Nehal Jadeja, Roma Patel / International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com
Vol. 3, Issue 2, March -April 2013, pp.1825-1830

Performance Evaluation of AODV, DSDV and DSR Routing Protocols Using NS-2 Simulator

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ABSTRACT

Manet stands for mobile adhoc network. It is type of adhoc network in which nodes are mobile and connected with each other via wireless connection. In this research we evaluate performance of three routing protocols AODV(Ad hoc On-Demand Distance Vector Routing),DSR(Dynamic Source Routing)and DSDV(Destination-Sequenced Distance Vector routing).We evaluate performance of routing protocols based on performance metrics Packet Delivery Ratio(Pdr), End to end delay and Throughput while varying the number of nodes and speed. The simulation is performed through the simulation tool NS-2 (Network Simulator- 2) due to its open source simplicity and free availability.

Keywords - AODV, DSDV, DSR, MANET, NS-2, Performance matrices

1. Introduction

Mobile Ad-hoc Networks (MANETs)[1][2] are autonomous self-organized networks without the aid of any established infrastructure or centralized administration (e.g., base stations or access points). Communication is done through wireless links among mobile hosts through their antennas.[ipmc].Mobile nodes may be cellular or satellite transmission or group of laptops. Mobile nodes can move independently in any direction. Each node in manet behave like host as well as router. Each nodes forward packet to other nodes. Research in this area is mostly simulation based Random waypoint is commonly used mobility model in this simulations. Random waypoint is simple model that may be applicable to some scenarios. In these networks routing protocols should be more dynamic so that they quickly respond to topological changes [3]. If two hosts are not within radio range, all message communication between them must pass through one or more intermediate hosts that double as routers. The hosts are free to move around randomly, thus changing the network topology dynamically. Thus routing protocols must be adaptive and able to maintain routes in spite of the changing network connectivity. Such networks are very useful in military and other tactical applications such as emergency rescue or exploration missions, where cellular infrastructure is unavailable or unreliable. Commercial applications are also likely where there is a need for ubiquitous communication services without the presence or use of a fixed infrastructure. Examples include on-they conferencing applications, networking intelligent devices or sensors etc...[4].

The rest of the paper is organized as follows: Section 2 presents description of the MANET routing protocols that is analyzed and compared. Section 3 gives a brief description of the Simulation Model and Performance matrices we use for evaluate routing protocols. Section 4 provides the simulation results and discusses it. Finally the conclusion is provided in section 5.

2. Description of Manet routing protocols

There are three types of routing protocols. Reactive, Proactive and Hybrid. Proactive protocols are Table driven protocols and maintain a routing table and Reactive protocols are On-Demand protocols and do not maintain a routing table Where Hybrid protocols are combine the proactive and reactive approaches. Following figure shows the classification of routing protocols.

We use three routing protocols in our simulation. AODV, DSR and DSDV. The mobile ad-hoc routing protocols considered in this study are described below.

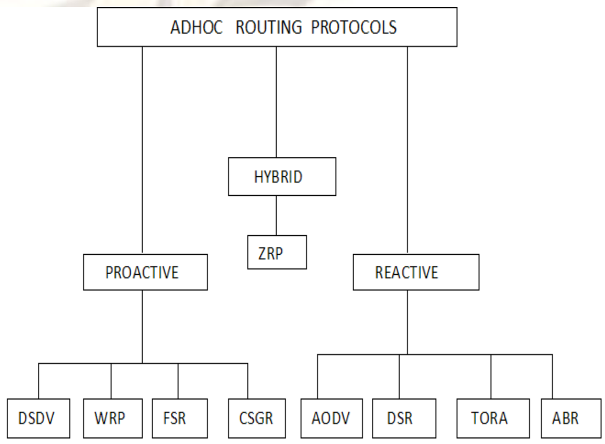

Fig.2.1 classification of adhoc routing protocols

2.1 Ad hoc On-Demand Distance Vector Routing (AODV)

The AODV is a Reactive on- demand "ad-hoc distance vector routing protocol". AODV is an improvement on DSDV because it typically minimizes the number of required broadcasts by creating routes on demand basis as opposed to maintaining a complete list of routes, as in the DSDV algorithm. When a source node desires to send a message to some destination node and does not already have a valid route to that destination, it initiates a path discovery process to locate the destination. In AODV each router maintains route table entries with the destination IP address, destination sequence number, hop count, next hop ID and lifetime [5]. This protocol performs Route Discovery using control messages Route Request (RREQ) and Route Reply (RREP). In AODV, routes are set up by flooding the network with RREQ packets which, however, do not collect the list of the traversed hops. Rather, as a RREQ traverses the network, the traversed mobile nodes store information about the source, the destination, and the mobile node from which they received the RREQ. The later information is used to set up the reverse path back to the source. When the RREQ reaches a mobile node, that knows a route to the destination or the destination itself, the mobile node responds to the source with a packet (RREP) which is routed through the reverse path set up by the RREQ. This sets the forward route from the source to the destination. To avoid overburdening the mobiles with information about routes which are no longer (if ever) used, nodes discard this information after a timeout. When either destination or intermediate node moves, a Route Error (RERR) is sent to the affected source nodes. When source node receives the RERR, it can reinitiate route discovery if the route is still needed. Neighborhood information is obtained by periodically broadcasting Hello packets [6]. For the maintenance of the routes, two methods can be used: a) ACK messages in MAC level or b) HELLO messages in network layer[7].

2.2 Dynamic Source Routing (DSR)

Dynamic Source Routing (DSR)[8] is a routing protocol for wireless mesh networks. It is similar to AODV in that it establishes a route on-demand when a transmitting mobile node requests one. However, it uses source routing instead of relying on the routing table at each intermediate device. Dynamic source routing protocol (DSR) is an on-demand, source routing protocol, whereby all the routing information is maintained (continually updated) at mobile nodes. DSR allows the network to be completely self-organizing and self-configuring, without the need for any existing network infrastructure or administration. The protocol is composed of the two main mechanisms of "Route Discovery" and "Route Maintenance", which work together to allow nodes to dis-cover and maintain routes to arbitrary destinations in the ad hoc network. An optimum path for a communication be-tween a source node and target node is determined by Route Discovery process. Route Maintenance ensures that the communication path remains optimum and loop-free according the change in network conditions, even if this requires altering the route during a transmission. Route Reply would only be generated if the message has reached the projected destination node (route record which is firstly contained in Route Request would be inserted into the Route Reply). To return the Route Reply, the destination node must have a route to the source node. If the route is in the route cache of target node, the route would be used. Otherwise, the node will reverse the route based on the route record in the Route Reply message header (symmetric links). In the event of fatal transmission, the Route Maintenance Phase is initiated whereby the Route Error packets are generated at a node. The incorrect hop will be detached from the node's route cache; all routes containing the hop are reduced at that point. Again, the Route Discovery Phase is initiated to determine the most viable route. It is beacon-less and hence it does not have need of periodic hello packet (beacon) transmissions, which are used by a node to inform its neighbors of its presence. The fundamental approach of this protocol during the route creation phase is to launch a route by flooding Route-Request packets in the network. The destination node, on getting a Route Request packet, responds by transferring a Route Reply packet back to the source, which carries the route traversed by the Route Request packet received.

2.3 Destination Sequenced Distance Vector (DSDV)

The Destination-Sequenced Distance Vector (DSDV)routing protocol [9] is a proactive routing protocol which is based on the Bellman-Ford algorithm. Each node in the network maintains a routing table which contains all available destinations with associated next hop towards them, metric and destination sequence numbers. Routing tables are updated by exchanging periodic messages (routing information) between mobile nodes. Each node periodically broadcasts its routing table to its neighbors. Broadcasting of the information is done with Network Protocol Data Units (NPDU) in two ways: a full dump and an incremental dump. A full dump requires multiple NPDUs, while the incremental requires only one NPDU to fit in all the information. A receiving node updates its table if it has received a better or a new route. When an information packet is received from another node, the receiver compares the new sequence number with the available sequence number for that entry. If that sequence number is larger, the entry will be updated with the new sequence number. If the information arrives with the same sequence number, the metric entry will be required. If the number of hops is smaller than the previous entry, the table will be updated. Update is performed periodically or when a significant change in the routing table is detected since the last update. If the network topology changes frequently, a full dump will be carried out, since an incremental dump will cause less traffic in a stable network topology. Route selection is performed according to the metric and sequence number criteria. The sequence number represents also the time indication that the destination node sends, allowing routing table update. If two identical routes are possible, the route with the larger sequence number will be saved and used, while the other will be destroyed.[10].

3. Simulation Model and Performance Matrices

we evaluate performance of three routing protocols using NS-2 simulator[11]. To evaluate performance we use three matrices Packet delivery ratio, end-to-end delay and throughput.

- Packet delivery ratio: It is the ratio of the number of data packets received by the destination node to the number of data packets sent by the source mobile node. It can be evaluated in terms of percentage (%)[5].
- End-to-end delay: This is the average time delay for data packets from the source node to the destination node. To find out the end-to-end delay the difference of packet sent and received time was stored and then dividing the total time difference over the total number of packet received gave the average end-to-end delay for the received packets. The performance is better when packet end to-end delay is low [1].
- Throughput: It is the rate of successfully transmitted data packets in a unit time in the Network during the simulation [7].
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3.1 Simulation Model

The simulations were performed using Network Simulator 2 (NS-2.34)[11]. The traffic sources are Constant Bit Rate (CBR). The source destination pairs are spread randomly over the network. The mobility model uses 'random waypoint model' in a rectangular field of 800m x 800m.In Table 3.1.1 we have summarized the model parameters that have been used for our experiments.

Table 3.1.1

Parameter	**Values**
Protocols	AODV,DSR and DSDV
Simulation time	200s
Number of Nodes	20,40,60
Simulation area	800 m × 800 m
Pause Time	0 s
Traffic Type	CBR
Maximum Speed	10,20,30,40,50,60
Mobility Model	Random Waypoint
Network Simulator	NS 2.34

4. Comparison between AODV,DSR and DSDV routing protocols

4.1 Packet delivery ratio

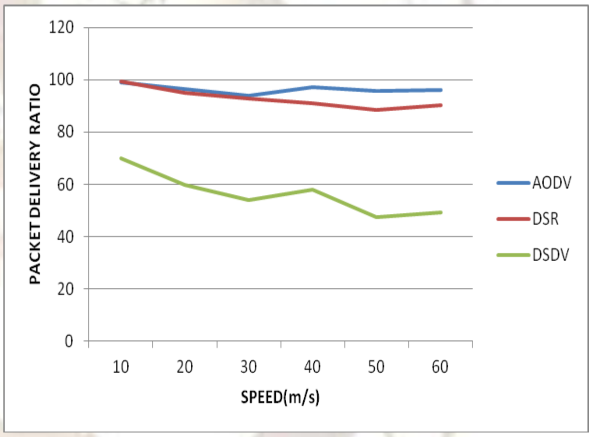

Fig.4.1.1 Packet delivery ratio for 20 nodes

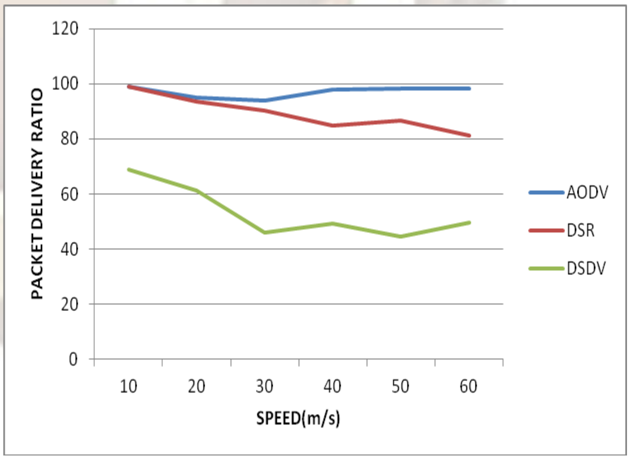

Fig.4.1.2 Packet delivery ratio for 40 nodes

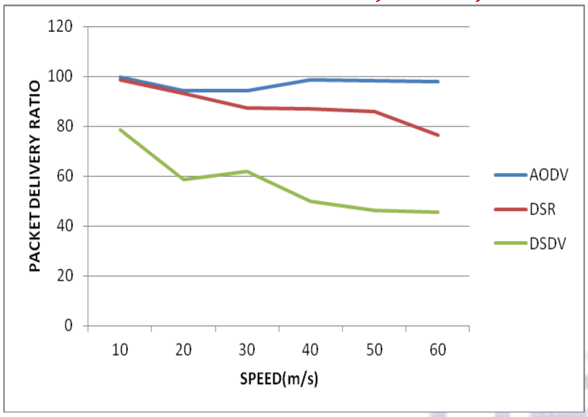

Fig.4.1.3 Packet delivery ratio for 60 nodes

As it can be seen from the above graphs we evaluate performance of AODV,DSR and DSDV for varying speed from 10m/s to 60m/for every number of nodes 20,40 and60 that we take in evaluation Packet delivery ratio for AODV is up to 95% to 100%.Pecket delivery ratio for DSR degrade up to 80% when speed increase. Performance of AODV protocol is better then DSR protocol for higher speed. Packet delivery ratio for DSDV is 45% to 70% and for high speed it degrades its performance up to 45%. AODV and DSR gives higher Packet delivery ratio then DSDV.At lower speed all three protocols perform well then higher speed. At speed 10m/s AODV and DSR deliver packets up to 100% and DSDV deliver packet unto 80% but at highest speed 60m/s AODV deliver packet up to 95%,DSR deliver packet up to 80% and DSDV deliver packet up to 45%.As per evaluation of performance AODV and DSR routing protocols can deliver more packets then DSDV routing protocol.

4.2 End-to-end delay

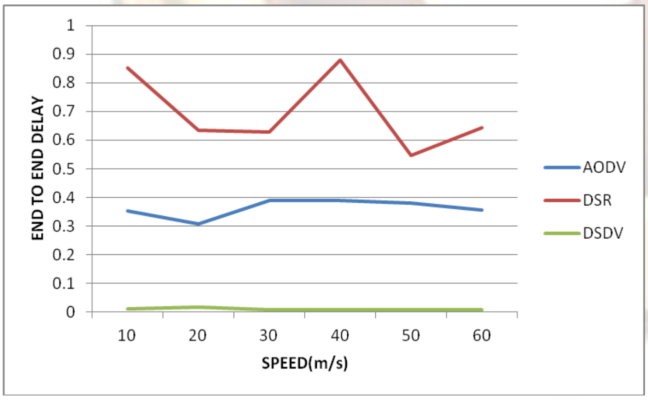

Fig.4.2.1 End-to-end delay for 20 nodes

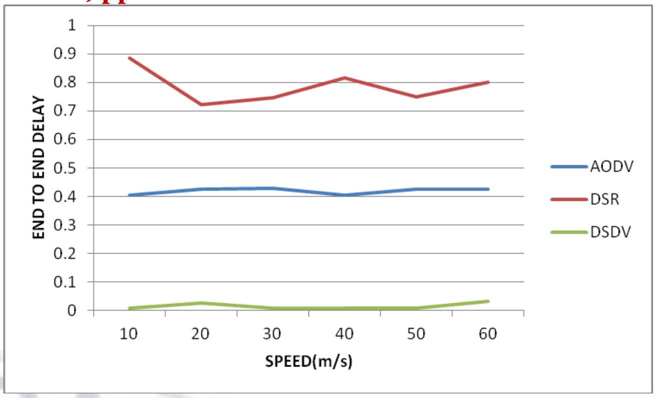

Fig.4.2.2 End-to-end delay for 40 nodes

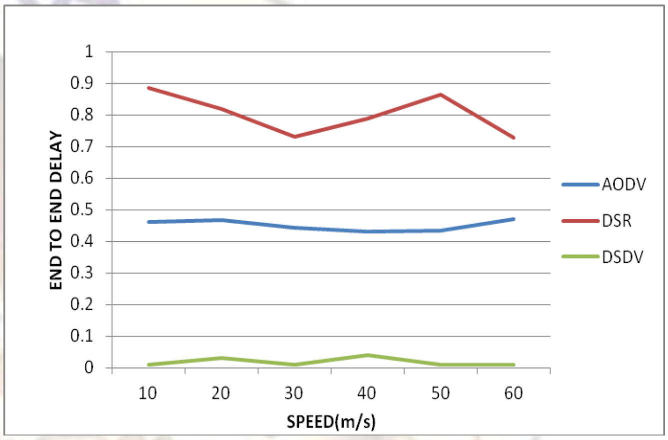

Fig.4.2.3 End-to-end delay for 60 nodes

As it can be seen from the above results, end to end delay is higher in DSR followed by DSDV and AODV. DSDV having the lowest and most stable End to End Delay in mobility. DSR is a On-Demand source routing protocol, and this is the major reason for it having a higher End-to-End Delay, where route is looked only when needed and there is a route Discovery mechanism happening every time and it also has to carry a large overhead each time, thus the higher delay. AODV on the other hand has only one route per destination in the routing table, which is constantly updated based on sequence number and DSDV has to continuously update the whole routing table periodically and when needed, which leads to a slight delay in delivery. The end to end delay does not change with increase in the number of nodes as the source and destination are in the same place moving with same speed, the increased number of nodes only might increase number of hops.

4.3 Throughput

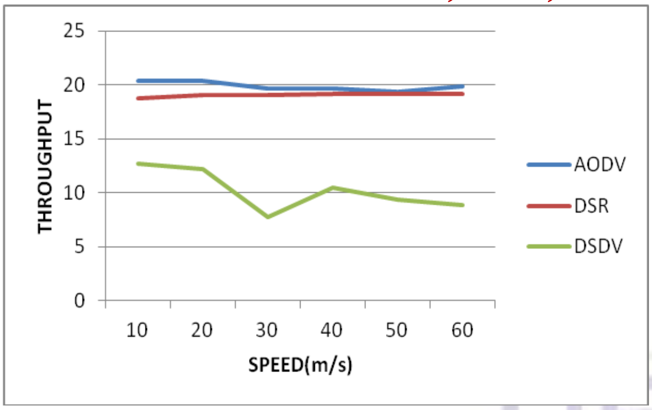

Fig.4.3.1 Throughput for 20 nodes

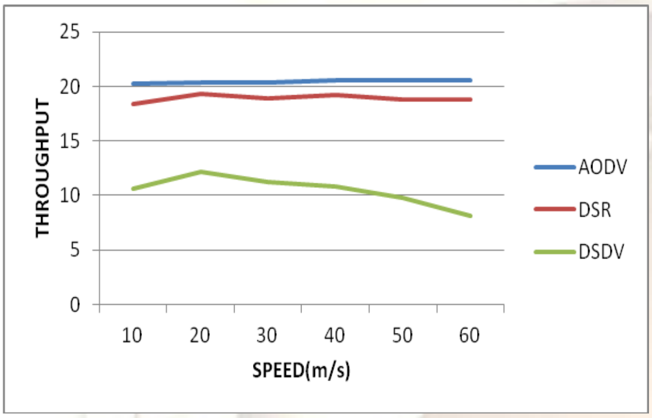

Fig.4.3.2 Throughput for 40 nodes

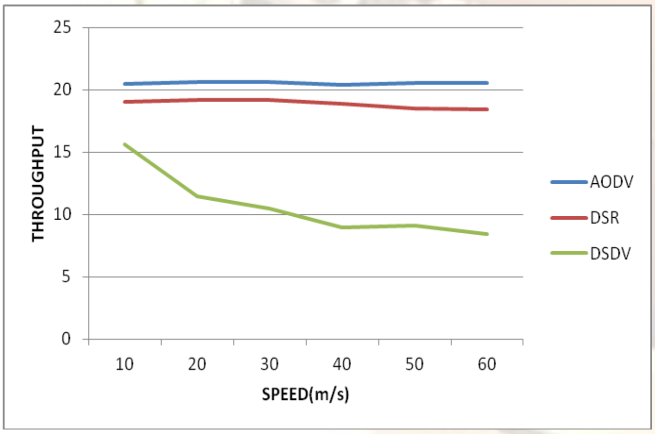

Fig.4.3.3 Throughput for 60 nodes

Throughput is the amount of data per unit time that is delivered from one node to another node via communication link. The throughput is measured in mega bits/second. Efficient routing protocols must have a greater throughput. As we can seen from the graph throughput for AODV is higher then DSR and DSDV routing protocols.

5. Conclusion

Our simulation work illustrates the performance of three routing protocols AODV, DSR and DSDV. The paper presents a study of the performance of routing protocols, used in MANETs.

- In the above simulation results 'Comparative Packet delivery ratio graphs' show that, the Packet delivery ratio of AODV is better than 'DSDV and DSR for 20-nodes, 40-nodes and 60-node scenario. When we increase speed from 10m/s to 60m/s ratio of delivered packet is degreed for all three routing protocols.
- Comparative Graphs for end-to-end delay shows that end-to-end delay for DSR protocol is higher than AODV and DSDV.End-to-end delay for DSDV is lowest from 0sec to 0.1sec and most stable then DSR and AODV routing protocols.
- Comparative Graphs for throughput shows that throughput for AODV is slightly higher then DSR routing protocol.DSDV has lowest throughput then both AODV and DSR routing protocols.

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