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A Simulation Based Performance Comparison of Routing Protocols on Mobile Ad-hoc Network

(Ad Hoc On-Demand Distance Vector (AODV) and Dynamic Source Routing (DSR))

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Abstract **– Mobile Ad-hoc Network (MANET) is a collection of wireless nodes that can dynamically form a network to exchange information without using any pre-existing fixed network infrastructure. In these networks there is no fixed topology due to the mobility of nodes, interference, multipath propagation and path loss. Hence a dynamic routing protocol is needed for these networks to function properly. Many Routing protocols have been developed for accomplishing this task. In this paper, a simulation based performance study and analysis is performed on two routing protocols over MANET. Ad Hoc On-Demand Distance Vector (AODV) and Dynamic Source Routing (DSR) are analyzed in this work. The performance differentials are analyzed using varying simulation time. These simulations are carried out using the ns-2 network simulator.**

Keywords **– Mobile Ad Hoc Networks, Pro-Active Protocols, Reactive Protocols, Ad Hoc On-Demand Distance Vector Routing Protocol, Dynamic Source Routing Protocol, Route Request, Route Reply.**

I. INTRODUCTION

Mobile ad hoc networks (MANET) consist of mobile platform which communicate with each other through wireless links without any predetermined infrastructure. Each node not only is a host but also as a router that maintains routes to and forwards data packets for other nodes in the network that may not be within direct wireless transmission range. Topology of a mobile ad-hoc network often changes rapidly and we need to manage this change and cope with problems raised through this type of networks. If the source and destination nodes are not within the transmission range of each other, then intermediate nodes would be served as intermediate routers for the communication between the two nodes. Moreover, mobile platform moves autonomously and communicates via dynamically changing network. Thus, frequent change of the network topology is a main challenge for many important topics, such as routing protocol, robustness and performance degradation.

II. ROUTING IN MANET

In mobile ad-hoc networks there is no infrastructure support as is the case with wireless networks, and since a destination node might be out of range of a source node transferring packets; so there is need of a routing procedure. This is always ready to find a path so as to forward the packets appropriately between the source and the destination. Within a cell, a base station can reach all mobile nodes without routing via broadcast in common wireless networks. In the case of ad-hoc networks, each node must be able to forward data for other nodes. This creates additional problems along with the problems of dynamic topology which is unpredictable connectivity changes.

Classification of routing protocols in mobile ad hoc network can be done in many ways, but most of these are done depending on routing strategy and network structure. The routing protocols can be categorized as flat routing, hierarchical routing and geographic position assisted routing while depending on the network structure. According to the routing strategy routing protocols can be broadly classified as Table-driven(Pro-Active) and On-Demand(Reactive).

Pro-Active/Table Driven Protocols- Proactive MANET protocols are also called as table-driven protocols and will actively determine the layout of the network. Through a regular exchange of network topology packets between the nodes of the network, at every single node an absolute picture of the network is maintained. There is hence minimal delay in determining the route to be taken. This is especially important for time-critical traffic. When the routing information becomes worthless quickly, there are many short-lived routes that are being determined and not used before they turn invalid. Therefore, another drawback resulting from the increased mobility is the amount of traffic overhead generated when evaluating these unnecessary routes. This is especially altered when the network size increases. The portion of the total control traffic that consists of actual practical data is further decreased.

Lastly, if the nodes transmit infrequently, most of the routing information is considered redundant. The nodes, however, continue to expend energy by continually updating these unused entries in their routing tables as mentioned, energy conservation is very important in a MANET system design. Therefore, this excessive expenditure of energy is not desired. Thus, proactive MANET protocols work best in networks that have low node mobility or where the nodes transmit data frequently. Examples of Proactive MANET Protocols include: Optimized Link State Routing (OLSR), Fish-eye State Routing (FSR), Destination-Sequenced Distance Vector (DSDV), Cluster-head Gateway Switch Routing Protocol (CGSR).

Reactive (On Demand) protocols- A different approach from table-driven routing is source-initiated on-demand routing. This type of routing creates routes only when desired by the source node. When a node requires a route to a destination, it initiates a route discovery process within the network. This process is completed once a route is found or all possible route permutations have been examined. Once a route has been established, it is maintained by a route maintenance procedure until either the destination becomes inaccessible along every path from the source or until the route is no longer desired.

III. Description of Protocols

A. AODV-

Ad hoc On-Demand Distance Vector (AODV) routing is a routing protocol for mobile ad hoc networks and other wireless ad-hoc networks. It is jointly developed in Nokia Research Centre of University of California, Santa Barbara and University of Cincinnati by C. Perkins and S. Das. It is an on-demand and distance-vector routing protocol, meaning that a route is established by AODV from a destination only on demand. AODV is capable of both unicast and multicast routing. It keeps these routes as long as they are desirable by the sources. Additionally, AODV creates trees which connect multicast group members. The trees are composed of the group members and the nodes needed to connect the members. The sequence numbers are used by AODV to ensure the freshness of routes. It is loop-free, self-starting, and scales to large numbers of mobile nodes.

AODV defines three types of control messages for route maintenance:

RREQ- A route request message is transmitted by a node requiring a route to a node. As an optimization AODV uses an expanding ring technique when flooding these messages. Every RREQ carries a time to live (TTL) value that states for how many hops this message should be forwarded. This value is set to a predefined value at the first transmission and increased at retransmissions. Retransmissions occur if no replies are received. Data packets waiting to be transmitted (i.e. the packets that initiated the RREQ). Every node maintains two separate counters: a node sequence number and a broadcast_ id.

RREP- A route reply message is unicasted back to the originator of a RREQ if the receiver is either the node using the requested address, or it has a valid route to the requested address. The reason one can unicast the message back, is that every route forwarding a RREQ caches a route back to the originator.

RERR- Nodes monitor the link status of next hops in active routes. When a link breakage in an active route is detected, a RERR message is used to notify other nodes of the loss of the link.

In order to enable this reporting mechanism, each node keeps a precursor list", containing the IP address for each its neighbors that are likely to use it as a next hop towards each destination. The below Figure 3.1 illustrates an AODV route lookup session. Node A wants to initiate traffic to node J for which it has no route. A transmit of a RREQ has been done, which is flooded to all nodes in the network. When this request is forwarded to J from H, J generates a RREP. This RREP is then unicasted back to A using the cached entries in nodes H, G and D.

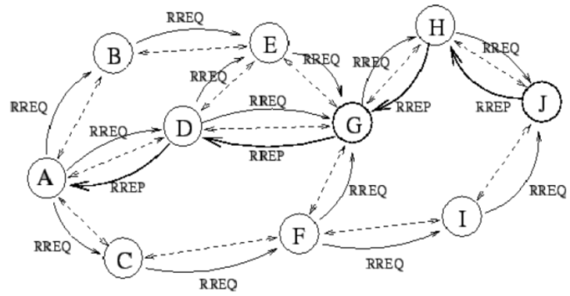

Fig.3.1. A possible path for a route replies if A wishes to find a route to J.

AODV builds routes using a route request/route reply query cycle. When a source node desires a route to a destination for which it does not already have a route, it broadcasts a route request (RREQ) packet across the network. Nodes receiving this packet update their information for the source node and set up backwards pointers to the source node in the route tables. In addition to 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 getting 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. 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. As long as the route remains active, it will continue to be maintained. A route is considered active as long as there are data packets periodically travelling from the source to the destination along that path. Once the source stops sending data packets, the links will time out and eventually be deleted from the intermediate node routing tables. If a link break occurs while the route is active, the node upstream of the break propagates a route error (RERR) message to the source node to inform it of the now unreachable destinations. After receiving the RERR, if the source node still desires the route, it can reinitiate route discovery.

Multicast routes are set up in a similar manner. A node wishing to join a multicast group broadcasts a RREQ with the destination IP address set to that of the multicast group and with the 'J'(join) flag set to indicate that it would like to join the group. Any node receiving this RREQ that is a member of the multicast tree that has a fresh enough sequence number for the multicast group may send a RREP. As the RREPs propagate back to the source, the

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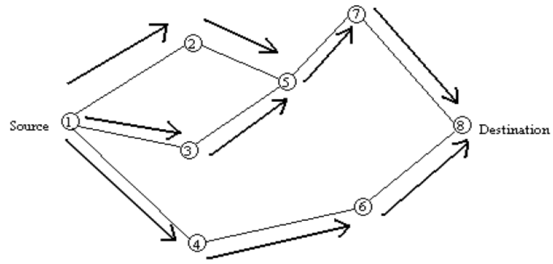
nodes forwarding the message set up pointers in their multicast route tables. As the source node receives the RREPs, it keeps track of the route with the freshest sequence number, and beyond that the smallest hop count to the next multicast group member. After the specified discovery period, the source nodes will unicast a Multicast Activation (MACT)message to its selected next hop. This message serves the purpose of activating the route. A node that does not receive this message that had set up a multicast route pointer will timeout and delete the pointer. If the node receiving the MACT was not already a part of the multicast tree, it will also have been keeping track of the best route from the RREPs it received. Hence it must also unicast a MACT to its next hop, and so on until a node that was previously a member of the multicast tree is reached.

B. DSR-

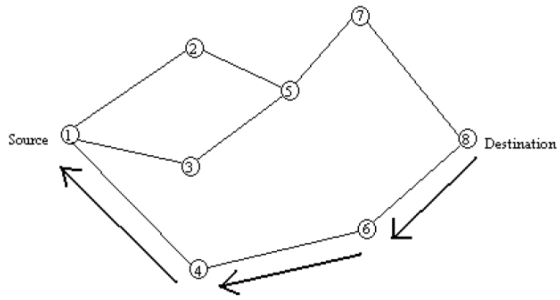
Dynamic Source Routing (DSR) is a routing protocol for wireless mesh networks. It is similar to AODV in that it establishes a route on-demand when a transmitting mobile node requests one. However, it uses source routing instead of relying on the routing table at each intermediate device. Dynamic source 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 discover and maintain routes to arbitrary destinations in the ad hoc network . An optimum path for a communication between 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.

The major dissimilarity between this and the other on-demand routing protocols is that 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 neighbours of its presence. The fundamental approach of this protocol during the route creation phase is to launch a route by flooding RouteRequest packets in the network as shown in Figure 3.2(a). The destination node, on getting a RouteRequest packet, responds by transferring a RouteReply packet back to the source,which carries the route traversed by the RouteRequest packet received.



(a) Propagation of request (PREQ) packet



(b) Path taken by the Route Reply (RREP) packet.
Fig.3.2. Creation of route in DSR

A destination node, after receiving the first RouteRequest packet, replies to the source node through the reverse path the RouteRequest packet had traversed as shown in Figure 3.2(b). Nodes can also be trained about the neighboring routes traversed by data packets if operated in the promiscuous mode. This route cache is also used during the route construction phase. If an intermediary node receiving a RouteRequest has a route to the destination node in its route cache, then it replies to the source node by sending a RouteReply with the entire route information from the source node to the destination node.

IV. Proposed Work

The breakthrough in the use of wireless cellular systems use the Mobile AD-Hoc networks were proposed to provide robust and reliable routing services. The idea was considered to be perfect until the misbehavior of selfish node was discovered. A mobile AD-Hoc network consists of nodes that move arbitrarily and form dynamic topologies. The nature of open structure and scarcely available battery based energy, node misbehaviors may exist in MANETS due to the presence of selfish nodes. A selfish node refuses to share its own resources and attempts to benefit from other nodes. These selfish nodes may severely affect the performance of network So to avoid the misbehavior problem of selfish nodes and thus for improving the performance of mobile Ad-Hoc networks (MANETS), we studied two reactive protocols i.e. AODV and DSR. Now Reactive protocol is identified as On-demand protocols because it creates routes only when these routes are needed. The need is initiated by the source, as the name suggests. When a source node requires a route to a destination, it initiates a route discovery process within the network. This process is completed once a route is found or all possible route permutations have been examined. After that there is a route maintenance procedure to keep up the valid routes and to remove the invalid routes. The two above mentioned reactive protocols can thus be defined as: AODV actually stands for “AD-Hoc On demand Distance Vector Routing Protocol”, which is a hop-by-hop routing protocol. It establishes a route from destination only on demand and keeps these routes as long as they are desirable by sources. It is capable of both unicast and multicast routing. DSR stands for “Dynamic Source Routing Protocol”, 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. The protocol is composed of the two main mechanisms of “Route Discovery” and “Route Maintenance”. Both the protocols are good in there place but they cannot be used together so in our project we will be comparing the protocols on the basis of the amount of packets received and the packets lost i.e. performance and reliability, thus evaluating the correct use of protocol at right places. For analyzing it we examine the evaluation on NS2 simulator tool.

V. Result Analysis

As already outlined we have taken two On-demand (Reactive) routing protocols, namely Ad hoc On-Demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR). The mobility model used is Random waypoint mobility model because it models the random movement of the mobile nodes. For all the simulations, the same movement models were used, the number of traffic sources was fixed at 10, the maximum speed of the nodes was set to 20m/s and the simulation time was varied as 10s, 15s, and 20s.

Scenario 1:

In this scenario some parameters with a specific value are considered. Those are as shown in table 5.1.

Table 5.1: Scenario 1 for implementation of AODV and DSR

Parameter	Value
Number of nodes	10
Simulation Time	10 sec
Pause Time	5ms
Environment Size	800x800
Transmission Range	250 m
Traffic Size	CBR(Constant Bit Rate)
Packet Size	512 bytes
Packet Rate	5 packets/s
Maximum Speed	20m/s
Queue Length	50
Simulator	ns-2.30
Mobility Model	Random Waypoint
Antenna Type	Omni directional

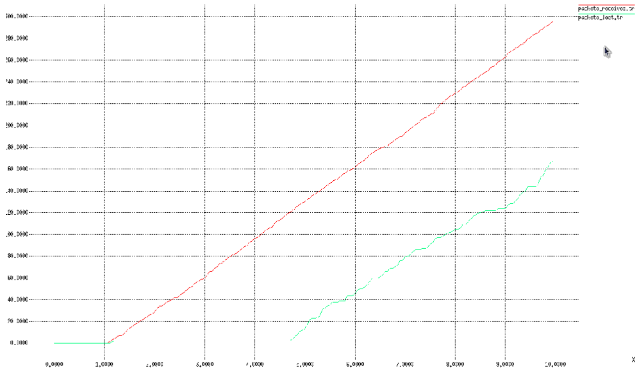


Fig.5.1. X Graph of 10 seconds simulation time of AODV

The Figure 5.1 shows the X graph of AODV. By the Figure we see that as the simulation start the packet received and packet loss is initially zero, because initially there is no CBR connection and nodes taking their right place. As the CBR connections establish between the nodes the number of packet received increases but no packet loss is there, it means all generated packets are being received by the nodes. But the packet loss increases substantially on the simulation time increases. Finally the packet received is more than the packet loss.

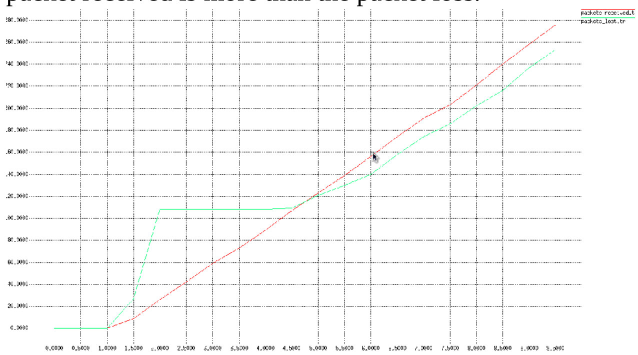


Fig.5.2. X Graph of and 10 seconds simulation time of DSR

The Figure 5.2 shows the X graph of DSR. By the Figure we see that as the simulation start the packet received and packet loss is initially zero, because initially there is no CBR connection and nodes taking their right place. As the CBR connections establish the number of packet lost increases very much as compare to packet received. It shows that mostly generated packets are being dropped by the nodes. But the packet loss decreases substantially on the simulation time increases, and number of packet received increases substantially on the simulation time increases.

Scenario 2:

Table 5.2: Scenario 2 for implementation of AODV and DSR

Parameter	Value
Number of nodes	10
Simulation Time	15 sec
Pause Time	5ms
Environment Size	800x800
Transmission Range	250 m
Traffic Size	CBR(Constant Bit Rate)

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Packet Size	512 bytes
Packet Rate	5 packets/s
Maximum Speed	20m/s
Queue Length	50
Simulator	ns-2.30
Mobility Model	Random Waypoint
Antenna Type	Omni directional

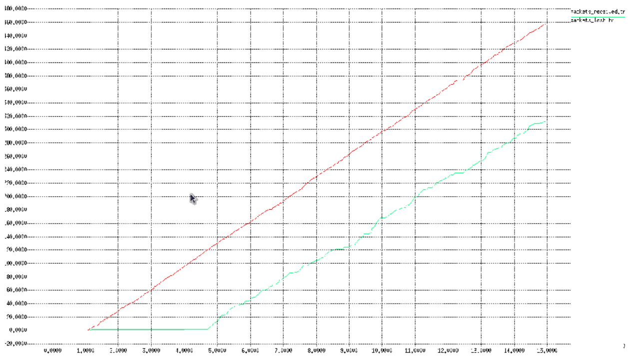
Fig.5.3. X Graph of and 15 seconds simulation time of AODV

The Figure 5.3 shows that the number of packet received increases according to simulation time; it means generated packets are being received at a good ratio by the node. But the simulation time increases the packet loss increases substantially.

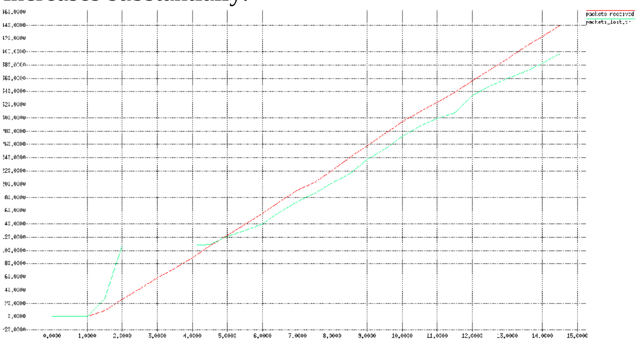
Fig.4.4*:* X Graph of 15 seconds simulation time of DSR

The Figure 5.4 shows that initially there is very high packet loss but the number of packet received increases according to simulation time; it means generated packets are being received at a good ratio by the nodes. Because the simulation time increases the packet loss decreases substantially.

Scenario 3:

Table 5.3: Scenario 3 for implementation of AODV and DSR

Parameter	Value
Number of nodes	10
Simulation Time	20 sec
Pause Time	5ms
Environment Size	800x800
Transmission Range	250 m
Traffic Size	CBR(Constant Bit Rate)
Packet Size	512 bytes
Packet Rate	5 packets/s
Maximum Speed	20m/s
Queue Length	50
Simulator	ns-2.30
Mobility Model	Random Waypoint
Antenna Type	Omni directional

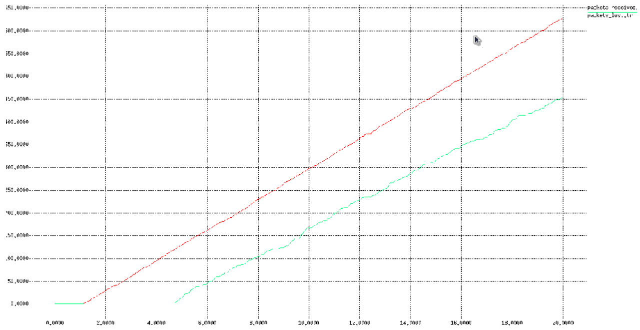
Fig.5.5. X Graph of 20 seconds simulation time of AODV

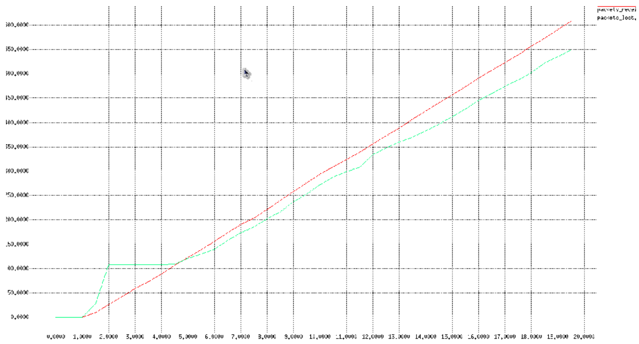
Fig.5.6. X Graph of 20 seconds simulation time of DSR

The above figures shows the same behavior of AODV & DSR in fact of packet receiving and packet loss, initially in AODV no packet loss and in DSR very high packet loss. But as simulation time increases the packet loss goes down and packet receiving increases.

VI. Conclusion

We have compared two On-demand routing protocols, namely, Ad hoc On-Demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR).The simulation of these protocols has been carried out using Ns-2 simulator.

Three different simulation scenarios are generated and the simulation time has varied from 10sec, 15sec and 20 sec. Other network parameters are kept constant during the simulation.

It is observed that the packet loss is very less in case of AODV, initially but it increases substantially on the simulation time increases. In case of DSR simulation the packet loss is very high initially but it decreases substantially on the simulation time increases.

So, we can conclude that if the MANET has to be setup for a small amount of time then AODV should be prefer due to low initial packet loss and DSR should not be prefer to setup a MANET for a small amount of time because initially there is packet loss is very high. If we have to use the MANET for a longer duration then both the protocols can be used, because after sometimes both the protocols have same ratio of packet delivering. But AODV have very good packet receiving ratio in comparison to DSR.

The two protocols Ad hoc On-Demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR) have been compared using simulation, it would be interesting to note the behaviour of these protocols on a real life test bed. In this work other network parameters such as number of mobile nodes, traffic type-CBR, simulation area etc. are kept constant. Whereas the simulation time is varied in the three different simulation scenarios. It would be interesting to observe the behaviour of these two protocols by varying these network parameters.

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