Performance Analysis of AODV & DSR Routing Protocol in Mobile Ad hoc Networks

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ABSTRACT
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. It is a relatively new routing philosophy that provides a scalable solution to relatively large network topologies. 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 an attempt has been made to compare the performance of two prominent on demand reactive routing protocols for MANETs: Ad hoc On Demand Distance Vector (AODV), Dynamic Source Routing (DSR) protocols. DSR and AODV are reactive gateway discovery algorithms where a mobile device of MANET connects by gateway only when it is needed. As per our findings the differences in the protocol mechanics lead to significant performance differentials for both of these protocols. The performance differentials are analyzed using varying simulation time. These simulations are carried out using the ns-2 network simulator. The results presented in this work illustrate the importance in carefully evaluating and implementing routing protocols in an ad hoc environment**.**

General Terms
The paper is subjected to the Mobile Communication on Ad hoc Networks (MANET), AODV and DSR.

Keywords
Ad hoc On Demand Distance Vector (AODV), Distance Source Routing (DSR), Mobile Ad Hoc Network (MANET)

1. INTRODUCTION
A wireless network is a growing new technology that will allow users to access services and information electronically, irrespective of their geographic position. Wireless networks can be classified in two types infrastructure network and infrastructure less (ad hoc) networks. Infrastructure network consists of a network with fixed and wired gateways. A mobile host interacts with a bridge in the network (called base station) within its communication radius. The mobile unit can move geographically while it is communicating. When it goes out of range of one base station, it connects with new base station and starts communicating through it. This is called handoff. Recent advancements such as Bluetooth introduced a fresh type of wireless systems which is frequently known as mobile ad-hoc networks. Mobile ad-hoc networks or "short live" networks control in the nonexistence of permanent infrastructure. Mobile ad-hoc network offers quick and horizontal network deployment in conditions where it is not possible otherwise. Ad-hoc is a Latin word, which means "for this or for this only." Mobile ad-hoc network is an autonomous system of mobile nodes connected by wireless links; each node operates as an end system and a router for all other nodes in the network.

Mobile ad hoc network is a group of wireless mobile computers (or nodes); in which nodes collaborate by forwarding packets for each other to allow them to communicate outside range of direct wireless transmission. Ad hoc networks require no centralized administration or fixed network infrastructure such as base stations or access points, and can be quickly and inexpensively set up as needed[5].

A MANET is an autonomous group of mobile users that communicate over reasonably slow wireless links. The network topology may vary rapidly and unpredictably over time, because the nodes are mobile. The network is decentralized, where all network activity, including discovering the topology and delivering messages must be executed by the nodes themselves. Hence routing functionality will have to be incorporated into the mobile nodes.

Mobile Ad-Hoc Network (MANET) is a kind of wireless ad-hoc network and it is a self-configuring network of mobile routers (and associated hosts) connected by wireless links – the union of which forms an arbitrary topology. The routers, the participating nodes act as router, are free to move randomly and manage themselves arbitrarily & thus, the network's wireless topology may change rapidly and unpredictably. Such a network may operate in a standalone fashion, or may be connected to the larger Internet.

Mobile ad hoc network is a collection of independent mobile nodes that can communicate to each other via radio waves. The mobile nodes can directly communicate to those nodes that are in radio range of each other, whereas others nodes need the help of intermediate nodes to route their packets. These networks are fully distributed, and can work at any place without the aid of any infrastructure. This property makes these networks highly robust.

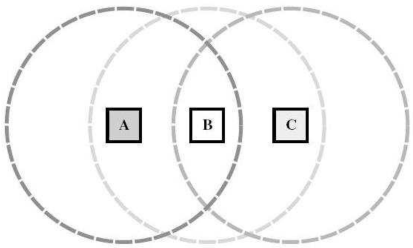

Figure 1 A simple ad-hoc network with three nodes

In the above Fig. 1 nodes A and C must discover the route through B in order to communicate. The circles indicate the nominal range of each node‘s radio transceiver. Nodes A and C are not in direct transmission range of each other, since A‘s circle does not cover C.

Mobile ad hoc network nodes are furnished with wireless transmitters and receivers using antennas, which may be highly directional (point-to-point), Omni directional (broadcast), probably steerable, or some combination there of [1]. At a given point in time, depending on positions of nodes, their transmitter and receiver coverage patterns, communication power levels and co-channel interference levels, a wireless connectivity in the form of a random, multihop graph or "ad hoc" network exists among the nodes.

The mobile ad hoc network (MANET) allows a more flexible communication model than traditional wire line networks since the user is not limited to a fixed physical location [1]. It is a new special network that does not have any fixed wired communication infrastructure or other network equipments. With no pre-existing fixed infrastructure, MANETs are gaining increasing popularity because of their ease of deployment and usability anytime and anywhere. So they are viewed as suitable systems which can support some specific applications as virtual classrooms, military communications, emergency search and rescue operations, data acquisition in hostile environments, communications set up in Exhibitions, conferences and meetings, in battle field among soldiers to coordinate defense or attack, at airport terminals for workers to share files etc. Host mobility can cause unpredictable network topology changes in MANETs. Hence, a highly adaptive routing scheme to deal with the dynamic topology is required. Many unicast routing protocols have been proposed for MANETs to achieve efficient routing [1] be done in many ways, but most of them are depending on routing strategy and network structure. According to the routing strategy, the routing protocols can be categorized as proactive and reactive routing (see Fig. 2), while depending on the network structure these are classified as flat, hierarchical and position based routing. Both the proactive and reactive protocols come under the flat routing.

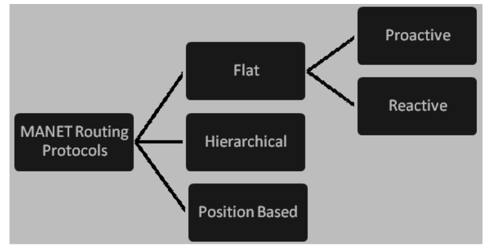

Figure 2 Classification of MANET routing protocols

1.1 Proactive Routing Protocols

A proactive routing protocol is also called "table-driven" routing protocol. Using a proactive routing protocol, nodes in a mobile ad hoc network continuously evaluate routes to all reachable nodes and attempt to maintain consistent, up-to-date routing information. Therefore, a source node can get a routing path immediately if it needs one. When a network topology change occurs, respective updates must be propagated throughout the network to notify the change. So if we noted to network topology changes in MANETs, the control overhead to maintain up-to-date network topology information is relatively high. Wireless Routing Protocol (WRP) [1], the Destination Sequence Distance Vector (DSDV) [1] and the Fisheye State Routing (FSR) [1] are all proactive routing protocols. Reactive Routing Protocols: Reactive routing protocols for mobile ad hoc networks are also called "on-demand" routing protocols. In a reactive routing protocol, routing paths are searched only when needed. When a source node wants to send packets to the destination but no route is available, it initiates a route discovery operation. In the route discovery operation, the source broadcasts route request (RREQ) packet. When the destination or a node that has a route to the destination receives the RREQ packet, a route reply (RREP) packet is created and forwarded back to the source. Each node usually uses hello messages to notify its existence to its neighbors. Therefore, the link status to the next hop in an active route can be monitored. When a node discovers a link disconnection, it broadcasts a route error (RERR) packet to its neighbors, which in turn propagates the RERR packet towards nodes whose routes may be affected by the disconnected link. Then, the affected source can re-initiate a route discovery operation if the route is still needed. Compared to the proactive routing protocols, less control overhead is a distinct advantage of the reactive routing protocols. Thus, reactive routing protocols have better scalability than proactive routing protocols. However, when using reactive routing protocols, source nodes may suffer from long delays for route searching before they can forward data packets. Hence these protocols are not suitable for real –time applications. The Dynamic Source Routing (DSR) [1] and Ad hoc On-demand Distance Vector routing (AODV) [1] are examples for reactive routing protocols.

1.2 Hierarchical Routing Protocols

Typically, when wireless network size increase (beyond certain thresholds), current "flat" routing schemes become infeasible because of link and processing overhead. One way to solve this problem and to produce scalable and efficient solutions is hierarchical routing. Wireless hierarchical routing is based on the idea of organizing nodes in groups and then assigning nodes different functionalities inside and outside of a group. The Zone Routing Protocol (ZRP) [8], Zone based Hierarchical Link State routing (ZHLS) [9] and Hybrid Ad hoc Routing Protocol (HARP) [10] are examples for hybrid routing protocols.

1.3 Position Based Routing Protocols

The advances in the development of Global Positioning System (GPS) nowadays make it possible to provide location information with a precision in the order of a few meters. They also provide universal timing. While location information can be used for directional routing in distributed ad hoc systems, the universal clock can provide global synchronizing among GPS equipped nodes. In position based routing protocols, instead of using routing tables and network addresses, the routing decisions are made on the basis of the current position of the source and the destination nodes. Location Aided Routing (LAR) [11] and Distance Routing Effect Algorithm for Mobility (DREAM) [12] are typical position based routing protocols proposed for mobile ad hoc networks. According to several experimental works, routing schemes that use positional information scale well [13]. In all of the unicast routing protocols, the robustness of the route is generally not involved as a requirement for its selection. Consequently, route breakups will frequently occur, induced by nodal mobility and/ or nodal and link failures as well as by fluctuations in the communications transport quality experienced across the networks communications links. The latter are caused by signal interferences, fading and multi-path phenomena and other causes producing ambient and environmental noise and signal interference processes. On the other hands, route breakups lead the frequent operation of rebuilding routes that consume lots of the network resources and the energy of nodes. Many efforts have been made to design reliable routing protocols that enhance network stability. The among all the routing protocols here we discuss the two reactive type of protocols AODV & DSR.

2. LITERATURE REVIEW

The Wireless Cellular Systems became pretty famous for its powerful concept of wireless connectivity, anytime, anywhere, irrespective of the geographical position of the user, it became very important to ensure that the data was sent or received with 100% accuracy without any loss in an infrastructure or infrastructure less networks. It was easy to promise a reliable connectivity in case of infrastructure network but a little difficult in infrastructure less network or AD-Hoc networks. MANET is a kind of wireless ad-hoc network and it is a self-configuring network of mobile routers (and associated hosts) connected by wireless links the union of which forms an arbitrary topology. The routers, the participating nodes act as router, are free to move randomly and manage themselves arbitrarily; thus, the network's wireless topology may change rapidly and unpredictably to a volatile topology which would make it hard to detect malicious nodes. These malicious nodes were called to be selfish nodes.

As the communication in Ad-hoc networks greatly depend on the efficient working of each node, it is rather very important to indentify such selfish nodes. From many years the researchers are trying to find out a solution for the security and misbehavior problems of MANETS and ended up with some finest techniques that either avoided selfish nodes or worked a way out even in their presence. However the introduction of AODV and DSR routing protocol can be rated the best of all these techniques, there are some other techniques in the field of research for a better option that proved to be a good start as stated below.

2.1 Description of Reactive Protocols

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 various Reactive Routing Protocols are discussed below:

2.1.1 Ad hoc On Demand Distance Vector Routing (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. The RREQ contains the following fields.

Table1 RREQ Fields

source address	broadcast ID	Source sequence no.	destination address	destination sequence no.	Hop count

The pair <source address, broadcast ID> uniquely identifies a RREQ. Broadcast_id is incremented whenever the source issues a new RREQ.

RREP- A route reply message is unicast 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.

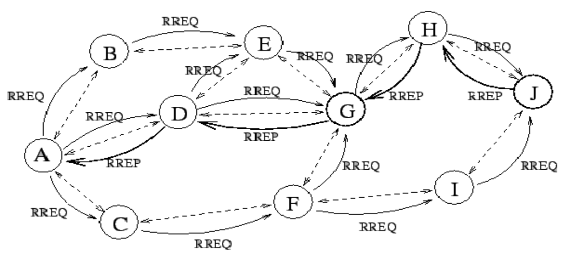

Figure 3 A possible path for a route replies if a wishes to find a route to J

The above Figure 3 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 unicast back to A using the cached entries in nodes H, G and D.

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 unicast 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 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.

AODV maintains routes for as long as the route is active. This includes maintaining a multicast tree for the life of the multicast group. Because the network nodes are mobile, it is likely that many link breakages along a route will occur during the lifetime of that route. The counting to infinity problem is avoided by AODV from the classical distance vector algorithm by using sequence numbers for every route. The counting to infinity problem is the situation where nodes update each other in a loop.

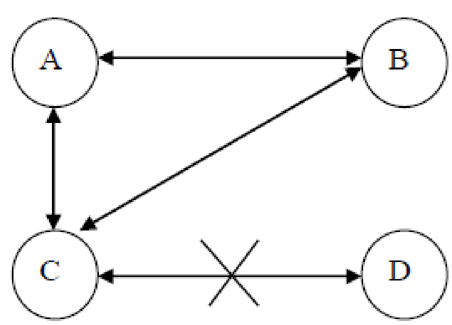

Figure 4 Counting to infinity problem

Consider nodes A, B, C and D making up a MANET as illustrated in Figure 2. A is not updated on the fact that its route to D via C is broken. This means that A has a registered route, with a metric of 2, to D. C has registered that the link to D is down, so once node

B is updated on the link breakage between C and D, it will calculate the shortest path to D to be via A using a metric of 3.C receives information that B can reach D in 3 hops and updates its metric to 4 hops. A then registers an update in hop-count for its route to D via C and updates the metric to 5. So they continue to increment the metric in a loop.
The way this is avoided in AODV, as by B noticing that as route to D is old based on a sequence number. B will then discard the route and C will be the node with the most recent routing information by which B will update its routing table.

2.1.2 Dynamic Source Routing (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 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.

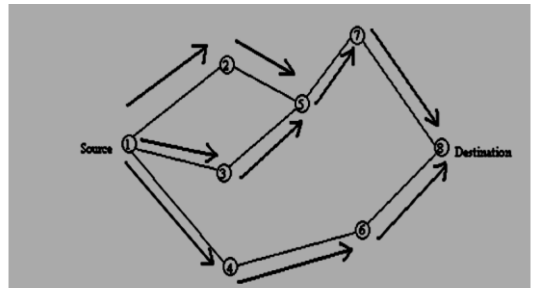

Figure 5(a) Propagation of Request (PREQ) packet

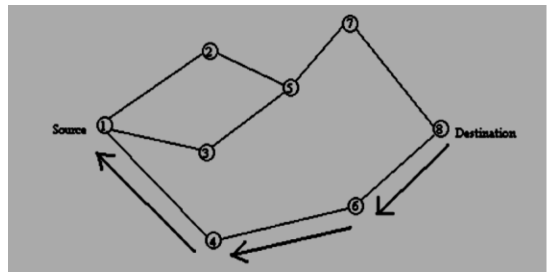

Figure 5(b) Creation of route in DSR

A destination node, after receiving the first Route Request packet, replies to the source node through the reverse path the Route Request packet had traversed. 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 Route Request has a route to the destination node in its route cache, then it replies to the source node by sending a Route Reply with the entire route information from the source node to the destination node.

3. 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 can not 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.

4. 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. We have used following simulations to study and analyze our result .They are NS2 network simulator, NAM editor to show the animated schema of the two protocols under study viz. AODV and DSR, their performances and their routing paths. Furthermore we have used X-graph to graphically represent the number of packets received and lost for both the protocols and hence comparing them. From the comparison the declaration for both the protocol as a AODV & DSR that which is the capable of handling the routing process smoothly.

The equivalent to the two protocols under the flat type of MANET, also we compare the number of protocols under the hirerchical & position based. By comparing the number of routing protocols we can find out the efficiency of rest of the protocols.

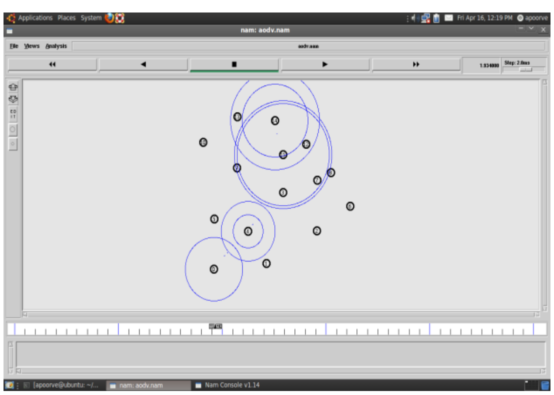

Figure 6 Route discovery and Packet Transmission in AODV

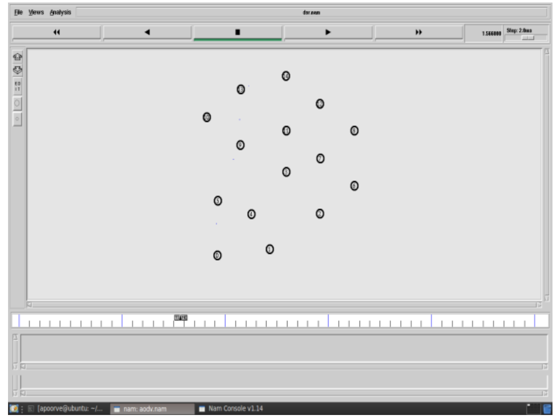

Figure 7 Route discovery and Packet Transmission in DSR

The above Figure 6 shows the packet transmission from the source node to the destination node using AODV protocol. Here all the nodes are mobile nodes and the selection of route is made by the current active node. Each and every node knows the status (Active or Dead) of the next node and communicates accordingly and hence reducing the packet loss.

The above Figure 7 shows the packet transmission from the source node to the destination node using DSR protocol. Here also all the nodes are mobile nodes and the selection of route is made by the source active node and the source node knows the shortest path. As their exists only one path and if a dead node occurs along the path it would receive the packets and cause packet loss.

In Figure 8 & Figure 9 shows the X graph of AODV & DSR respectively. By studying the above graph 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

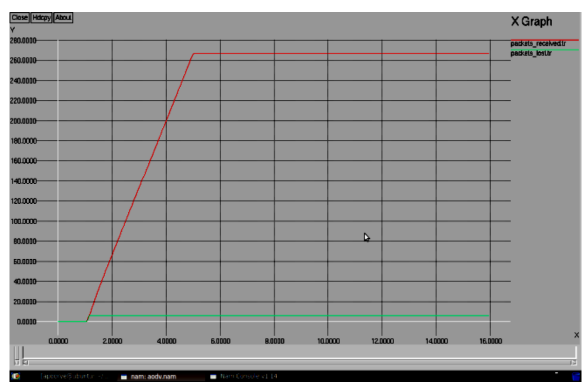

Figure 8 Graphical Representation of AODV protocol

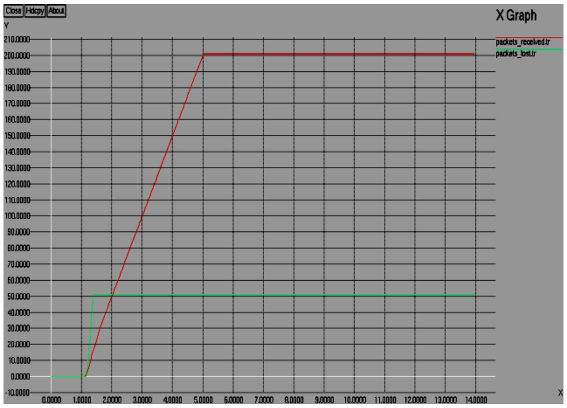

Figure 9 Graphical Representation of DSR protocol

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. We studied the output of both the protocols and found that the AODV protocol is much better then compared to DSR protocol as the package losses is very low in AODV as compared to the package loss in DSR.

5. CONCLUSION

This paper review and compare the two protocols. The conclusion 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 some times both the protocols have same ratio of packet delivering. But AODV have very good packet receiving ratio in comparison to DSR.

AODV and DSR are very similar, but AODV mechanisms are easier to implement and to integrate with other mechanisms using other different routing protocols. Moreover, AODV has better scalability and its header size on data packet is relative constant. However, AODV maintains only one route per destination. This is one of the major problems in AODV, since every time a route is broken; a route discovery has to be initiated. This leads to more overhead, higher delays and high packet lost. On the other hand, DSR seems to be more stable and has less overhead than AODV. DSR can make use of multiple paths and does not send a periodic packet as AODV. Moreover, it stores all usable routing information extracted from overhearing packets. However, these overheard route information could lead to inconsistencies.

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 behavior of these protocols on a real life test bed.

6. ACKNOWLEDGEMENT

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