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A Comparitive Performance Study of DSDV, AODV and DSR MANET Protocols using NS2.34

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***Abstract*— A mobile ad-hoc network is an infrastructure less network of mobile devices that self-regulatethemselves. The paper aims to examine the three main ad-hoc routing protocols-DSDV, AODV and DSRusing NS2.34. Theperformance of these protocols is analysed and compared on the basis of simulation results with respect to varying number of nodes and varying simulation area. The various performance metrics-packet delivery ratio, average end to end delay, throughput and packet loss percentage are computed with varying number of nodes and network area. Thesimulation results show that DSR outperforms in terms of packet delivery ratio and DSDV leads to greatest packet loss percentage. Consequently, DSDV is preferred in smaller network while DSR and AODV is preferable in a large or dynamic network. However, the performance of protocols degrades with increase in simulation area.**

Keywords— ***DSDV, AODV, DSR, NS2.34, varying number of nodes, varying network area.***

I. INTRODUCTION

A mobile ad-hoc network(MANET) is a networking system of mobile devices that does not depend on any fixed infrastructure or permanent backbone. This network carries unreliable links or the varying number of communicating devices. These mobile devices can have the different data rate, energy, packetsize and transmission range. Such network configures and maintain itself if any communicating device locates out of transmission range. Military and some commercial systems that require dynamic adaptive connectivity are major applications of Manet. However, routing in Manet is difficult as devices locate themselves randomly. As conventional protocols cannot handle broken links in mobile network and they converge slowly to topological changes. Hence, routing inManet has emerged as a major research area.

A. Related Work

Elizabeth M. Royer[3] broadly classified ad-hoc routing protocols in two categories- proactive and reactive routing protocols followed by the qualitative comparison among them,

But, the paper presents only theoretical discrimination. Samyak Shah etal[4] compared the protocols on the basis of packet delivery fraction, average end-to-end delay and normalized routing load parameters with varying pause time and a number of sources using NS2 simulator on FEDORA platform.Shefali Goyal et. al[5] has discussed AODV, DSDV and DSR along with their advantages and limitations followed by the same simulation results[4]. Luis Girone Quesada[6] discussed the characteristics and mechanism of various ad-hoc routing protocols- AODV, DSR, OLSR and ZRP.

The paper examines the performance of the three main ad-hoc routing protocols- DSDV, AODV and DSR. The next section describes these protocols, their benefits and limitations. The later sections shows the comparative analysis of protocols based on simulation results in NS2.34.

II. MANET ROUTING PROTOCOLS

Manet routing protocols are used to determine the appropriate loop free pathfrom source node to other devices in an ad-hoc network. These protocols may also employ some power saving features and generally follow a shortest path strategy to establish a communication path. Ad-hoc routing protocols are broadly classified in two categories-

- Proactive or table driven routing protocol
- Reactive or on-demand driven routing protocol

Proctive routing protocols maintain consistent and up-to-date routing information by periodic routing exchanges among neighboring nodes. Here, the devices broadcast information both periodically and eventually. Each node carries large routing information which is sometimes not used and hence unsuitable for large network.DSDV is a proactive routing protocol.

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In reactive routing protocols, theroute is determined and maintained in two main steps-

- Route Discovery
- Route Maintenance

Route discovery process is initiated when a source desires to transmit data and it does not know a valid hop sequence to destination. Once a path is determined, it is maintained against unreachable or broken link. Here, the nodes maintain local connectivity with the assistance of periodic broadcasts of HELLO packets or acknowledgements. Likewise, the nodepropagates link failure notification to upstream hops if it detects link failure and in such cases, the source reinitiates route discovery procedure. Such protocols evolve less traffic overhead as routes are determined on demand basis and hence, may have larger battery life. But, there is a considerable initial delay caused due to route discovery procedure.Ad-hoc on-demand distance vector routing protocol(AODV) and dynamic source routing protocol(DSR)are the main on-demand routing protocols that are discussed here.

A. Destination Sequenced Distance Vector (DSDV) Protocol

DSDV protocol is a progress made to Bellman Ford algorithm[8][9]. It handles infinite loop problem with the use of sequence number. The sequence number is generated and associated with the destination router and used to discriminate the newer routes in routing table. Usually, the owner node has authority to increment the sequence number to an even value after each broadcast, but whenever, a node detects link failure it can also increment sequence number to next odd value. The route selection is made on the basis of newest or largest sequence number, but shortest path metric is also considered if multiple route entries have same sequence number.

1) Benefits: Ithas the following benefits-

- Availability of routing information.
- Lower initial delay as it does not initiate route discovery procedure.
- It handles link failure within less time as routes are always available.
- It can follow full dump updates in case of high mobility and incremental approach if network is stable[3] thereby, avoiding extra traffic.

2) Limitations: It imbibes some disadvantages too:

- Large consumption of battery power and network resources[16].
- Inappropriate in large or highly dynamic network.
- Wastage of bandwidth as there isa large numberof routing exchanges.
- Maintenance of large routing table occupies more storage area.
- Greater queuing delay in large network.
- Do not support multicasting[11].

B. Ad-hoc on Demand Distance Vector (AODV) Protocol

AODV is classified as pure on-demand route acquisitionsystem[8], as nodes that are not on a selected path neither maintain routing information nor participate in routing table exchanges. Here, each node maintains sequence number and broadcast id. Broadcast id is generated by the source and incremented for every other broadcast. The source that has no valid route, initiates the route discovery with the propagation of route request packet(RREQ) which comprises source address, source sequence number, broadcast id, destination address, destination sequence number and hop count[6]. The intermediate nodes reply to the source node only if they assist a route to destination with equal or greater sequence number than that RREQ packet and also ignore the duplicate RREQs.

Here, both reverse and forward paths are determined before transmitting the original content. While RREQ propagates in network, the destination or intermediate nodes record the address of the previous node from which they receive the first RREQ packet. These nodes propagate route reply (RREP) to source along the same recorded address sequence in reverse direction. The routing information is maintained only till the reverse path is not determined. Likewise, forward path is learned with the help of RREP propagation in the network. Once a route is established, it is maintained through the route maintenance procedure.

1) Benefits: It has the following benefits-

- The lesser number of routing exchanges as it is an on-demand protocol.
- Less consumption of battery resource, network bandwidth and other network resources.
- It supports multicasting[11].
- It records only the address of its neighbor node and thus, incurs less routing overhead.
- Preferable in VANET[10].
- Appropriate for large or highly dynamic networks.
- Can support multimedia content- text, audio, images but not video.

2) Limitations: It imbibes some disadvantages too:

- Higher initial delay due to route discovery procedure.
- A considerable time is consumed in handling broken links whenever route discovery procedure is reinitiated.
- Longer delay in smaller network.
- Large communication complexity as it uses bidirectional link for propagation of both RREQ and RREP messages.

C. Dynamic Source Routing (DSR) Protocol

DSR is a source routing protocol where, the sourceknows the entire route to the destination before initiating transmission. Here, each node maintains a route cache where it records learned hop sequence to all possible destinations.Like AODV, the source initiates route discovery by broadcasting RREQ if no valid route is found in its route cache.

The intermediate nodes append their own address in RREQ's header when no route record is available in their route cache and then forward the RREQ in the network. The intermediate nodes ignore duplicate RREQs. The RREQ message propagates through the network until it reaches either the destination node or an intermediate node that has a valid route to the destination in its route cache. The destination or intermediate node, reply to source by propagating route reply (RREP) message along the recorded hop sequence in RREQ's

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header, but in reverse order. The intermediate node that has a direct route to the destination, appends that route to the route record of RREQ and then reply back to source. RREP carries the entire hop sequence and source learns the route as soon as it receives the RREP.

1) *Benefits: It has the following benefits-*
   - The lesser number of routing exchanges as it is an on-demand protocol.
   - Less consumption of battery resource, network bandwidth and other network resources.
   - Each node learns the entire route from source to itself.
   - Less routing load, if routes are available in route cache.
   - Beneficial in low mobility.
   - It has lower routing overload than AODV through the maintenance of route cache.

2) *Limitations: It imbibes some disadvantages too:*
   - Higher initial delay due to route discovery procedure.
   - A considerable time is consumed in handling broken links as route discovery procedure is reinitiated.
   - Large communication complexity as it uses bidirectional link for propagation of both RREQ and RREP messages.
   - Routing overhead carried by the RREQ's in the form of entire route record in its header.
   - It is not suitable for multimedia content.
   - Not preferred in VANET[10].
   - It does not support multicasting[11].

III. SIMULATION METHODOLOGY

The simulation is done using NS2.34 in UBUNTU. NS2 is a discrete event simulator. It uses two languages-
- C++ in its backend
- Tool command language (TCL) as front-end[12],[13].

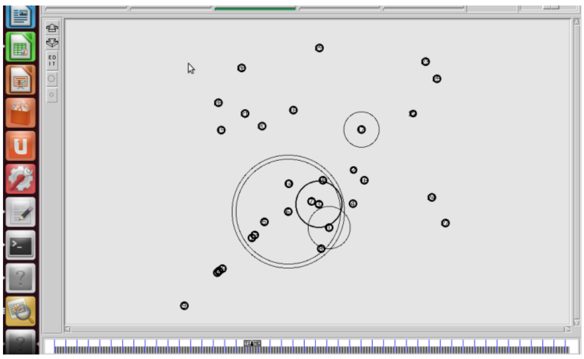

Fig. 1 Network animator file for AODV using 50 nodes in NS2.34

A. Performance Metrics

The four main performance metrics that are observed to study the comparative performance of these three protocols includes- packet delivery ratio, average end-to-end delay, throughput and packet loss percentage.

1) *Packet delivery ratio:* It is the ratio of the total number of packets received by the UDP agent at destination node to the total number of packets sent by the UDP agent at source node. It can be expressed as:

$$\text{Packet delivery ratio} = \frac{\text{Total no. of packets received at the destination}}{\text{Total no. of packets sent by the source}}$$

2) *Average end-to-end delay:* Delay is the total time taken by the packets to reach from the source to destination. It can be expressed as:

$$\text{Average end to end delay} = \frac{[\text{Total time duration evolved by the packets to reach destination}]}{\text{Total number of packets transmitted}}$$

Delay is basically the total of time taken by CPU processor, queuing delay of packets, transmission time and propagation delay.

Processing delay(dp) is the time taken by CPU to determine where to direct the received packet. Queuing delay(dq) is actually the waiting time of the packet in a queue till it is transmitted. Queuing delay of Nth packet in queue is same as transmission delay of (N-1) packets where; transmission delay(dt) is the time consumed to pop out all bits of packets from queue onto the link. Propagation delay(dg) is the total time consumed by the packet to travel from downstream to upstream routers[14]. Khaja Anvar Ali Siddiqui et. al[14] has discussed the mathematical modelling of delay by the given expressions:

$$D_e = n * D_n$$
$$D_e = n(dp + dq + dt + dg)$$
$$f(d) = n(dp + p(N+1)/2r + D/c)$$

where;
D_e= end-to-end delay
n = number of intermediate routers
D_n= Total nodal delay
p= packet size
r = data rate
N = maximum available bandwidth,
D = total geometric distance of the route
c = link speed.

3) *Packet loss percentage:* It is the percentage of the number of lost packets during transmission of the total number of send packets. Packet loss usually occurs if the buffer capacity is full at intermediate nodes. It is expressed as:

$$\text{Packet loss percentage} = \left[\frac{\text{Total number of lost packets}}{\text{Total number of send packets}}\right]*100$$

4) *Throughput:* It is measured as the total number of bits transmitted per unit time.

V RESULTS AND DISCUSSION

The simulation results show the performance of these protocols in terms of packet delivery ratio, average end to end delay, throughput and packet loss percentage with respect to varying number of nodes and varying network area.

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TABLE I SIMULATION PARAMETERS

Network simulation model Parameters	Value of parameters
Network type	Mobile
Radio propagation model	Two ray ground propagation
Antenna	Omni directional
Mobility pattern	Random
Queue length	50
Number of nodes/number of connections	10, 20, 30, 40, 50
Traffic Type (Application/Agent)	CBR/UDP
Simulation time	100 simulation runs
Simulation area	800 X 800
Data rate	20mb
Packet size	512
Maximum number of packets	1000000

The below figures show the performance behavior of DSDV, AODV and DSR through simulation in NS2.34.

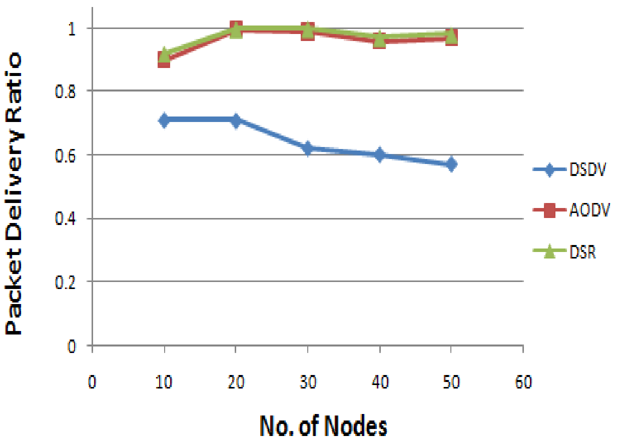

Fig. 2(a)Packet delivery ratio with varying no. of nodes

Figure 2(a) shows that DSDV has lower packet delivery ratio in comparison to the other two on-demand protocols. Here, the queue gets full if there are large number of exchanges in the network and thus, the number of lost packets increases.While, DSR slightly outperforms AODV as routes can be made available in route cache.

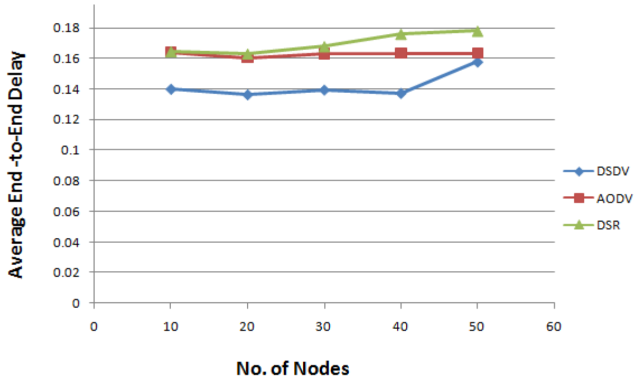

Fig. 2(b) Average end-to-end delay with varying number of nodes

Figure 2(b) shows that DSDV outperforms DSR and AODV in terms of average delay. DSR shows lower delaythan AODV in small network as it can get the valid route from route cache. However, with the increase of network size, DSR degrades its performance. Hence, AODV performs better in large network.

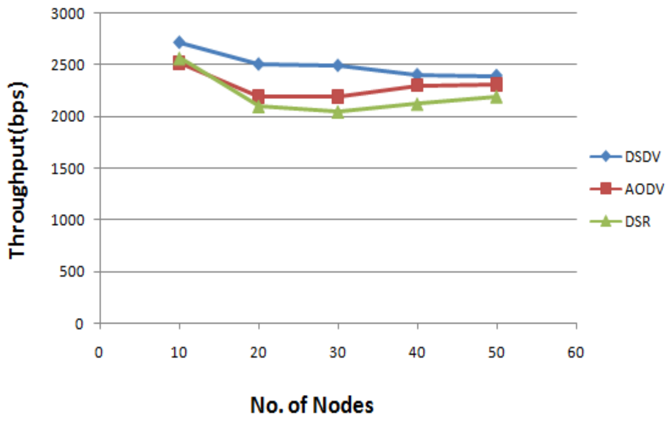

Fig. 2(c) Throughput with varying number of nodes

Figure 2(c) represents that DSDV shows the better performance in smaller network. However, AODV outperforms in large network.

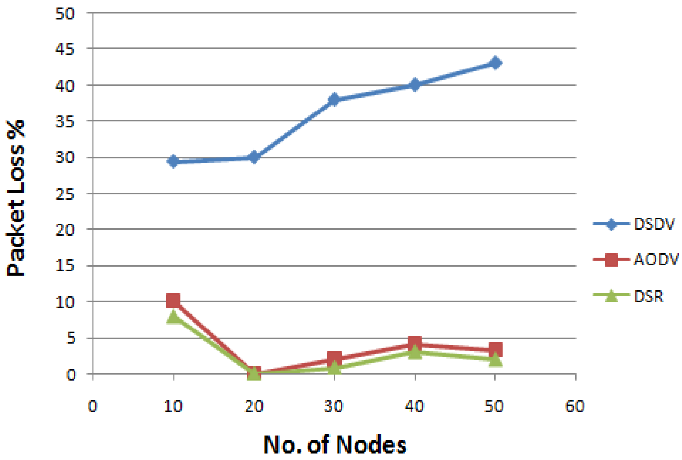

Fig. 2(d) Packet loss percentage with varying number of nodes

Packet loss percentage is inversely related to packet delivery ratio. Figure 2(d) represents thatDSR has lower packet loss percentage than AODV, as routes can be made available from route cache.

However, there are some other network factors- distance between source and destination, packet size, maximum number of packets, data rate, traffic, channel, network size, mobility, number of nodes that influence the network behavior to a significant value. The following results show the comparative study of DSDV, AODV and DSR protocols with respect to varying simulation area. Here, number of nodes are fixed to 30 nodes.

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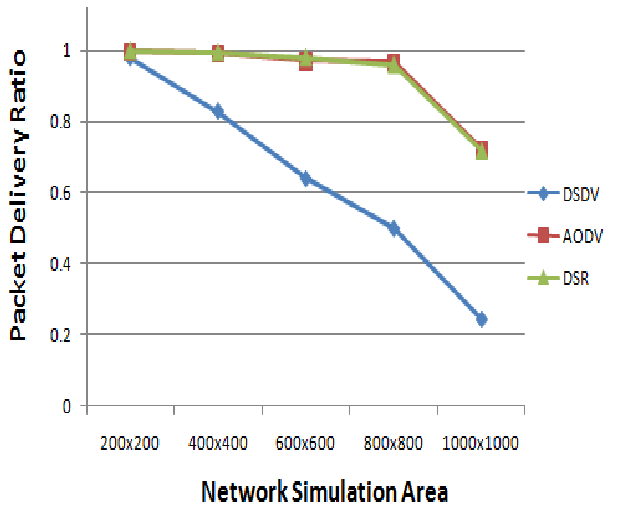

Figure 3.3 (a) Packet delivery ratio with varying network simulation area

Figure3.3(a) shows that the increase in distance between source and destination or between intermediate nodes along the routing path lowers the value of packet delivery ratio.

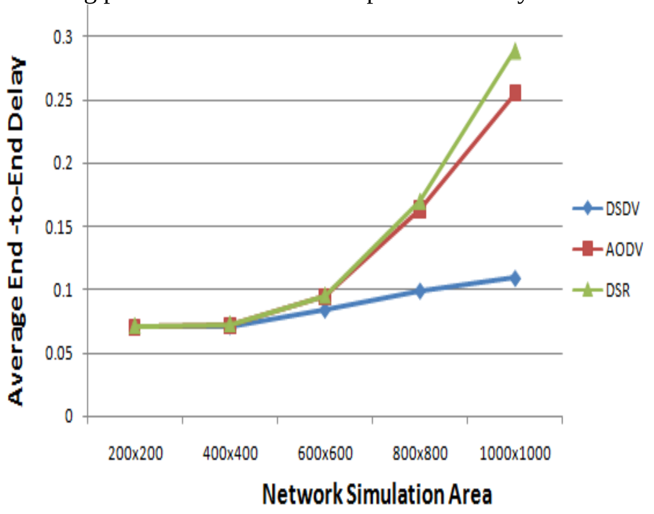

Figure 3.3 (b) Average end-to-end delay with varying network simulation area

The figure 3.3(b) shows that the average delay increases with increase in network area. Here, DSDV shows better performance as it incurs the lowest initial delay and hence preferable in smaller network.

The figure 3.3(c) shows that the performance of protocols decreases with increase in network area. However, AODV shows average performance while DSDV outperforms DSR.

Packet loss percentage is inversely related to packet delivery ratio

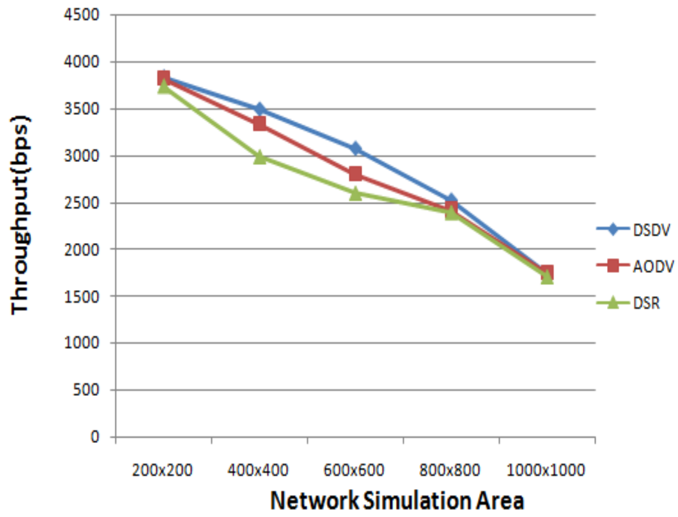

Figure 3.3 (c) Throughput with varying network simulation area

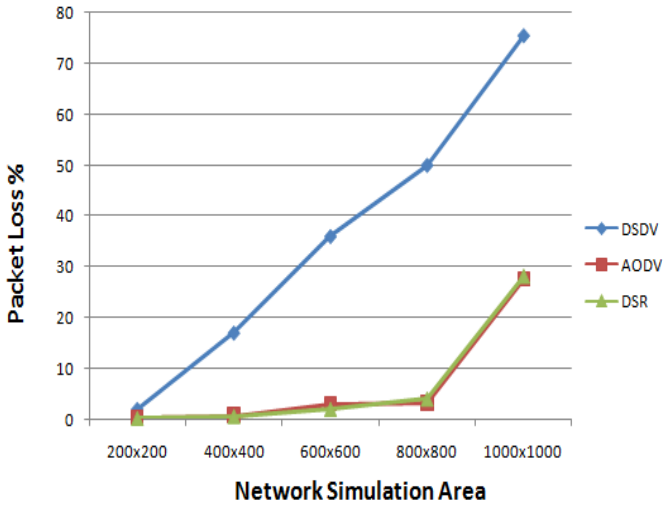

Figure 3.3 (d) Packet loss percentage with varying network simulation area

IV. CONCLUSION

In this paper, the analysis of simulation results shows the comparative performance of these protocols under the specified scenario. It is observed that none of the three protocols perform well in all scenarios. Also, it can beconcluded that DSDV is suitable only in small low dynamic network whereas; AODV and DSR are preferable in large network. But, in case of high mobility, AODV is usually preferred.Also, the protocols degrade their performance with respect to increasing simulation area. Further, we can also consider some more important performance metrics for analysis such as; routing load,wheather conditions or mobility.

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