Comparison Study of Adhoc Networks Routing Protocols Using NS2

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Abstract— **Adhoc networks are the next step in the evolution of wireless architecture, delivering wireless services for a large variety of applications; they are very useful in emergency search-and-rescue operations, in the applications where the persons wish to quickly share information, and data acquisition operations in inhospitable terrain. Ad hoc wireless networks are increasingly gaining importance due to their advantages such as low cost and ease of deployment . In recent years, a variety of new routing protocols targeted specifically at this environment have been developed like Destination-Sequenced Distance-Vector (DSDV), Dynamic Source Routing (DSR), Ad Hoc On-Demand Distance Vector Routing (AODV). In this report, I will present a comparison study of the performance of these routing algorithms in ad hoc networks under the IEEE 802.11s specifications**

I. INTRODUCTION

Ad hoc network consists of nodes which are mobile and can be connected in an arbitrary manner. All nodes of these networks behave as routers. The term routing refers to the process of selecting paths in a computer network along which to send data. This process can be defined as a routing protocol, used to exchange information about topology and link weights, computes paths between nodes and all of that can be done using a routing algorithm.

Mobile ad-hoc networks (MANETs) are self-organized networks. Communication in an ad-hoc network does not require existence of a central base station or a fixed network topology. Each node of an ad-hoc network can be both a host and a router. As well as destination of some information packets while at the same time it can act as relay station for other packets to get their final destination. This makes communication between nodes outside direct radio range of each other possible, is probably the most distinct difference between mobile ad-hoc networks and wireless LANs [1].
Traditional routing protocols cannot perform in such environment resulting in development such routing protocols for ad hoc networks, i.e. AODV, DSR and DSDV.

The rest of the report is organized as follows; in the following section, I will briefly review AODV, DSDV and DSR protocols. In next section; I will present detailed observation on simulation environment. Finally, presents Simulation results, analysis followed by conclusions.

II. DESCRIPTION OF THE AD-HOC ROUTING PROTOCOLS

2.1. Ad hoc On Demand Distance Vector (AODV)

AODV routing protocol designed for ad hoc mobile networks and it is suitable for both unicast and multicast routing [1]. The meaning of demand that it builds routes between nodes only as preferred by source nodes. It maintains these routes as long as they are needed by the sources. Moreover, AODV forms trees which connect multicast group members. The trees are composed of the group members and the nodes needed to connect the members. AODV uses sequence numbers to ensure the freshness of routes. It is loop-free, self-starting, and scales to large numbers of mobile nodes [2].
AODV builds routes using a route request / route reply query cycle. The source node broadcasts a route request (RREQ) packet across the network when its needs a route to a certain destination which it doesn't have rout information about it. The other nodes receiving this packet update their information for the source node and set up backwards pointers to the source node in the route tables and the source node's IP address, current sequence number, and broadcast ID, the RREQ also contains the most recent sequence number for the destination of which the source node is aware. A node receiving the RREQ may send a route reply (RREP) if it is either the destination or if it has a route to the destination with corresponding sequence number greater than or equal to that contained in the RREQ. If this is the case, it unicasts a RREP back to the source [3]. Otherwise, it rebroadcasts the RREQ. Nodes keep track of the RREQ's source IP address and broadcast ID. If they receive a RREQ which they have already processed, they discard the RREQ and do not forward it. As the RREP propagates back to the source, nodes set up forward pointers to the destination. Once the source node receives the RREP, it may begin to forward data packets to the destination. If the source later receives a RREP containing a greater sequence number or contains the same sequence number with a smaller hop count, it may update its routing information for that destination and begin using the better route.
Nodes monitor the link status of next hops in active routes, when a link break in an active route is detected; a RERR message is used to notify other nodes that the loss of that link has occurred. The RERR message indicates which destinations are now unreachable due to the loss of the link.

2.2. Destination Sequenced Distance Vector (DSDV)

DSDV is a Table driven routing protocol and uses sequence numbers to mark each node to improve upon the loop problem. Routing information is distributed between nodes via sending "full dumps" and incremental updates. "Settling time" [4] metric is used to determine update interval. Each node

maintains a routing table consisting of entries with each for a destination. Each entry contains a metric to that destination and the recently sequence number broadcast from that destination. Upon receiving an update from a neighbor, a node updates an entry in its own routing table if, for that entry, the update contains a higher sequence number or the update contains a same sequence number but a shorter metric than that has been seen before.
To update an entry, a node sets the metric in its table entry for that destination to one hop more than the metric in that neighbor's update. When a node sends an update message, it puts a sequence number in the entry for itself in that update and sets the metric value to zero; for each of other entries, it duplicates all the entries maintained in its own routing table.
Clearly, the sequence numbers and metric values containing in each update play a vital role in DSDV operation. A malicious node can easily disrupt the routing protocol by arbitrarily tempering the sequence numbers or the metrics [4] [5].

2.3. Dynamic Source Routing (DSR)

The key distinguishing feature of DSR is the use of source routing. That is, the sender knows the complete hop-by-hop route to the destination. These routes are stored in a route cache. The data packets carry the source route in the packet header. When a node in the ad hoc network attempts to send a data packet to a destination for which it does not already know the route, it uses a route discovery process to dynamically determine such a route. Route discovery works by flooding the network with route request (RREQ) packets. Each node receiving an RREQ rebroadcasts it, unless it is the destination or it has a route to the destination in its route cache. Such a node replies to the RREQ with a route reply (RREP) packet that is routed back to the original source. RREQ and RREP packets are also source routed. The RREQ builds up the path traversed across the network. The RREP routes itself back to the source by traversing this path backward. The route carried back by the RREP packet is cached at the source for future use. If any link on a source route is broken, the source node is notified using a route error (RERR) packet. The source removes any route using this link from its cache. A new route discovery process must be initiated by the source if this route is still needed. DSR makes very aggressive use of source routing and route caching. No special mechanism to detect routing loops is needed. Also, any forwarding node caches the source route in a packet it forwards for possible future use.

III. SIMULATION PARAMETERS

3.1. Performance Metrics

The comparison between the three routing protocols in this projects concentrate on 3 performance metrics which are:

Throughput: is the ratio of total amounts of data that reaches the receiver from the source to the time taken by the receiver to receive the last packet. It is represented in packets per second or bits per second. In the Ad Hoc Networks unreliable communication, limited energy, limited bandwidth and frequent topology change affect throughput [4][6].
Average end-to-end delay of data packets: the average time that a packet takes to traverse the network. This is the time from the generation of the packet in the sender up to its reception at the destination's application layer and it is measured in seconds. It therefore includes all the delays in the network such as buffer queues, transmission time and delays induced by routing activities and MAC control exchanges. Various applications require different levels of packet delay. Delay sensitive applications such as voice require a low average delay in the network whereas other applications such as FTP may be tolerant to delays up to a certain level. Ad hoc Networks are characterized by node mobility, packet retransmissions due to weak signal strengths between nodes cause the delay in the network to increase. The End-to-End delay is therefore a measure of how well a routing protocol adapts to the various constraints in the network and represents the reliability of the routing protocol [7] [8].

Average Routing Overhead: is the total number of routing packets divided by total number of delivered data packets. This metric provides an indication of the extra bandwidth consumed by overhead to deliver data traffic. It is crucial as the size of routing packets may vary. The routing overhead describes how many routing packets for route discovery and route maintenance need to be sent in order to propagate the CBR packets. It is an important measure for the scalability of a protocol. It for instance determines, if a protocol will function in congested or low-bandwidth situations or how much node battery power it consumes [6].

3.2. The Simulation Assumptions

The simulations in this report made using the Network Simulator (NS-2) which provides the implementation of the DSR, AODV, and DSDV. I run the simulation in accept as in the later on described scenario. The detailed trace file created by each run is stored to disk, and analyzed using a variety of scripts "*.tr"* files for example the file that counts the number of packets successfully delivered and the length of the paths taken by the packets, as well as additional information about the internal functioning of each scripts executed. In each time I collected these data from the trace file and made the simulations many times (five times exactly). I stored the results in a MATLAB file (a matrix) and I took the average of the results and plot these results using MATLAB.
The following assumptions are considered when building the Tcl script:

- *Traffic models*

Random traffic connections of TCP and CBR can be setup between mobile nodes using a traffic-scenario generator script. This traffic generator script is available under ~ns/indep-utils/cmu-scen-gen and is called cbrgen.tcl. It can be used to create CBR and TCP traffics connections between wireless mobile nodes. For the simulations carried out, traffic models were generated for 40 nodes with cbr traffic sources.

- *Mobility models*

The node-movement generator is available under ~ns/indep-utils/cmu-scen-gen/setdest directory. Mobility models were created for the simulations, with simulation times of 0,50,100,150,200 seconds, maximum speed of 20m/s, topology boundary of 1500x300 and simulation pause time of 60secs.

All flows in the system are assumed to have the same type of traffic source. All the senders have traffic with the rate of data rate/number of stations packet per second; in summary; Table 1 shows the simulation parameters used in the simulations.

Table 1 : Simulation Parameters

Parameter	***Value***
Simulation time	0,50,100,150, 200 s
Routing Protocol	DSR, AODV & DSDV
Pause Time	60 s
Mac Type	802.11
Number of Nodes	10,25,40,75, 100
Environment Size	1500 X 300
Speed	20 m/s
Traffic Type	CBR,TCP
Packet Size	512 Bytes

IV. RESULTS AND PERFORMANCE

Performance of AODV, DSR and DSDV protocols is evaluated under both CBR and TCP traffic pattern. Simulation is done by using NS-2. Varying the simulation time and Number of Sources to see the performance difference between these protocols for each performance metric parameter.

4.1. Throughput:

The unit of throughput is Mbps, however we have taken Kilo bits per second (Kbps). Varying the number of nodes and obtaining the throughput values for each number of nodes in the CBR traffic shown in Figure 1.

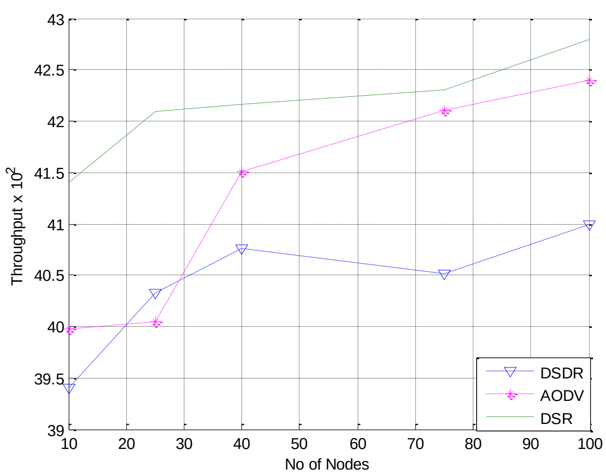

Figure 1: Number of Nodes vs. Throughput for CBR traffic

Now, the simulations repeated for 40 nodes and with various simulations time shown in Table 1. The packets were sent at a rate of 10 packets/sec. Figure 2 describes the results.

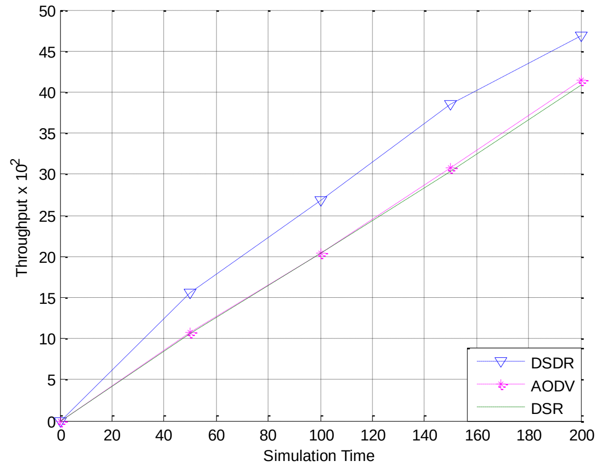

Figure 2: Simulation Time vs. Throughput for CBR traffic

In case of TCP traffic, throughput increases in slow amount for all three protocols independent of number of nodes as shown in Figure 3. While throughput changes rapidly when varying the simulation time as cleared in Figure 4.

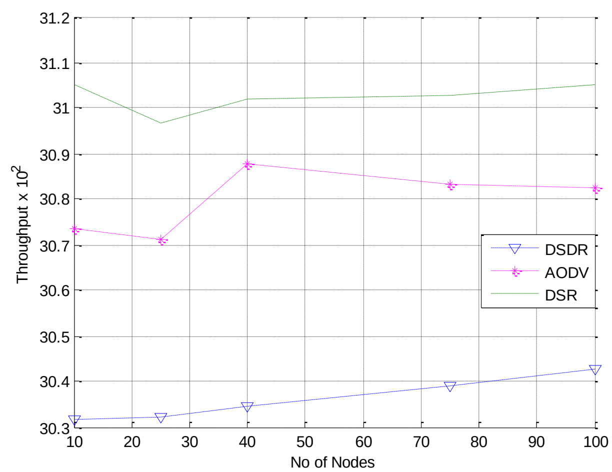

Figure 3: Number of Nodes vs. Throughput for TCP traffic

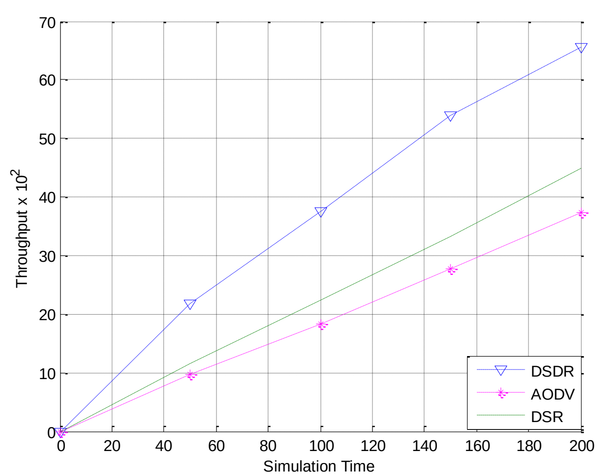

Figure 4: Simulation Time vs. Throughput for TCP traffic

4.2. Average End to End Delay Result

When the buffers become full quickly in CBR traffic, so the packets have to stay in the buffers longer period of time before they are sent. For average end-to-end delay, the performance of DSR decreases and varies with the number of nodes. However, the performance of DSDV is degrading due to increase in the number of nodes the load of exchange of routing tables becomes high and the frequency of exchange also increases due to the mobility of nodes. The performance of AODV increases and remains constant as the number of nodes increases as in Figure 5.

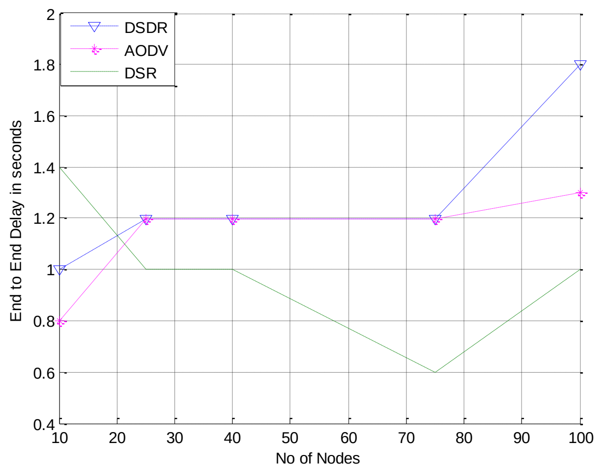

Figure 5: Average End-to-End Delay for Vs No. of Nodes in CBR Traffic

In TCP as in Figure 6. Average end-to-end Delay is also remains almost constant in DSDV while it varies in the case of AODV and DSR protocols with respect to change in simulation time.

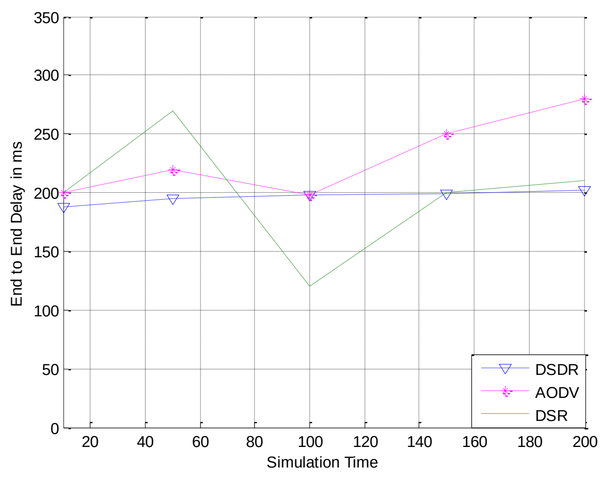

Figure 6: Average End-to-End Delay for Vs Simulation Time in CBR Traffic

In case of TCP Figures7show the average End-to-End delay for the DSDV, AODV and DSR protocols for various numbers of nodes.

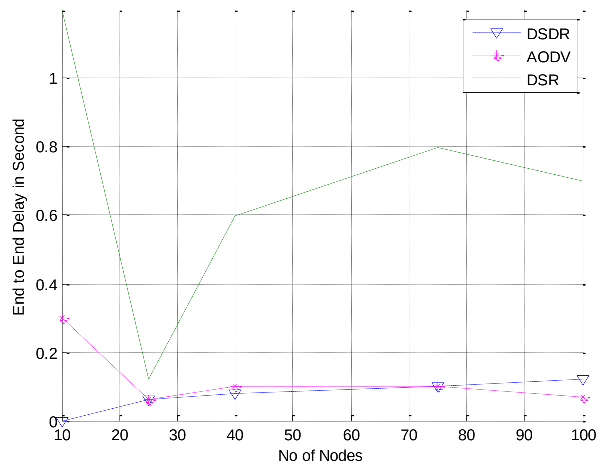

Figure 7: Average End-to-End Delay for Vs. No. of Nodes in TCP Traffic

It is clear that in Figure 8 that DSDV has the shortest End-to-End delay than AODV and DSR since DSDV is a proactive protocol and all routing information are already stored in table. Hence, it consumes lesser time.

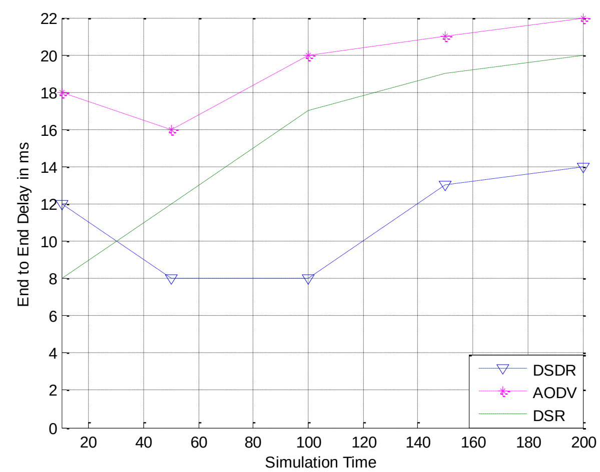

Figure 8: Average End-to-End Delay for Vs Simulation Time in TCP Traffic

4.3. Average Routing Overhead Results

Figure 9 illustrate the performance for average routing overhead required by all three protocols when subjected to various numbers of nodes. This metric gives an idea of the extra bandwidth that is required to deliver the data packets.

It can be seen that DSR exhibits the highest average routing overhead because of its route cache property. It generates the highest no. of routing packets but its loss of packets is also more. Moreover, AODV routing overhead gradually increases in case change in no. of nodes.

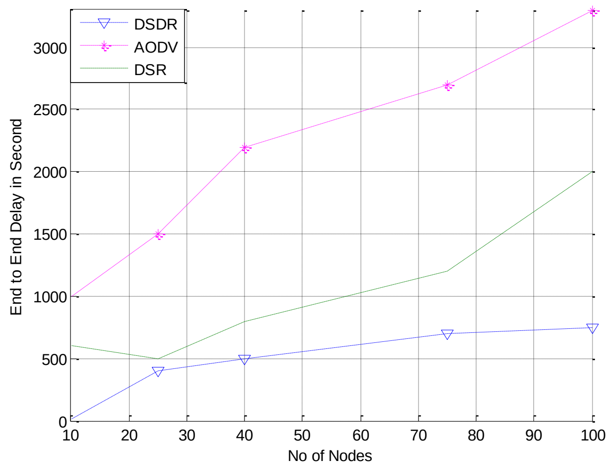

Figure 9: Average Routing Overhead Vs No of Nodes

However, AODV starts decreasing as simulation time is increased as in Figure 10. DSDV is independent of change in simulation time and no. of nodes. Routing overhead is lowest and constant in both test cases because of its table-driven nature. However, it gradually increases a bit for change in no. of nodes.

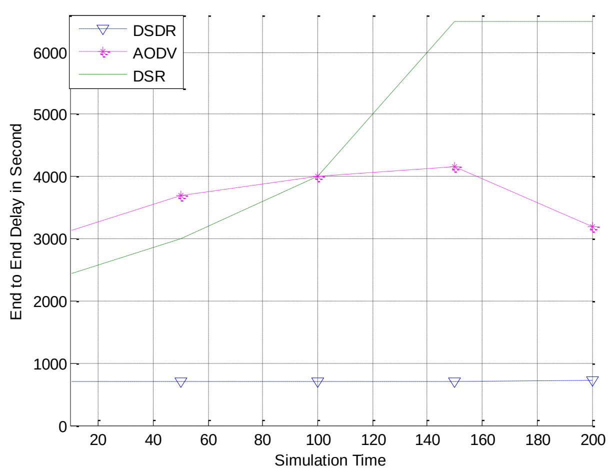

Figure 10: Average Routing Overhead Vs Simulation Time

V. Conclusions

This project compared the performance of DSDV, AODV and DSR routing protocols for ad hoc networks using ns-2 simulations based on both CBR and TCP traffic. These routing protocols were compared in terms of Throughput, Average end-to end delay and Average Routing Overhead when subjected to change in no. of nodes and the simulation time. Simulation results show:

- DSR shows higher throughput than the DSDV and AODV since its routing overhead is less than others. The rate of packet received for AODV is better than the DSDV.
- End-to-end delay in AODV is not affected by change in simulation time. It is affected when no. of nodes is changed; however, it gets stable as the no. of nodes is increased. Its performance is similarity to DSDV.
- DSDV performs better than DSR and AODV as far as average end-to-end delay is concerned. End-to-end delay in DSDV is independent of any change in simulation time or no. of nodes. It is lowest and most stable in both test cases.
- In terms of average routing overhead DSDV performs better than AODV and DSR. AODV follows DSDV closely for average routing overhead.
- AODV performance is the best considering its ability to maintain connection by periodic exchange of information, which is required for TCP, based traffic.
- It is also true that any of the three protocols is the best. Their performance depends upon the different scenarios.

VI. References

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