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Comparative Study of Reactive Routing Protocols AODV and DSR for 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. In this work 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 is a 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. .**

***Keywords:*- MANETS, AODV - Ad Hoc On-demand Distance Vector Routing, DSRP - Dynamic Source Routing Protocol, TORA - Temporally Ordered Routing Algorithm, NAM- Network Animator, NS- Network Simulator.**

I. 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. Infrastructured network consists of a network with fixed and wired gateways. A 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.

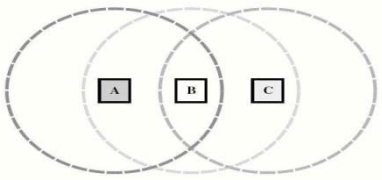

Fig1 Example of a simple ad-hoc network with three participating nodes

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.

II. CHARACTERISTICS OF MANET

Mobile ad hoc network nodes are furnished with wireless transmitters and receivers using antennas, which may be highly directional (point-to-point), omnidirectional (broadcast), probably steer able, or some combination thereof [4]. 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.

III. ROUTING PROTOCOLS

A. Pro-Active / Table Driven routing 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 [3]. 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 exclusive 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. Example 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)

B. Reactive (On Demand) protocols

Portable nodes- Notebooks, palmtops or even mobile phones usually compose wireless ad-hoc networks. This portability also brings a significant issue of mobility. This is a key issue in ad-hoc networks. The mobility of the nodes causes the topology of the network to change constantly.Reactive routing protocols were intended for these types of environments. Paths will be constantly changing. Instead, whenever a node needs a route to a given target, it initiates a route discovery process on the fly, for discovering out a pathway [8]. Reactive protocols start to set up routes on-demand. The routing protocol will try to establish such a route, whenever any node wants to initiate communication with another node to which it has no route. This kind of protocols is usually based on flooding the network with Route Request (RREQ) and Route reply (RERP) messages .By the help of Route request message the route is discovered from source to target node; and as the target node gets a RREQ message it send RERP message for the confirmation that the route has been established. This kind of protocol is usually very effective on single-rate networks. It usually minimizes the number of hops of the selected path. However, on multi-rate networks, the number of hops is not as important as the throughput that can be obtained on a given path [15].
The different types of On Demand driven protocols are:

- Ad hoc On Demand Distance Vector (AODV)
- Dynamic Source routing protocol (DSR)
- Temporally ordered routing algorithm (TORA)
- Associativity Based routing (ABR)
- Signal Stability-Based Adaptive Routing (SSA)
- Location-Aided Routing Protocol (LAR)

C. 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:

I) Ad hoc On Demand Distance Vector Routing (AODV)

Ad hoc On-Demand Distance Vector (AODV) routing is a routing protocol for mobile adhoc 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 [2]. AODV is capable of both unicast and multicast routing [16]. 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 [10].

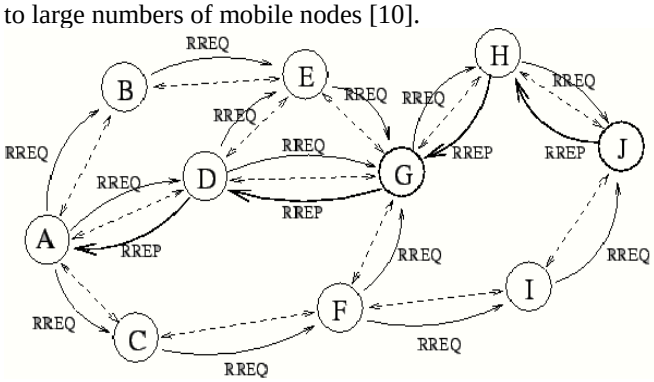

Fig 2 A Possible path for Root replies if wishes to find a route to J [9]

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.

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.[4] 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 report in precursor list", containing the IP address for each its neighbors that are likely to use it as a next hop towards each destination.

Advantages and Disadvantages

The main advantage of AODV protocol is that routes are established on demand and destination sequence numbers are used to find the latest route to the destination [5]. The connection setup delay is less. The HELLO messages supporting the routes maintenance are range-limited, so they do not cause unnecessary overhead

in the network. One of the disadvantages of this protocol is that intermediate nodes can lead to inconsistent routes if the source sequence number is very old and the intermediate nodes have a higher but not the latest destination sequence number, thereby having stale entries. Also multiple Route Reply packets in response to a single Route Request packet can lead to heavy control overhead [13]. Another disadvantage of AODV is that the periodic beaconing leads to unnecessary bandwidth consumption

II) 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 [13].Dynamic source routing protocol (DSR) is an on-demand, source routing protocol [6], 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 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.

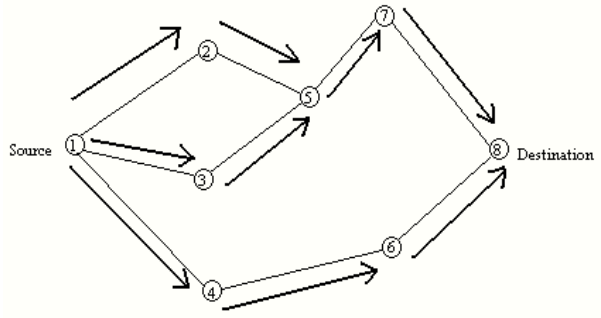

Fig 3 (a). Propagation of request (PREQ) packet

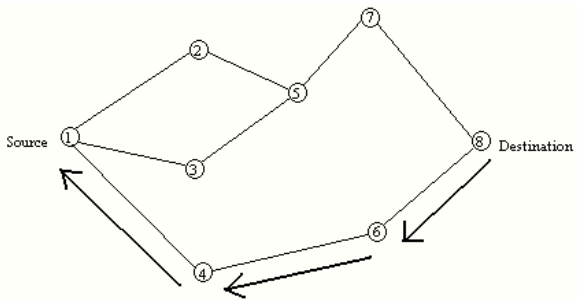

Fig 3 (b). Path taken by the Route Reply (RREP) Packet

Advantages and Disadvantages

DSR uses a reactive approach which eliminates the need to periodically flood the network with table update messages which are required in a table-driven approach [6]. The intermediate nodes also utilize the route cache information efficiently to reduce the control overhead. The disadvantage of DSR is that the route maintenance mechanism does not locally repair a broken down link. The connection setup delay is higher than in table-driven protocols. Even though the protocol performs well in static and low-mobility environments, the performance degrades rapidly with increasing mobility. Also, considerable routing overhead is involved due to the source-routing mechanism employed in DSR. This routing overhead is directly proportional to the path length.

TABLE I COMPARISON FOR REACTIVE ROUTING PROTOCOL

Parameters	AODV	DSR
Route Selection	Shortest and Updated Path	Shortest and Updated Path
Route Computation	Broadcast	Broadcast
Route	Multiple	Multiple
Topology Structure	Flat	Flat
Broadcast	Full	Full
Source Routing	Yes	No
Update	Event driven	Event driven
Update Information	Route Error	Route Error
Method	Unicast	Unicast
Beacon	Yes	No
Loop Free	Yes	Yes
Route Reconfiguration	Erase Route, Notify source	Erase Route, Notify source

IV. CONCLUSION

A comparison between AODV and DSR Reactive routing protocol of MANETs has been made in this paper. We need to undertake much deeper study of all these reactive routing protocols which could prove beneficial to make enhancements in performance of these protocols. It is highly recommended that we start with the basic building blocks of these protocols and see how each of these blocks interact with each other and thereby observing how the interaction could be coordinated more effectively so as to lead to increase in performance differentials.

This paper is based on, description of infrastructure network protocols and the comparison of protocols AODV and DSR. As seen from the paper that the needs and requirements of routing protocols for general ad hoc networks is very unique compared to routing protocols for Infrastructure networks. AODV although is an On-Demand routing protocol yet it maintains routing tables. We can say that it has Features of both table driven and reactive routing protocol. It has only one entry per source/destination pair, so it has to resort to route discovery more often than DSR. DSR do not make use of any routing tables. Instead it can have more than one route per source/destination pair. It makes complete use of source routing, that means the source or the initiator of the data packet has to determine the complete hop by hop route to the destination. Due to the availability of many alternate

routes it has to resort to route discovery less often than AODV [3].

On the basis of result, it was concluded that as the packet size is increased the end-to-end delay of AODV is lesser than that of DSR for larger number of nodes; average throughput of generating packets for DSR is larger than that of AODV for larger number of Nodes and traffic sources. However the average throughput of generating packets for AODV is greater when the numbers of nodes are 40 and 80. Delay is an important metric which decides the efficiency of the routing protocol

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