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Performance Analysis of AODV and DSR Routing Protocols in Mobile Ad-Hoc Network

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Abstract: The Mobile Ad-Hoc Networks (MANET) technology is a self-organized wireless interconnection of communication devices without the use of any fixed network infrastructure/backbone. The performance of Ad-hoc on-demand Distance Vector (AODV) and Dynamic Source Routing (DSR) protocol is two MANET protocol. Selecting an appropriate routing protocol for steering data packet is a very important issue to evaluate the performance of wireless mobile ad-hoc networks (MANET). In order to guarantee an optimum use of these protocols, we need to test different routing protocols performances. This paper presents the performance analysis comparison of ad-hoc on-demand routing protocol (AODV) and Dynamic Source Routing (DSR) under different performance metrics like throughput, packet drop rate and end-to-end delay. Efficiency achieved by the AODV protocol is higher than DSR protocol in mobile ad-hoc networks. The simulation is done in Network Simulator (NS) 2.

Keywords: AODV, DSR, Mobile ad-hoc networks, NS2 simulator, Performance, Routing protocol.

I. Introduction

Wireless Mobile Ad-Hoc Network (MANET) includes a set of independent mobile nodes forming autonomously and communicates in an infrastructure-less environment. Since the location of nodes modifies in a specific time, the network topology changes erratically. Each node becomes a member of the network, while it is located in this environment. Mobile nodes can communicate with other devices in their radio transmission range or outside of this area by relaying nodes. Mobile Ad-Hoc network is a kind of wireless network and Self Configuring network of moving routers associated with a wireless network. The routers are free to move randomly and organize themselves arbitrarily, thus, the network's wireless topology may change rapidly and unpredictably. Mobile Ad-Hoc network is an infrastructure-less network due to mobile routers. Each node or router must forward the packets unrelated to its own use. Main challenges to maintain the Mobile Ad-Hoc network are no central controlling authority, limited power ability, continuously maintain the information required to properly route traffic. Some other simulation results have been done on individual protocols. Several simulation-based performance comparisons have been done for ad-hoc routing protocols in recent years. The performance comparison of two on-demand routing protocols AODV and DSR have been presented using NS-2 Simulator. AODV is an on-demand routing protocol. The AODV algorithm gives an easy way to get change in the link situation. Dynamic Source Routing Protocol is a reactive routing protocol and is called on-demand routing protocol. It is a source routing protocol that is why it is a simple and efficient protocol. It can be used in multi-hop wireless Ad-Hoc networks. The DSR network is totally self-organizing and self-configuring. The protocols is just composed of two mechanisms i.e. route discovery and route maintenance.

Paper is organized as follows: Section I introduction, literature review in Section II, performance metrics considered for studies in Section III, system design in Section IV, implementation in Section V followed by conclusion in Section VI.

II. Literature Review

Performance analysis in reactive Routing protocols in wireless mobile Ad-Hoc networks using DSR, AODV and AOMDV [1]. Selecting an appropriate routing protocol for steering data packets is a very important issue to evaluate the performance in MANETs. They check some performance metrics such as throughput, end-to-end delay and packet delivery ratio in order to find the best routing protocol. Each node or router must forward the packets unrelated to its own use. Main challenges to maintain the Mobile Ad-Hoc network are No central controlling authority, limited power ability, continuously maintain the information required to properly route traffic. The performance comparison of two on-demand routing protocols AODV and DSR have been presented using NS-2 Simulator. Mobile Ad-Hoc networks are highly dynamic networks characterized by the absence of physical infrastructure [2]. In this paper, comparison on Mobile Ad-Hoc network routing protocols DSDV, AODV and DSR using network simulator NS2.34. The performance

matrix includes PDR (Packet Delivery Ratio), Throughput, End to End Delay, Routing overhead. We are comparing the performance of routing protocols when packet size changes, when time interval between packet sending changes, when mobility of nodes changes. Mobile Ad-hoc Network [3] had become one of top area of research, due to their simplicity of deployment. They evaluated the performance of AODV, DSDV and DSR, routing protocols for MANET using NS2 Simulator.

The system [4] in MANET is an Ad-Hoc mobile network which consists of autonomous mobile nodes which are Self Organizing in an infrastructure-less setup. Simulation analysis of two common routing protocols: AODV and DSR are performed varying the node density in a fixed size area with highly mobile nodes moving at random speeds. Analysis of two prominent on-demand routing protocols: AODV and DSR, for the static Ad-Hoc network, is compared on the basis of throughput, jitter and data received at the server. In static Ad-Hoc scenarios, the performance of DSR is better than AODV as the information of the route is always present in the cache, which avoids the route discovery process. DSR is preferred because the result analysis depicts that throughput and data received at the server is high and jitter is low for DSR as compared to AODV [5]. Dynamic Source Routing (DSR) and Ad-Hoc On-Demand Distance Vector (AODV) are two types of reactive protocols.

Ad-Hoc access network nodes can be used to expand capacity of multi-hop communication range of mobile communication system, even business adjacent to the community, improve edge data rates [6]. The paper proposes a QoS gateway discovery protocol which uses the time delay and stable route to the gateway selection conditions. And according to the gateway discovery protocol, it also proposes a fast handover scheme which can decrease the handover time and improve the handover efficiency. Delay aware routing protocols make path selection between source and destination based on the delay over the discovered links during routing discovery and routing table calculations [7]. However, networks that require high Quality of Service (QoS) needs to consider several criteria's that could affect the quality of the chosen path in packet forwarding process. This study presents a review of existing delay aware routing protocols looking at their proposed solutions features, which could be very useful for future improvement.

III. Performance Metrices Considered for Studies

A. Average End-to-End Delay of Data Packets

It is defined as the average end-to-end delay of data packets a network. The sum of all time differences between the packet sent and received divided by the number of packets gives the average end-to-end delay. The lower the end-to-end delay the better the application performance.

$$AED = \Sigma \text{ (Received Time – Sent Time)/Total Data Packets Received} \quad (1)$$

B. Average Throughput

It is measured as the ratio of the amount of received data to the amount of simulation time and tells about how soon an end-user is able to receive data. A higher throughput implies better QoS of the network.

$$\text{Average Throughput} = \text{Total Received Bytes/Elapsed Time} \quad (2)$$

C. Packet Delivery Ratio

Packet delivery ratio is calculated by dividing the number of packets received at the destination by the number of packets originated at the source. For the best performance packet delivery ratio of routing protocol should be as high as possible. If the ratio is 1, it will be the best delivery ratio of the routing protocol.

$$PDR = \text{No. of Received Packets/No. of Sent Packets} \quad (3)$$

IV. System Design

A simulation is an important tool in the development of mobile ad-hoc networks. It provides an excellent environment to experiment and verify routing protocol correctness. The AODV routing protocol is a reactive routing protocol. Therefore, routes are determined only when needed. The mobility model is used in each of the simulation scenarios is the random waypoint model. In every simulation, nodes are initially placed within the fixed network area.

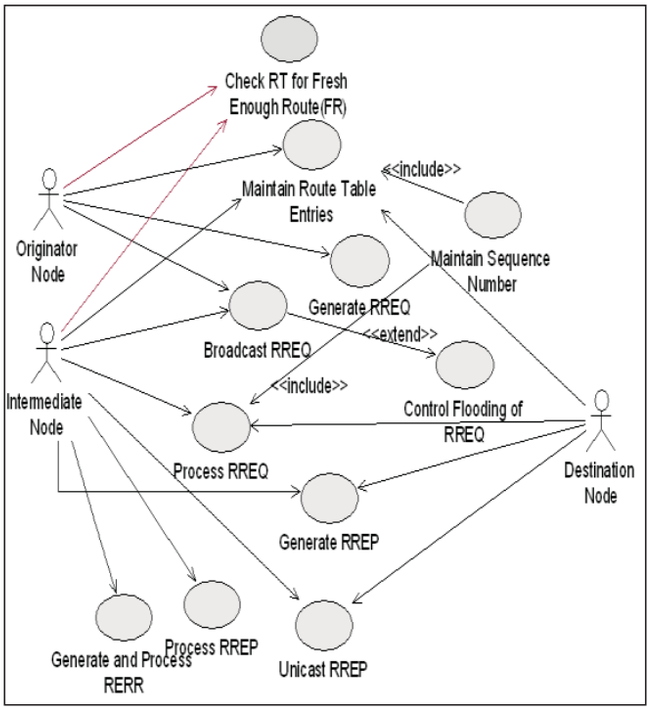

Fig. 1: Use Case Model for AODV

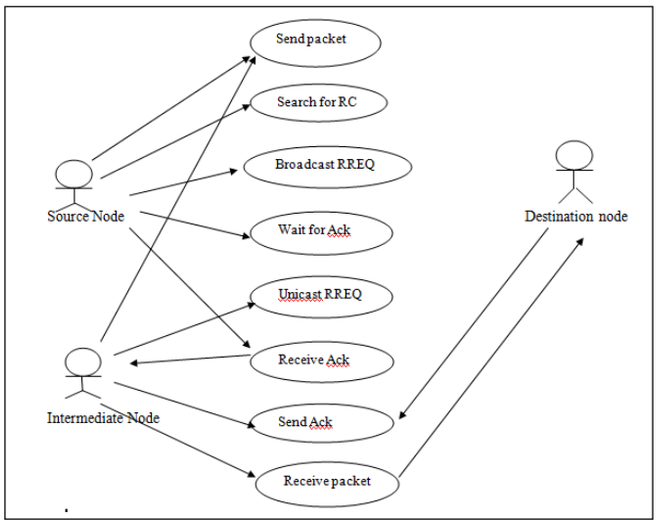

Fig. 2: Use Case Model for DSR

A. Ad-Hoc On-Demand Distance Vector Routing Protocol Working

In AODV the source node and destination nodes IP addresses are already known. The goal is to identify, discover and maintain the optimal route between source and a destination node in order to send/receive data packets and informative. Each node comprises of a routing table along with below-mentioned format of route request (RREQ) packet.

RREQ{Destination IP, Destination Sequence Number, Source IP, Source Sequence Number, Hop Count}.

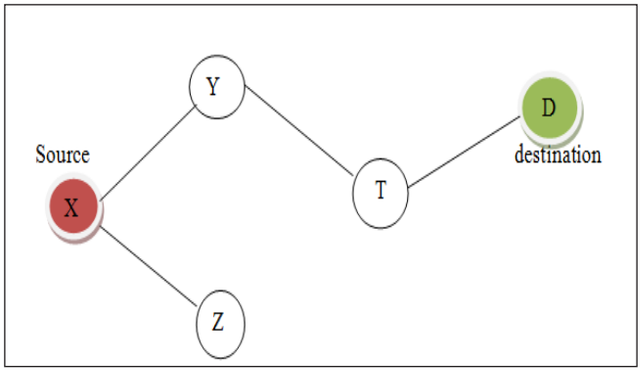

Fig. 3: Ad-Hoc on Demand Distance Vector Network

Step 1: Source node "X" will send route request i.e. RREQ packet to its neighbours "y" and "z".

Step 2: Node "Y" & "Z" will check for route and will respond using RRESP packet back to source "X". Here in this case, "Z" is the last node but the destination. It will send the RREQ packet to "X" stating "Route Not Found". But node "Y" will send RRESP packet stating "Route Found" and it will further broadcast the RRESP to node "T".

Step 3: Now the field of net hop in the RREQ format will be updated, Node "T" will send back the "Route Found" message to node "Y" and will update the next hop field further.

B. Dynamic Source Routing Protocol Working

Dynamic source routing does broadcast the route to its neighbours but does not flood the information. It only traces the route by calculating the total distance or by calculating the number of nodes present in between the source and destination nodes.

Step 1: Start from source node N1 and broadcast the information about it to its neighbors, i.e., in this case, the route information is "<1>", because of its one-to-one link between node N1 and N2

Step 2: Broadcast previous route information to neighbors of node N2 i.e. to node N3, N4, N5. The new route will remain the same "<1,2>" in all the cases.

Step 3: Take node N3 and broadcast the previous route (<1,2>) to next neighbouring nodes i.e. node N6. New route till node N6 will be "<1,2,3>" and the same process can be done for others i.e. node N4 and N5.

Step 4: Further, broadcast the new routes i.e. <1,2,3,6>, <1,2,4>, <1,2,5> to nodes N8, N7 & N9 respectively.

Step 5: Repeat the steps until the destination node is reached via all the routes.

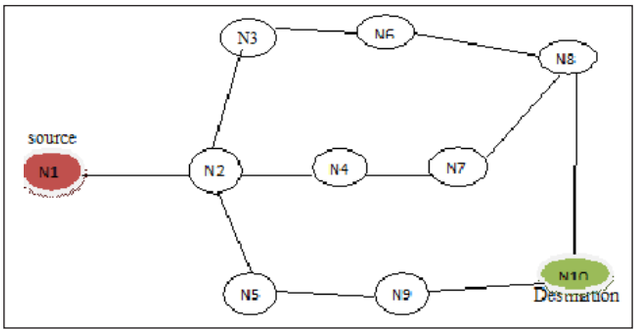

Fig. 4: Dynamic Source Routing Network

V. Implementation and Result Analysis

When a packet is forwarded from the source node to the other node, the node checks whether the node is the destination node or the neighbour node. If the node is destination node then the packet reaches to the destination node else the packet will be forwarded to the neighbor node until it reaches the destination node.

We have simulated the above mentioned two protocols using an efficient simulation tool network simulator (version 2.34) Ns is a discrete event simulated targeted at networking research.

Ns provides substantial support for simulation TCP, routing and multicast protocols over wired and wireless networks.

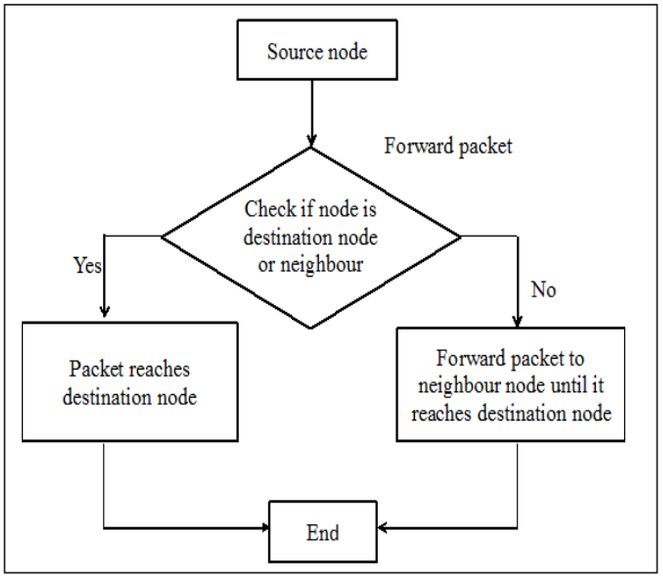

Fig. 5: Flowchart for Forwarding Packet in MANET

Our main objective of the simulation is the comparison of the performance of both the protocols. In order to evaluate the performance of these two protocols, the performance metric used is simulation time versus packet delivery. Also, throughput and delay of the packet have also been considered. In the graph that follows, the number of nodes is expressed along the X-axis and PDR, throughput, a delay is expressed along Y-axis. In this paper three cases, studies discussed below to compare two routing protocols.

Case 1: Varying number of nodes and comparing with different performance parameters:

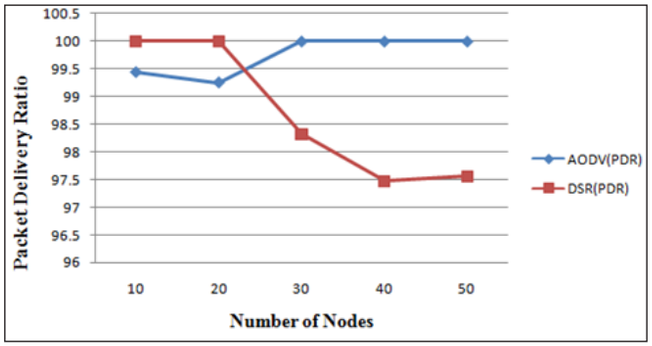

Fig. 6: Varying Number of Nodes in AODV and DSR for PDR

The packet delivery ratio in AODV is high when the number of node increases and in DSR packet delivery ratio is low when the number of nodes increases.

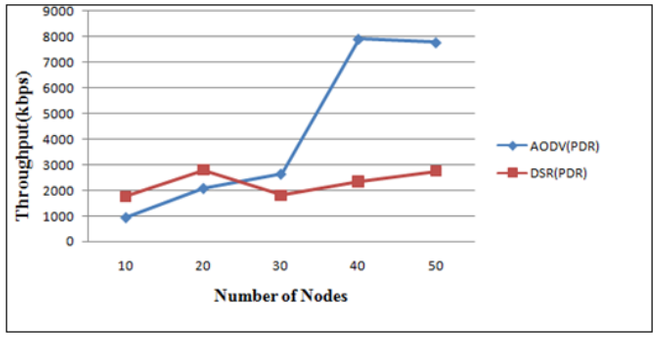

Fig. 7: Varying Number of Nodes in AODV and DSR for THROUGHPUT

The throughput in AODV is high when the number of node increases. In DSR throughput slightly increase but less than AODV when the number of node increases.

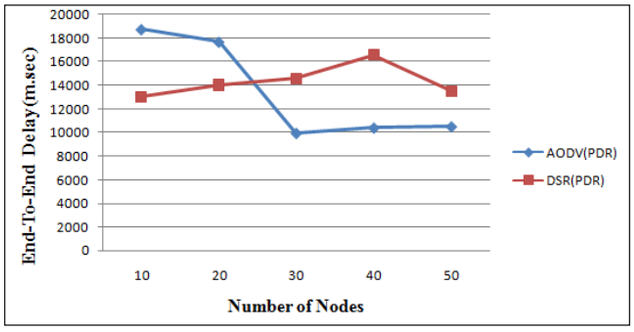

Fig. 8: Varying Number of Nodes in AODV and DSR for DELAY

The delay in AODV is low when the number of node increases. In DSR it will slightly increase than AODV when the number of node increases.

Case 2: Varying node mobility and comparing with the performance parameter:

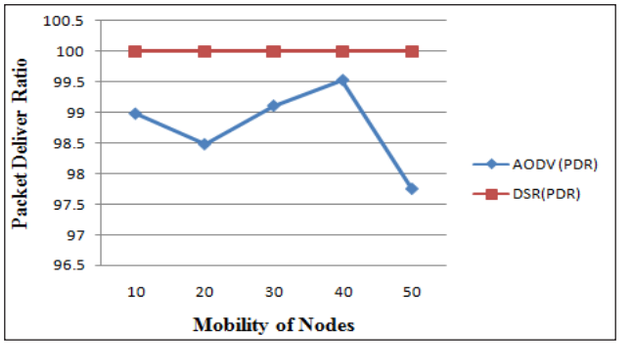

Fig. 9: Varying Node Mobility in AODV and DSR for PDR

The packet delivery ratio in the AODV decreases when increasing the speed of nodes. In DSR increases when increasing the node speed.

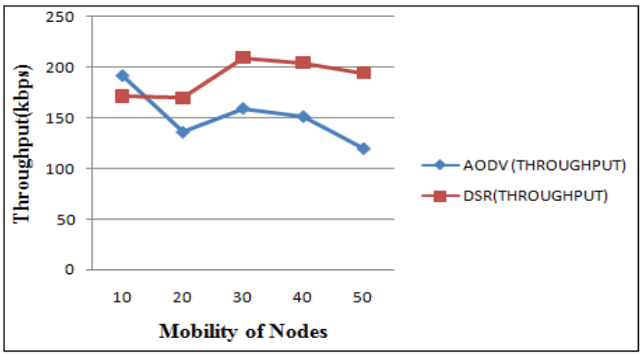

Fig. 10: Varying Node Mobility in AODV and DSR for THROUGHPUT

The throughput in AODV decreases when increasing the node speed. In DSR when speed of node increases compare to throughput is high.

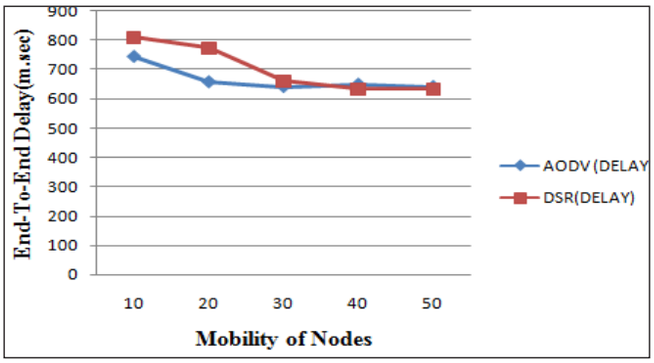

Fig. 11: Varying Node Mobility in AODV and DSR for DELAY

The delay in AODV and DSR decreases when node speed increases. On increasing the node speed at 40 ms both AODV and DSR have the same delay.

Case 3: Varying packet size and comparing with different performance parameter:

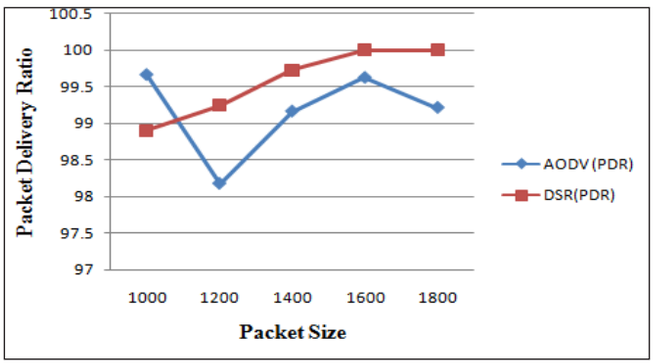

Fig. 12: Varying Packet Size in AODV and DSR for PDR

The packet delivery ratio in decreases AODV and increases in DSR as the increase in packet size.

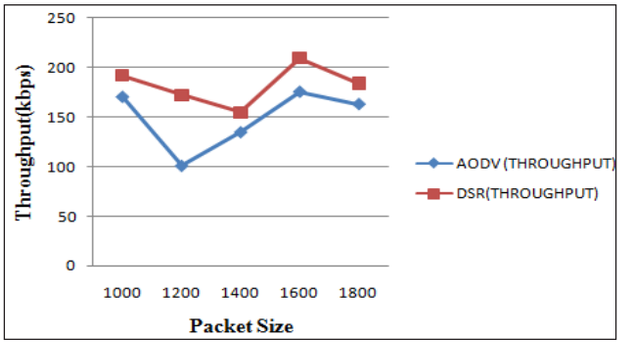

Fig. 13: Varying Packet Size in AODV and DSR for THROUGHPUT

The throughput in AODV decreases and in DSR slightly increases when packet size increases.

The delay in AODV and DSR same till the packet size is 1200 kbps. After that delay in DSR is increased when packet size increases compared to AODV.

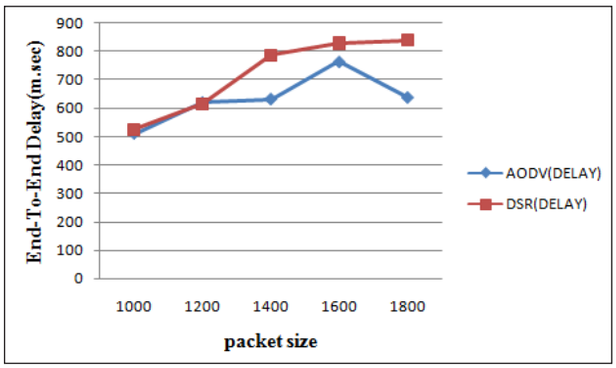

Fig. 14: Varying Packet Size in AODV and DSR for DELAY

VI. Conclusion

We have simulated AODV and DSR with varying number of nodes, increasing mobility of the node and increasing the packet size by using NS2 simulator. This comparison is based on the packet delivery ratio, end to end delay and throughput. It can be concluded that as the number of nodes is increasing, the delay in AODV also increases. The opposite is true for DSR which decreases in delay when the number of nodes increases. The DSR shows better performance than AODV. Use AODV when node density is very high and use DSR in low node densities. Choosing the best protocol is totally related to the size of the network and the other conditions like the mobility of nodes. It is aimed to have an in-depth study of performance metrics in large size networks. AODV performed good in some situations than DSR protocol but overall DSR is performing better than AODV protocol like if we compare the average end to end delay. AODV and DSR protocols perform better at less packet size. Performance of all two protocols decreases as the mobility of nodes increase.

Throughput of AODV is always very high compared to DSR when the number of nodes is increasing. Hence AODV performs better in stressful networks where node density is very high. With increasing number of nodes, DSR performs poorly.

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