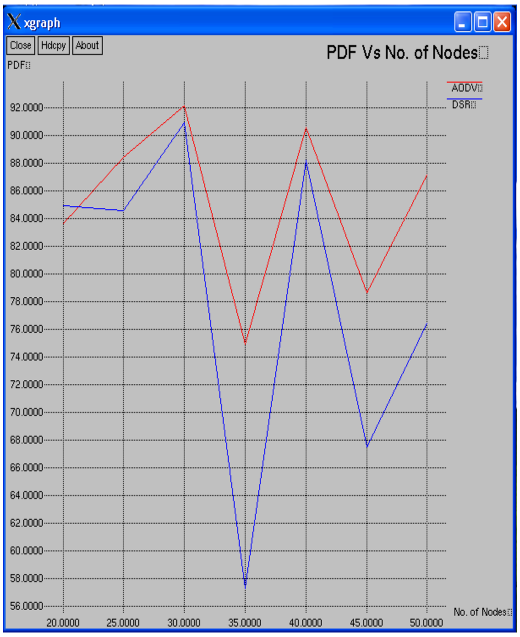

Figure 7.Packet Delivery Fraction for AODV and DSR for 40% connections

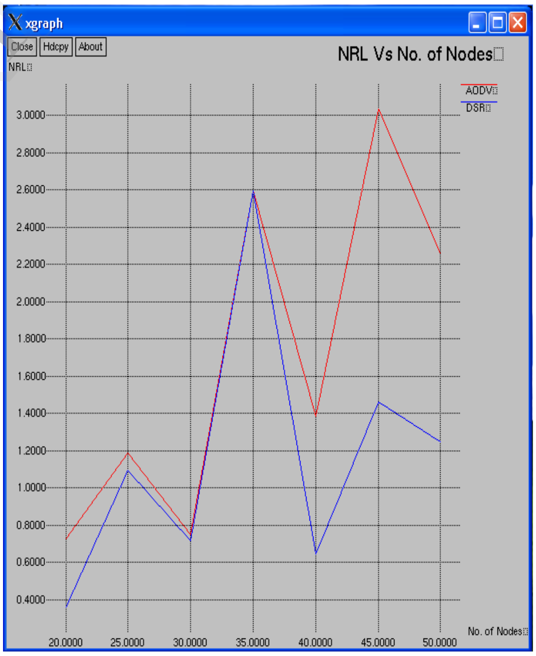

Figure 8. Normalized Routing Load for AODV and DSR for 40% connections

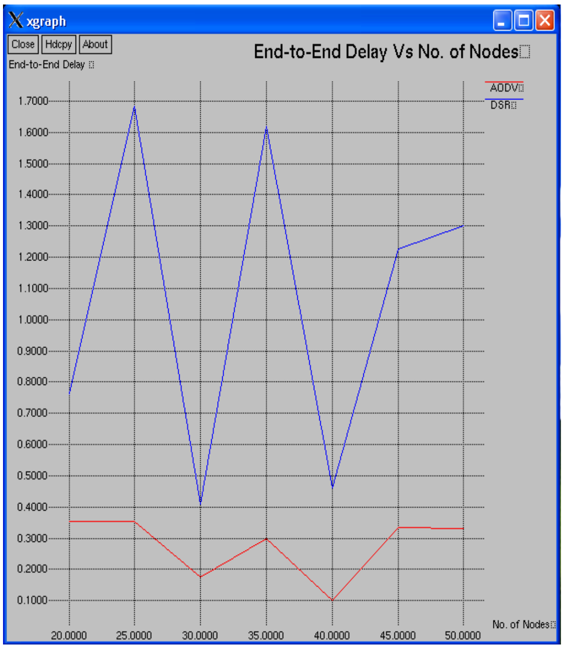

Figure 9. Average End to End Delay for AODV and DSR for 40% connections

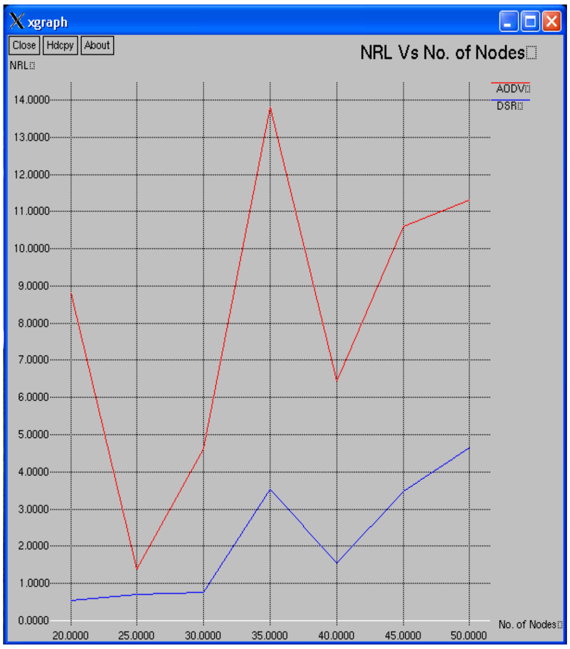

Figure 11. Normalized Routing load for 60% connections

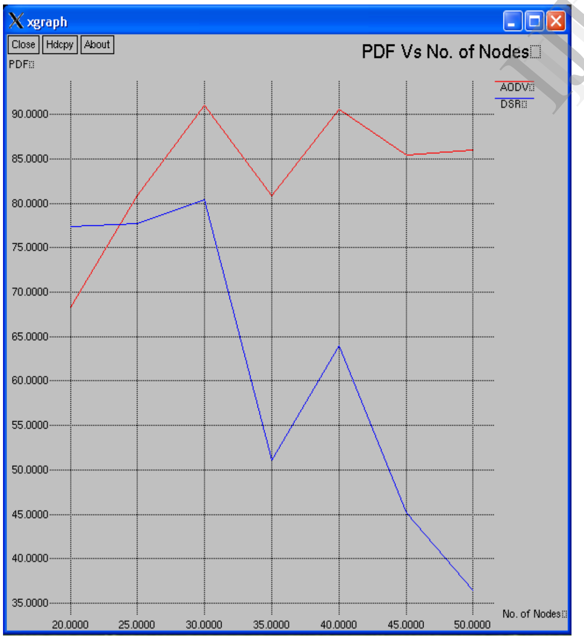

Figure 10. Packet Delivery Fraction for 60% connections

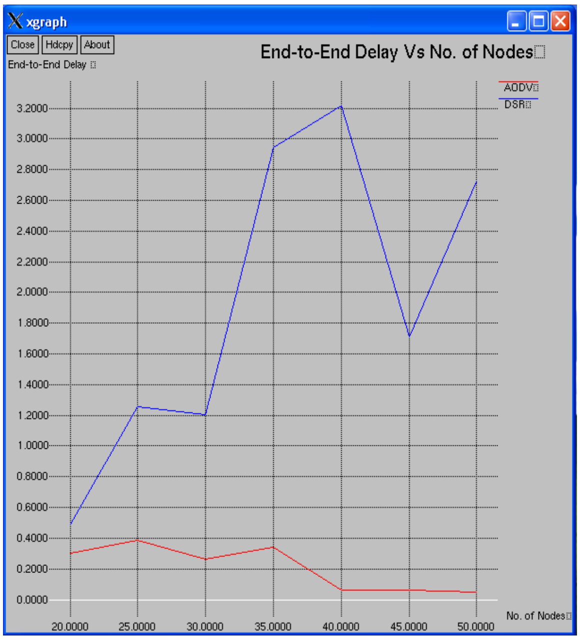

Figure 12. Average End to End delay for 60% connections

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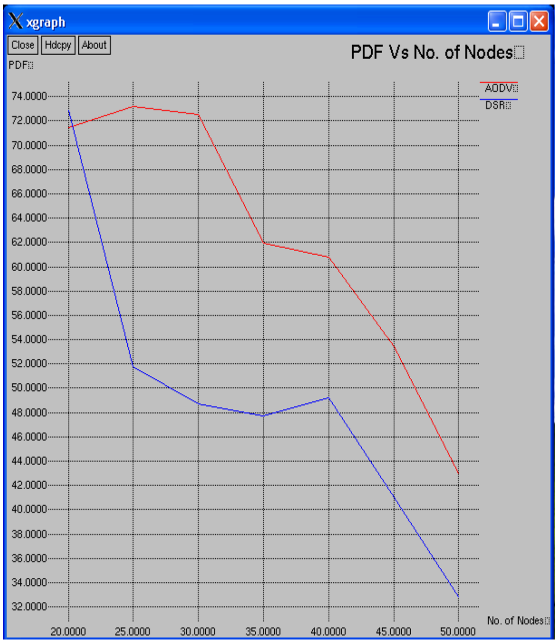

Figure 13. Packet Delivery Fraction for 80% connections

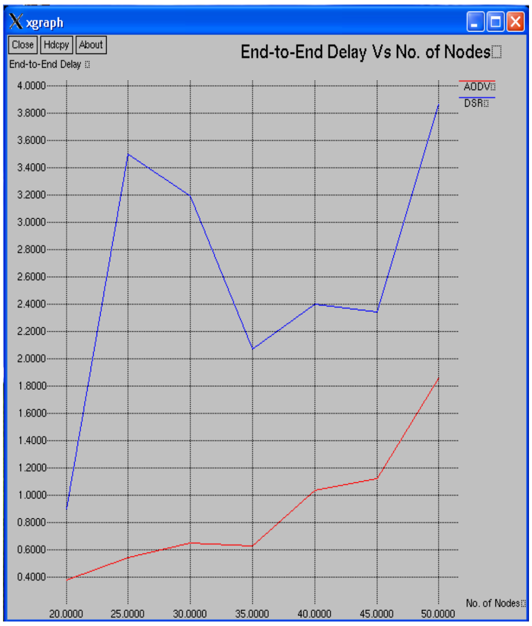

Figure 15. Average End to End delay for 80%connections

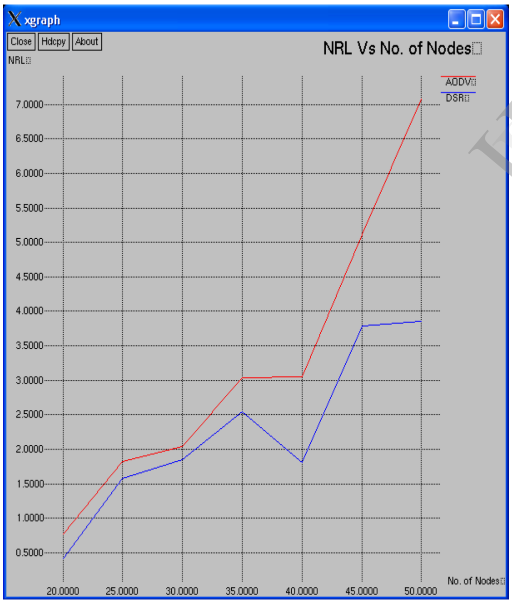

Figure 14. Normalized Routing load for 80% connections

6. CONCLUSION

In this simulation work, the performance of two on demand routing protocols AODV and DSR are compared and analyzed. The comparison is done using performance metrics like packet delivery fraction, average end-to-end delay, and normalized routing load with increasing the number of mobile nodes up to 50 and varying the traffic connections as 40%, 60%, 80%. From fig. 7, fig 10 and fig 13, we observe that packet delivery fraction of AODV is greater than DSR hence AODV has better performance than DSR with varying number of nodes due to its on demand characteristics to determine the freshness of the routes. The Average end-to- end delay in AODV is less than the DSR routing protocol hence AODV shows better performance as seen from fig. 9, fig 12 and fig 15 this is because DSR often uses stale routes due to the large route cache, which leads to frequent packet retransmission and extremely high delay times. In fig 8, fig 11 and fig 14 normalized routing load is shown, we observed that DSR exhibits low overhead. Hence when routing overhead is concerned DSR performs well. This is due to aggressive caching and maintains multiple routes per destination whereas AODV maintain one route per destination. Finally we conclude that considering overall performance AODV performs better than DSR for varying node density even though the routing overhead is higher than DSR.

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