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Comparative Study of AODV, DSR and AOMDV Routing Protocols in MANET

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Abstract: A Mobile Ad-hoc Network MANET is a dynamic wireless network that is formed even if an infrastructure in which each nodes act as a router does not exist. MANET is an autonomous system in which mobile nodes are connected by wireless links. All the nodes operate as an end system and as a router, to route packets. The nodes are freely movable and organize themselves into a network. The change in positions of these nodes is frequent. In this work we attempt to compare the performance of three prominent on demand reactive routing protocols AODV, DSR and AOMDV.

Keywords: MANETS, AODV, DSR, AOMDV.

I. INTRODUCTION

A mobile ad hoc network [1] is a collection of digital data terminals equipped with wireless transceivers. These terminals can communicate with one another without using any fixed networking infrastructure. Transmission of data packets on a common wireless Channel is done to maintain the communication. Fixed infrastructure like base stations, is not present in it, which precisely makes an ad hoc network different from wireless LAN. Communication from a mobile terminal in an infrastructure network, such as a cellular network, is always maintained with a fixed base station. The mobile terminal (node) in an ad hoc network can communicate directly with another node in its radio transmission range. For the node which is out of its radio range, data packets use a store-and-forward multi hop transmission principle. All nodes in an ad hoc network are needed to pass on packets in support of other nodes.

The design of ad hoc network faces quite a few challenges.

1) The nodes in an ad hoc network,i.e. the source nodes, the subsequent destinations and the routing nodes forwarding traffic between them, may be moving.
2) As the wireless communication range has limits, the link between a pair of adjacent nodes breaks soon as they move out of range. Classification of routing protocols in mobile ad hoc network namely Proactive, Reactive and Hybrid.

A. Proactive routing protocols

Proactive protocols execute routing operations between all source destination pairs every so often, independent of the need of such routes. These protocols attempt to maintain shortest path routes by using periodically updated views of the network topology. These are typically maintained in routing tables in each node and updated with the acquisition of new information. Proactive protocols have certain advantages.

a) They provide lower latency in data delivery
b) Possibility of supporting applications that have quality-of-service constraints.

Their main disadvantage is wastage of bandwidth in sending update packets periodically even when they are not necessary, such as when there are no link breakages or when only a few routes are needed Examples of Proactive MANET Protocols include: Optimized Link State Routing (OLSR), Fish-eye State Routing (FSR), Destination-Sequenced Distance Vector (DSDV) etc.

B. Reactive routing protocols

Reactive protocols are intended to curtail routing overhead. Instead of keeping track of the dynamic changes in the network topology to continuously maintain the direct shortest routes to all possible destinations, these protocols settle on routes only when needed. Typically, these protocols find out the route from source to the desired destination when source is required to transmit a data packet and the path to the destination is unknown. So long as a route exists, reactive routing protocols just maintain the route and choose to discover a new route only when the existing one breaks. The benefit of this on-demand operation is that it mostly has a comparatively lower average routing overhead than in proactive protocols. Yet, it has the drawback that flooding can occur while discovering the route which may involve flooding the whole network with query packets. Flooding is wasteful, which can be required quite often when there is a high mobility or when the number of active source-destination pairs are high. Moreover, route discovery increases the delay in packet delivery as the source has to wait till the route is determined before the packet can be sent. Even after these shortcomings, on-demand protocols comparatively seek more attention than proactive routing protocols, as the bandwidth benefit makes them even scalable. Main thought behind on-demand routing is to search and preserve only required routes.

On the other hand, data packets face queuing delays at the source because of 3 reasons

1) When the routes are created as the need arises

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2) When the route discovery is in process during the session initiation
3) When route is being repaired on a failure

An additional, not so obvious outcome of on-demand routing is that routes may become suboptimal, as time progresses. This is because with a pure on-demand protocol a route is continued to be used until it fails. AODV is a on demand driven protocol, AOMDV is Ad-hoc On-demand Multipath Distance Vector Routing

C. *Hybrid Routing Protocols*

Hybrid protocol is a blend of Proactive and Reactive approaches. An example of such a protocol is the Zone Routing Protocol (ZRP), temporally ordered routing algorithm (TORA).

Our discussion is limited to three on-demand ad-hoc routing protocols AODV, AOMDV and DSR.

II. CLASSIFICATION OF ROUTING PROTOCOLS

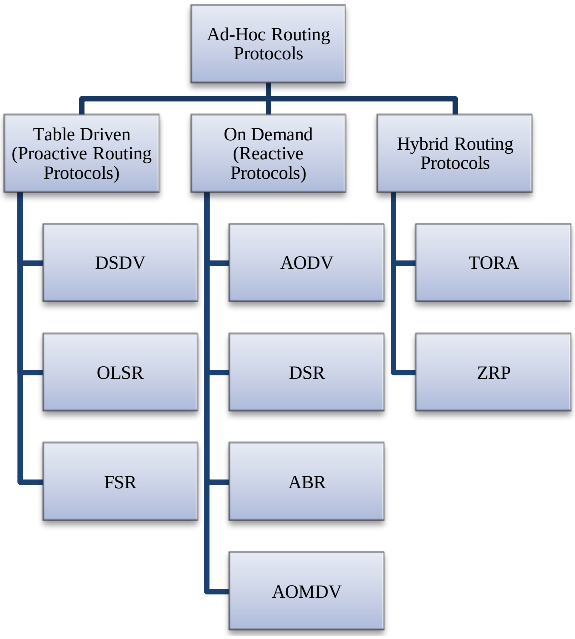

Fig 1: Classification of Routing Protocols in Wireless Ad-Hoc Networks

A) *Ad Hoc on Demand Distance Vector (AODV)*

It discovers routes on demand basis & uses routing tables for preserving the route information.

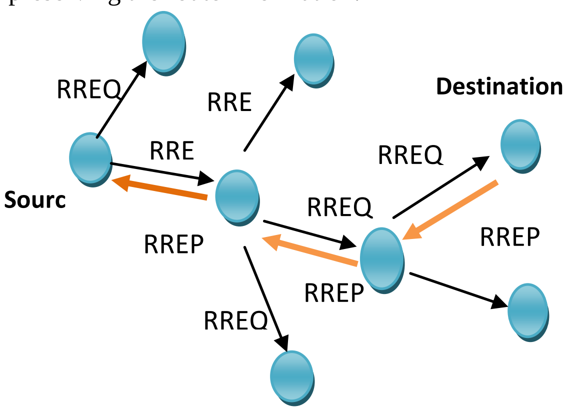

Fig 2: AODV Routing Protocol with RREQ & RREP Message

It is not required to keep up routes to nodes that are not active in transmitting & receiving as it is a reactive protocol. AODV's route discovery process involves Route Request (RREQ) messages. RREQ message is broadcasted to all the adjacent nodes. Until the desired destination knowing fresh route is reached, the message continues to get flooded in the network. Sequence numbers are important to avoid loops. RREQ message cause bypassed node to allocate route table entries for reverse route. The destination node unicasts a Route Reply (RREP) back to the Source node. Node transmitting a RREP message creates routing table entries for forward route [3] [4] [5].

For maintaining the nodes, HELLO messages are sent to adjacent nodes periodically. It is concluded that link to that specific node is down If a node is unable to receive consecutive HELLO messages from an adjacent node. A Route Error (RERR) message is sent if a node detects a broken link to any upstream node. When a node receives a RERR message it will indicate a new source discovery process. Figure (Fig.3) shows AODV routing protocol with RERR message.

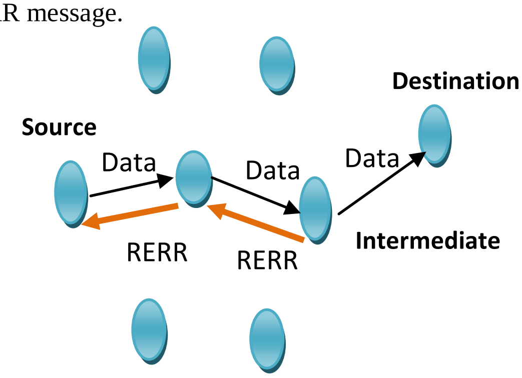

Fig 3: AODV Routing Protocol with RERR Message

B) *Dynamic Source Routing (DSR)*

The Dynamic Source Routing (DSR) is an on demand source routing protocol [6] that employs route discovery and route maintenance procedures same as that of AODV. In DSR, each node maintains a route cache with entries that are continuously updated as the node learns new routes. Similar to AODV, a node wishing to send a packet will first examine its route cache to see whether it already has a route to the destination. If there is no valid route in the cache, the sender initiates a route discovery procedure by broadcasting a route request packet, which contains the address of the destination, the address of the source, and a unique request ID. As this request propagates through the network, each node inserts its own address into the request packet before rebroadcasting it. As a consequence, a request packet records a route consisting of all nodes it has visited. When a node receives a request packet and finds its own address recorded in the packet, it discards this packet and does not rebroadcast it further. A node keeps a record of lately forwarded request packets, and maintains the cache of their sender addresses, request IDs, and rejects any duplicate request packets. The entire path from the source to the destination will have recorded once a request packet arrives at the destination. In symmetric networks, the destination node can unicast a response

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packet, containing the collected route information, back to the source using the exact same path as taken by the request packet. In networks which has asymmetric links, the destination itself can initiate a route discovery procedure to the source, in which the request packet also contains the path from source to the destination. Once the response packet (or the destination's request packet) arrives at the source, the source can add the new route into its memory and start to transmit packets to the destination. Like AODV, DSR also uses a route maintenance procedure based on error messages, which are generated whenever the data link layer detects a transmission failure due to a broken link. Compared to proactive routing protocols, DSR shares similar benefits & Drawbacks as AODV. Unlike AODV, each packet in DSR carries route information, which allows intermediate nodes to add new routes proactively to their own caches. DSR's support of asymmetric links is yet another advantage when compared with AODV.

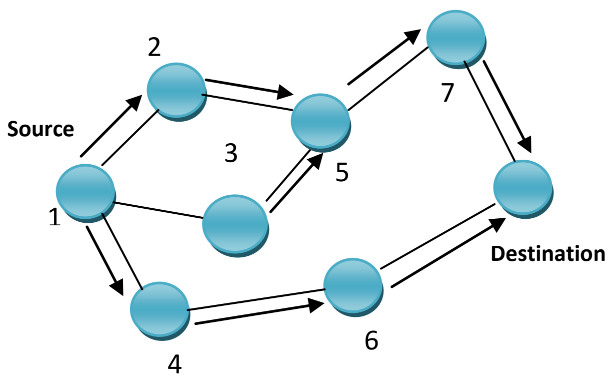

Fig 4: Propagation of request (PREQ) packet

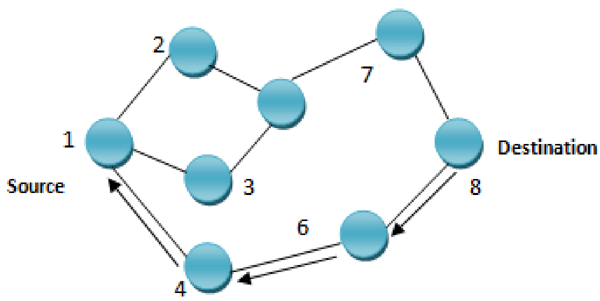

Fig 5: Path taken by the Route Reply (RREP) packet

C) Ad-hoc On-demand Multipath Distance Vector Routing (AOMDV)

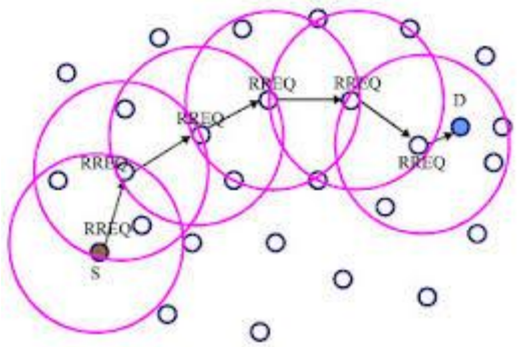

Fig 5: AOMDV Request Response [9]

Ad-hoc On-demand Multipath Distance Vector Routing (AOMDV) [7] protocol is an extension to the AODV protocol as far as calculating multiple loop-free and link disjoint paths is concerned[8]. The routing table entry for each destination contain a list of the next-hops along and the respective hop counts. All the next hops have the same sequence number. This helps in keeping track of a route. For each destination, a node maintains the advertised hop count, which is defined as the maximum hop count for all the paths, which is used for sending route advertisements of the destination. Each duplicate route advertisement received by a node defines an alternate path to the destination. Loop freedom is assured for a node by accepting alternate paths to destination if it has a less hop count than the advertised hop count for that destination. Because the maximum hop count is used, the advertised hop count therefore does not change for the same sequence number [8]. When a route advertisement is received for a destination with a greater sequence number, the next-hop list and the advertised hop count are reinitialized. AOMDV can be used to find node-disjoint or link-disjoint routes. To find node-disjoint routes, each node does not immediately reject duplicate RREQs. Each RREQs arriving via a different neighbor of the source defines a node-disjoint path. This is because nodes cannot be broadcast duplicate RREQs, so any two RREQs arriving at an intermediate node via a different neighbor of the source could not have traversed the same node. In an attempt to get multiple link-disjoint routes, the destination replies to duplicate RREQs, the destination only replies to RREQs arriving via unique neighbors. After the first hop, the RREPs follow the reverse paths, which are node disjoint and thus link-disjoint. The trajectories of each RREP may intersect at an intermediate node, but each takes a different reverse path to the source to ensure link is disjoint [8]. The advantage of using AOMDV is that it allows intermediate nodes to reply to RREQs, while still selecting disjoint paths. But, AOMDV has more message overheads during route discovery due to increased flooding and since it is a multipath routing protocol, the destination replies to the multiple RREQs those results are in longer overhead.

Sr. no	Performance Constraints	DSR	AODV	AOMDV
1	Proactive	No	No	No
2	Reactive	Yes	Yes	Yes
3	Hybrid	No	No	No
4	Loop Free Routers Available		Yes	Yes
5	Scalability	Yes	Yes	Yes
6	Route optimization	Yes	Yes	Yes
7	Distributed Environment	Yes	Yes	Yes
8	Unidirectional Link	Yes	No	No
9	Multicast	No	No	Yes
10	Periodic Broadcast	No	Yes	Yes
11	QoS Support	Less	Less	More
12	Route Maintenance	Yes	No	No
13	Type of Protocol	Distance Vector	Distance Vector	Distance Vector
14	Message Overhead	Less	Less	Less
15	Delay in New Route Discovery	Less	More	Moderate

Fig 6:-Performance analysis of DSR, AODV, AOMDV

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