An Analysis of DSR, DSDV, AODV and Adv.-AODV Routing Protocols in MANET

Sandeep Kumar Gautam
Computer Science & Engineering Department
United college of engineering & research, GBTU
Allahabad, India
gautambsp09@gmail.com

Associate Prof. Shashank dwivedi
Computer Science & Engineering Department
United college of engineering & research, GBTU
Allahabad, India
shashankdwivedi@united.ac.in

Abstract – A mobile Ad-Hoc network is a collection of autonomous wireless nodes without any fixed infrastructure and centralized administration. Mobile ad hoc network (MANET) is an autonomous system of mobile nodes connected by wireless links. Each node operates not only as an end system, but also as a router to forward packets. The nodes are free to move about and organize themselves into a network. These nodes change position frequently. The main classes of routing protocols are Proactive, Reactive and Hybrid. A Reactive (on-demand) routing strategy is a popular routing category for wireless ad hoc routing The design follows the idea that each node tries to reduce routing overhead by sending routing packets whenever a communication is requested. In this paper, we evaluate the performance of reactive routing protocols, Ad hoc On demand Distance Vector (AODV) and Dynamic Source Routing (DSR) and proactive routing protocol Destination Sequenced Distance Vector (DSDV).The major goal of this study is to analyze the performance of well known MANETs routing protocol in high mobility case under low, medium and high density scenario. Unlike military applications, most of the other applications of MANETs require moderate to high mobility. In this paper, we evaluate the performance of reactive routing protocols, Advanced- Ad hoc On demand Distance Vector (Adv.-AODV), Ad hoc On demand Distance Vector (AODV) and Dynamic Source Routing (DSR) and proactive routing protocol Destination Sequenced Distance Vector (DSDV)[7][9].The major goal of this study is to analyze the performance of well known MANETs routing protocol in high mobility case under low, medium and high density scenario. Unlike military applications, most of the other applications of MANETs require moderate to high mobility. In this paper we analyzed the Adv.-AODV, AODV, DSDV and DSR protocols based on the performance metrics such as packet delivery ratio, average end to end delay and throughput in different test environments.

Keywords- *Ad Hoc Network, Routing Protocol, Adv.- AODV, AODV, DSDV, DSR etc.*

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I. INTRODUCTION

A mobile ad hoc network is a type of ad hoc network having digital data terminals. These data terminals equipped with wireless transceivers that helps to communicate with one another in various networks, Such as a Wi-Fi or cellular or using Satellites. The communication is done by the transmission of data packets over a several common wireless Channel. If there is any type of absence of any fixed infrastructure, such as an array of base stations, that makes an ad hoc networks different from other wireless LANs.

The communication medium changes due to the absence of any fixed infrastructure, such as an array of base stations that makes ad hoc networks different from other wireless LANs. The Mobile communication in an infrastructure network, such as a cellular network, is regularly maintained with a fixed base station, a mobile terminal (node) in an ad hoc network can send data packets directly to another node if they are located within its radio transmission range.

If a node wants to communicate with another node that is located outside its radio range then data packets are relayed over a sequence of intermediate nodes using a store-and-forward (multi hop transmission principle). If any node wants to transmit packets in an ad hoc network to another node then the packets are relayed on behalf of other nodes. Thus, a mobile ad hoc network is sometimes also called a multi hop wireless network. The Structural design of an ad hoc network is complex, because of presence of forwarding traffic in all nodes of an ad hoc network, including the source nodes and corresponding destinations, as well as the routing nodes forwarding traffic between them, such as mobile. If the wireless transmission range is limited, then the wireless link between a pair of neighboring nodes halts when they move out of range.

The second reason is due to the absence of centralized control, the design of an ad hoc network is complicated. The networking functions in the network topology and multiple accesses, such as selecting paths in the network topology and transmitting of data packets over the most appropriate multi hop paths that must be performed in a distributed way. The routing of packets is difficult due to the presence of fixed communication bandwidth in the wireless channel. These limitations are resolved by using different layers. To maintain stable communication links between peers, the physical layer must undertake the path loss, fading and multi-user interference. When unsynchronized users want to transmit packets on a shared channel, then the data link layer (DLL) should make the physical link reliable. After that the medium access control (MAC) sub layer is performed in the DLL. The tracks changed in the network topology by the network layer should be the best route to any desired destination. In the dynamic wireless network, the transport layer must match the delay and packet loss. Even the application layer needs to handle frequent disconnections.

II. ROUTING PROTOCOLS FOR MANET

Routing protocols in ad hoc depends and vary on the type of the networks. Based on the routing information updated mechanisms, ad hoc network routing protocols are classified into three major categories. First one is Proactive (table driven routing Protocols), Reactive (on-demand routing protocols) and the last one is hybrid routing protocols. They can also be categorized according to the need of specific resources, such as power aware routing protocol, load aware routing protocols and so on.

A. Pro-active Routing (Table-driven)

Table driven ad hoc routing protocols maintain at all times routing information regarding the connectivity of every node to all other nodes that participate in the network. . Also known as proactive, these protocols allow every node to have a clear and consistent view of the network topology by propagating periodic updates. Therefore, all nodes are able to make immediate decisions regarding the forwarding of a specific packet.

A.1 Destination Sequenced Distance Vector (DSDV)[2]

DSDV algorithm used to send data packets using routing table, such as a Distance vector. Each routing table has sequence number which is generated by destination. In this algorithm updates are transmitted periodically in dynamically varying topology to maintain consistency among the routing table. Every mobile station, send its own routing table to its next current neighbors. Routing information is send to its current neighbor by broadcasting or multicasting. The transmissions of packets are periodically and incrementally as changes are detected. If a node invalidates its entry to a destination node due to loss of next hop node, then it increments its sequence number by (X+1) and uses new sequence number (X+1) in its next advertisement of the route. Every mobile computer broadcast its data which contains new sequence number, Destination IP address, Number of hops required between Source and destination and Sequence number of the destination including information received. The two methods used for reducing the information carried in each broadcast message are:-

i. Full dump: The dump carries all the available routing information.

ii. Incremental carry: The message carries only changed information since the last full dump.

Sometimes a mobile host receives a worse metric table than the upcoming sequence number updated. In that case, the destination may change at every new sequence number updated. The best solution of this problem, if mobile host can determine that a route with a better metric is likely to shown updated, is to delay the information of advertisement. In this case two routing tables are maintained, one is for the forwarding of packets and the other for incrementing of routing information packets. DSDV challenges a loop free path to every destination without requiring any nodes that participate in any complex update coordination protocol. The routing tables in this protocol of each node can be visualized as forming N trees and one rooted at each destination. The Main advantage of this protocol is to create ad hoc networks with a small number of nodes.

The disadvantages of DSDV protocol is regular updating of its routing tables, which slow down the battery power and some amount of bandwidth, when the network is idle.

If the topology of the network changes then a new sequence number is generated which is necessary before the network re-converges. Thus, DSDV is not suitable for highly dynamic networks.

B. Reactive Routing (On-demand) [8]

Reactive routing protocols, it is more suitable for ad hoc networks and no need to maintain up-to-date information about the network topology, as is done by the proactive ones, but they create routes on demand. The most popular reactive routing protocols are the Ad hoc On Demand Distance Vector Routing (AODV) and the Dynamic Source Routing (DSR). This type of protocols finds a route on demand by flooding the network with Route Request packets.

B.1 Dynamic Source Routing (DSR) [1][3]

In DSR, when a mobile (source) wants to communicate with another mobile (destination), firstly it makes routing table which is based on flooding. The source node generates a RREQ packet that is transmitted over the network. The RREQ packet contains a list of hops which is collected by the route request packet as it is propagated through the network. Once the RREQ reaches either the destination or a node that knows a route to the destination, it responds with a RREP along the reverse of the route collected by the RREQ [6]. In this way the source may receive several RREP messages from corresponding nodes, so there will be to different routes to the destination. DSR selects one of these routes which are shortest and it maintains the other routes in a cache. The routes in the cache can be used as substitutes to speed up the route discovery if the selected route gets disconnected. To avoid that RREQ packets travel forever in the network, nodes, that have already processed a RREQ,

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discard any further RREQ bearing the same identifier. The main difference between DSR and AODV is in the way they keep the information about the routes: in DSR it is stored in the source while in AODV it is stored in the intermediate nodes. However, the route discovery phase of both is based on flooding.

This means that all nodes in the network must participate in every discovery process, regardless of their potential in actually contributing to set up the route or not, thus increasing the network load.

B.2 Ad hoc On Demand Distance Vector (AODV)

AODV [4][5] protocol allows mobile nodes to quickly obtain routes for new destinations, and it does not require nodes to maintain routes to destinations that are not in active communication. Also, AODV routing permits mobile nodes to respond link breakages and changes in network topology in a timely manner. The main objectives of the protocol is quickly and dynamically adapt to changes of conditions on the network links, for example, due to mobility of nodes the AODV protocol works as a pure on-demand route acquisition system. 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 Hello packets.

For the maintenance of the routes, two methods can be used:

a) ACK messages in MAC level or
b) HELLO messages in network layer.

The main advantage of this protocol is that routes are established on demand and destination sequence numbers are used to find the latest route to the destination. The connection setup delay is lower. The disadvantage of this protocol is that intermediate nodes can lead to inconsistent routes if the source sequence number is very old and the entries. Also multiple RREP packets in response to a single RREQ packet can lead to heavy control overhead. Another disadvantage of AODV is that the periodic beaconing leads to unnecessary bandwidth consumption.

B.3 Advanced Ad hoc On Demand Distance Vector (Adv.-AODV) [6]

The Advanced Ad hoc On Demand Distance Vector is better performed from the AODV routing protocols during transmission with the help of some simple topology. In advanced AODV, there are four nodes in this network and the initial topology is a grid, the method shown in Table-1. In beginning during the transmission of nodes, the two pairs of nodes are not interference with each other. At 10s, Node 2 moves towards the direction of Node 0 with a speed of 10 m/s. The distance between Node 0 and Node 2 becomes smaller and smaller, and at time 15 s, these two nodes begin to be in each others carrier sensing range, which means that these two nodes begin to share the same channel. The maximum bandwidth of the channel is around 3.64 Mbps. In AODV, where there is no QoS [10] requirement, when Node 2 is in the interference range of Node 0, traffics are kept on and some packets are lost during the transmission, whereas, in Adv.-AODV, the QoS is ensured. When the promised data rate cannot be satisfied any more, traffic of Node 2 is stopped at once. From this case, we could see that the Adv.-AODV achieved the function of ensuring the QoS not only at the route discovery stage, but also during the transmission. Once the QoS is not satisfied, the traffic is stopped. In the topology, the area size is 1000 m * 1000 m, and 50 nodes are in this area. 50 s is added at the beginning of each simulation to stabilize the mobility model. Every simulation runs 500 s in total. Each data point in the results represents an average of ten runs with same traffic models but different randomly generated mobility scenarios. For fair comparisons, same mobility and traffic scenarios are used in Adv.-AODV routing protocols.

III. METRICS FOR PERFORMANCE COMPARISON

Some important performance metrics [11] [12] can be evaluated:-

A. Packet delivery fraction: -

The ratio of the data packets delivered to the destinations to those generated by the CBR sources. It specifies the packet loss rate, which limits the maximum throughput of the network.

B. End-to-End Delay: -

This metric represents the average end-to-end time delay and indicates how much time it will take for a packet to travel from the source node to the application layer of the destination node. It includes all possible

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delay caused by buffering during route discovery latency, transmission delays at the MAC, queuing at interface queue, and propagation and transfer time. It is measured in seconds.

C. Throughput: -

The total packets delivered to individual destination over total time divided by total time taken. The first two metrics are the most important for best-effort traffic. The routing load metric evaluates the efficiency of the routing protocol. Note, however these metrics are not completely independent. For example, lower packet delivery fraction means that the delay metric is evaluated with fewer samples. In the conventional wisdom, the longer the path lengths, the higher the probability of a packet drops. Thus with a lower delivery fraction, samples are usually based in favor of smaller path lengths and thus have less delay.

IV. SIMULATION SETUP

The simulations were performed using Network Simulator 2 (NS-2.35). 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 1000m x 1000m with 50. Different network scenario for different number of nodes for 5 connections and 10 connections are generated. In Table 1, we have summarized the model parameters that have been used for our experiments.

Table 1. Simulation Parameter

Parameter	Parameter value
Simulator	NS-2.35
Simulation Area	1000m X 1000m
MAC Protocol	IEEE 802.11
Mobile Nodes	50
Antenna Type	Omni antenna
Propagation Model	Two Ray Ground
Number of connections	5,10
Packet Size	512 byte
Routing Protocols	Ad.-AODV,AODV, DSDV & DSR
Simulation Time	100 Sec.
Mobility Model	Random waypoint
Pause Time	40

V. SIMULATION RESULT AND ANALYSIS

In this Section, we compare the capabilities of the three routing protocol studied in this paper. To evaluate more reliable performance of Adv.-AODV, AODV, DSDV and DSR routing protocols in same simulation environment (25 to 200 mobile nodes). Simulations results are collected from a total of 60 scenarios of the three protocols. Performance metrics are calculated from trace file, with the help of AWK program. The simulation results are shown in the following section in the form of line graphs. In this Graph there is a comparison between the three protocols by using different sources. As already outlined we have taken four routing protocols, namely Destination Sequenced Distance Vector (DSDV), Dynamic Source Routing (DSR), Ad hoc On-Demand Distance Vector Routing (AODV) and Advanced Ad hoc On-Demand Distance Vector Routing (Adv.-AODV).

The mobility model used is Random waypoint mobility model because it models the random movement of the mobile nodes. We ran the simulation environments for 50 sec for one scenario with pause times varying from 0 to 50 second. Packet delivery fraction, end to end delay and throughput are calculated for DSR, DSDV, AODV and Adv.-AODV. The results are analyzed below with their corresponding graphs. From studying the figure Fig 4.4 we note that at pause time 0 sec; Adv.-AODV has a better PDF value when compared to DSDV, AODV and DSR for each set of connections. But Adv.-AODV gives better performance with increasing pause time. At pause time 50 sec, Adv.-AODV has best PDF value compared to AODV, DSR and DSDV for both scenarios. From studying the figure Fig 4.3 for throughput, we note that at pause time 0 sec, DSR has a better throughput when compared to DSDV, AODV and Adv.-AODV for each set of connections. But with increasing pause time, average throughput of Adv.-AODV is better compared to AODV, DSR, and DSDV for each set of connections. The delay is affected by high rate of CBR packets as well. The buffers become full much quicker, so the packets have to stay in the buffers for a much longer period of time before they are sent. From studying the figure Fig 4.2 Adv.-AODV has better end to end delay from DSDV, AODV and DSR protocols.

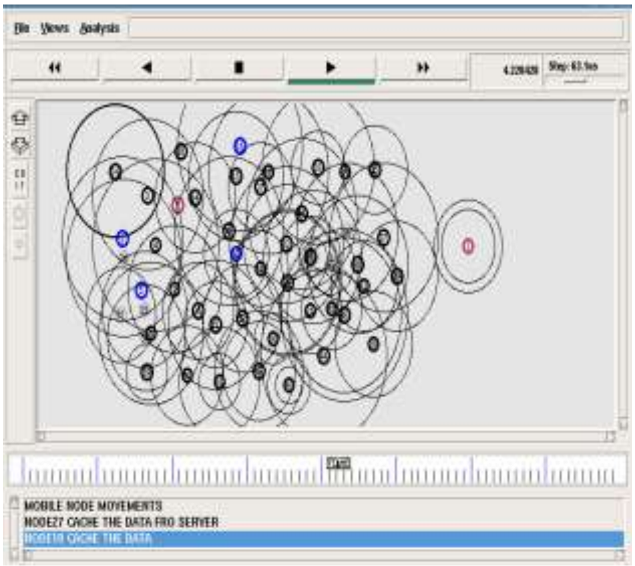


Fig.1 Simulation Snapshot

In the above figure we have use 50 nodes for simulation using DSR, DSDV, AODV and Adv.-AODV protocols.

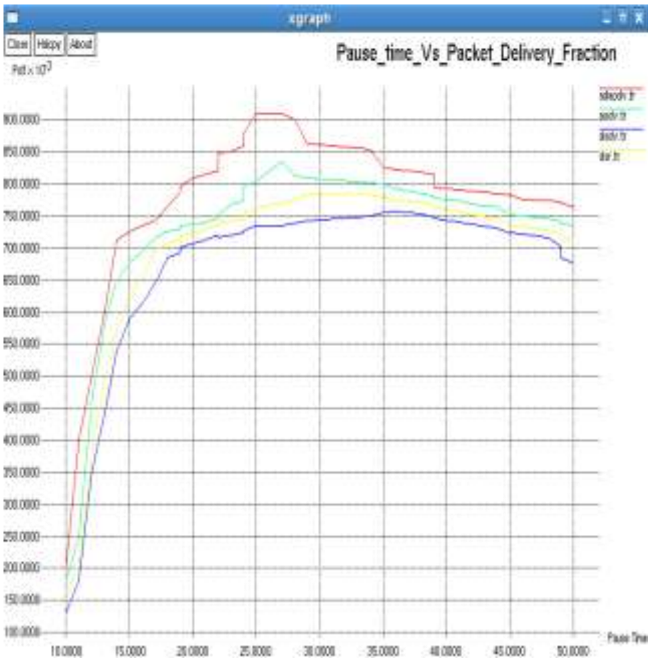
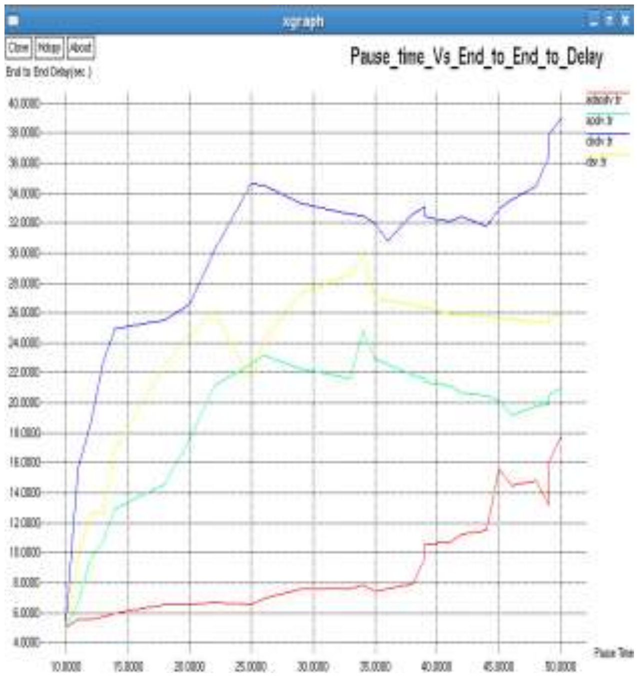


Fig. 2 Comparison of Adv.-AODV, AODV, DSDV and DSR on basis of Packet Delivery Fraction at maximum connection 50

2. Comparison of Adv.-AODV, AODV, DSDV and DSR on basis of Throughput at maximum connection 50



3. Comparison of Adv.-AODV, AODV, DSDV and DSR on basis of end to end delay at maximum connection 50

VI. CONCLUSION

This paper evaluated the performance of Adv.-AODV, AODV, DSDV and DSR using ns-2. Comparison was based on the packet delivery fraction, throughput and end-to-end delay. We concluded that in the static network (pause time 50 sec), Adv.-AODV gives better performance as compared to AODV, DSDV and DSR in terms of packet delivery fraction and throughput and end-to end delay. In the result, Adv.-AODV works well as compare to the other three protocols and it shows the better effects when network density is relatively high. If someone wants to work in the area of ad hoc network with the aim of improving of QOS in terms reducing the end to end delay and increasing the throughput and packet delivery fraction for ad hoc networks can get benefit from this Adv.-AODV.

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Authors

Guide:- Associate Prof. Shashank Dwivedi

Qualification: - B.tech, M.tech

Area Of Interest:-Computer organization & Architecture

Email:- shashankdwivedi@united.ac.in

Author: - Sandeep Kumar Gautam

Qualification: - B.tech, M.tech (pursuing)

Area Of Interest:-Networking, Wireless Sensor Network

Email:- gautambsp09@gmail.com