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A Review on Different Routing Protocols in MANETS

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***Abstract*—MANET is a collection of wireless mobile nodes that can freely and dynamically self organize into arbitrary and temporary adhoc network topologies. The different features of Mobile Adhoc Network are Distributed operations, Multi-hop routing, Dynamic topology, Energy constrained operations etc. Routing protocols help nodes in MANET to communicate with each other. In Unipath routing protocols single path is formed between two communicating nodes and in multipath routing multipath paths are formed between communicating nodes.**

Keywords—MANET, Unipath Routing, Multipath Routing, DSDV, DSR, AODV, AOMDV.

1. INTRODUCTION

A Mobile Ad-hoc network is composed of number of wireless mobile nodes which are capable of communicating with each other without the use of a network infrastructure or any centralised administration. It is self directed network with collection of mobile users that communicate over relatively bandwidth constrained wireless links. Since the nodes are mobile, the network topology may change dynamically and it is unable to retract over time. The network is distributed, where all activities of network like adapting topology and delivery of messages must be executed by the nodes themselves, i.e., routing functionality will be incorporated into mobile nodes. The nodes which are in radio range of each other can communicate directly, and others communicate through intermediate nodes to route their packets. Each node communicate through its wireless interface. As the network is fully distributed, so it can work without a fixed infrastructure as access points and base stations. Figure1 shows a simple adhoc network with three nodes. Node 1 and node 3 are not in range of each other, so node 2 act as router to route packets between node 1 and node 3.

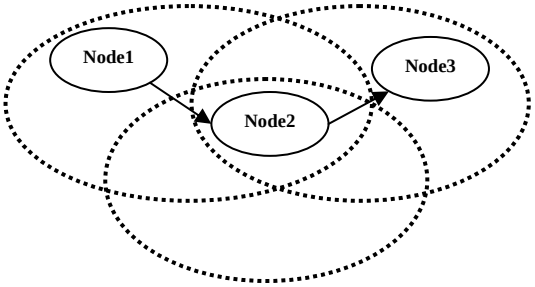

Figure 1: A Simple Adhoc Network

1.1 Characteristics of Manets

i) **Distributed Operations:** As there is no background network for central control of the network operation, the control of the network is distributed among the nodes. The nodes in a mobile adhoc network should cooperate with each other and communicate with each other, and each node performs the function of routing and security as and when needed.

ii) **Multi-hop Routing:** When a node wants to send data to another node, which is not in its radio range, then the intermediate nodes act as router to provide route between these nodes.

iii) **Dynamic Topology:** As the nodes in MANETs are mobile i.e. can move arbitrarily, so the network topology can change frequently and unpredictably. The nodes in the network set their routes dynamically over time.

iv) **Energy Constrained Operations:** Each node in the network depends on batteries or some other exhaustible means for their energy, which is limits the capabilities i.e. services and applications provided by a node. This is one of the major issues in the MANETs, as one node act as receiver and router at the same time, so additional energy is required in forwarding messages.

v) **Heterogeneity in node and link capabilities:** every node in the network may have one or more different radio interfaces which have varying transmitting and receiving capabilities, which operates on different frequency bands. This variation in the node radio capabilities leads to asymmetric links. Each node may also have different processing capabilities because of heterogeneity in software/hardware configuration. For such heterogeneous network, the design of protocols and algorithms is complicated, requiring dynamic adaptation to the changing conditions.

vi) **Limited Bandwidth:** Wireless links continue to have significantly lower capacity than their hardwired counterparts. In addition, the realized throughput of wireless communication-after accounting for the effects for multiple access, fading, noise and interference conditions, etc., is often much less than a radio's maximum transition rate.

vii) **Security:** Mobile wireless networks are more prone to threats than infrastructured networks. As in MANETs, all the networking functions like routing, packet forwarding are performed by the nodes itself, because of this reason securing a mobile wireless network is

very challenging. The increased possibility of eavesdropping, spoofing and minimization of denial-of-service type attacks should be carefully into consideration.

1.2 Advantages of MANET

The advantages of an Ad-Hoc network are as follows:

- Manets help providing access to information and services irrespective of geographic position.
- Manets do not have any central network administration. It is a self-configuring network, where nodes also act as routers. So, it is less expensive as compared to wired network.
- Adhoc network is scalable, i.e. it can accommodate the addition of more nodes.
- Improved flexibility.
- Manets are robust, because of decentralize administration.
- The network can be set up at any place and time.

2. ROUTING PROTOCOLS

Routing protocols are used to discover routes between nodes, helps the nodes to communicate within the network. The principal aim of ad-hoc routing protocol is to set up correct and efficient route between a pair of nodes in order that messages between the nodes may be delivered in a timely manner. The route between the nodes should be constructed in such a way that it has minimum number of overheads and bandwidth consumption. The two major categories of adhoc networks are:

I. Unipath Routing Protocols
II. Multipath Routing Protocols

Unipath Routing Protocols

The unipath routing protocols create a single route between a pair of source and destination. In response to every route break a new discovery is required, which leads to high overheads and latency. The unipath routing protocols work in two parts:

i) **Route Discovery:** to find route between source and destination.
ii) **Route Maintenance:** to repair a broken route or finding a new route in the case of route failure.

The most commonly used unipath routing protocols are Destination Sequenced Distance Vector (DSDV) Routing Protocol, Dynamic Source Routing (DSR) Protocol, Ad-hoc On-demand Distance Vector (AODV) Routing Protocol, etc.

Multipath Routing Protocols

The multipath routing protocols create multiple routes between a pair of source and destination to have load balancing to satisfy Quality of Service (QoS) requirements. The multipath routing protocols work in three steps:

i) **Route Discovery:** to find multipath nodes disjoint, link disjoint or non-disjoint routes between source and destination.
ii) **Traffic Allocation:** once the routes are discovered between source and destination, the source node has to select a set of paths to the destination and then begins sending data to the destination along the paths.
iii) **Path Maintenance:** regenerating paths after initial path discovery, so as to avoid link/node failures that may occur over time and node mobility.

The benefits of multipath routing protocols are as follows:

i) **Fault Tolerance:** The redundant information is being routed to the destination through different paths, this reduces the probability of the interruption in communication in case of link failures.
ii) **Load Balancing:** To avoid congestion in links, the traffic is being transmitted using alternative paths.
iii) **Bandwidth Aggregation:** The data is being split into multiple streams and then sent through different paths to the same destination. This helps in effective bandwidth aggregation.
iv) **Reduced Delay:** In the unipath routing protocols, to avoid a route failure a new route discovery process needs to be initiated. This leads to high route discovery delay. This delay is minimized in multipath routing protocols by backup routes that have been identified in route discovery process.

The most recently used multipath routing protocols are Temporally Ordered Routing Algorithm (TORA) Routing Protocol, Ad-hoc On-demand Multipath Distance Vector (AOMDV) Routing Protocol.

2.1 Destination Sequenced Distance Vector (DSDV) Routing Protocol

Destination-Sequenced Distance-Vector Routing (DSDV) is a table-driven routing scheme for ad hoc mobile networks based on the Bellman-Ford algorithm. The improvement made to the Bellman-Ford algorithm includes freedom from loops in routing tables by using sequence numbers. It was developed by C. Perkins and P. Bhagwat in 1994. The DSDV protocol can be used in mobile ad hoc networking environments by assuming that each participating node acts as a router. Each node must maintain a table that consists of all the possible destinations. In this routing protocol, an entry of the table contains the address identifier of a destination, the shortest known distance metric to that destination measured in hop counts and the address identifier of the node that is the first hop on the shortest path to the destination. Each mobile node in the system maintains a routing table in which all the possible destinations and the number of hops to them in the network are recorded. A sequence number is also associated with each route/path to the destination. The route labeled with the highest sequence number is always used. This also helps in identifying the stale routes from the new ones, thereby avoiding the formation of loops. Also, to minimize the traffic generated, there are two types of packets in the system. One is known as “full dump”, which is a packet that carries all the information about a change. However, at the time of occasional movement, another type of packet called “incremental” will be used, which will carry just the changes, thereby, increasing the overall efficiency of the system. DSDV requires a regular update of its routing tables, which uses up battery power and a small amount of bandwidth even when the network is idle. Whenever the topology of the network changes, a new sequence number is necessary before the network re-

converges; thus, DSDV is not suitable for highly dynamic networks.

2.2 Ad-Hoc On-Demand Distance Vector (AODV) Routing Protocol

The Ad hoc On Demand Distance Vector (AODV) routing algorithm is a routing protocol designed for ad hoc mobile networks. AODV is capable of both unicast and multicast routing. It is an on demand algorithm, meaning that it builds routes between nodes only as desired by source nodes. It maintains these routes as long as they are needed by the sources. Additionally, AODV forms trees which connect multicast group members. The trees are composed of the group members and the nodes needed to connect the members. AODV uses sequence numbers to ensure the freshness of routes. It is loop-free, self-starting, and scales to large numbers of mobile nodes. The AODV protocol uses *route request* (RREQ) messages flooded through the network in order to discover the paths required by a source node. An intermediate node that receives a RREQ replies to it using a *route reply* message only if it has a route to the destination whose corresponding destination sequence number is greater or equal to the one contained in the RREQ. The RREQ also contains the most recent sequence number for the destination of which the source node is aware. A node receiving 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 traveling 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 destination(s).

2.3 Dynamic Source Routing (DSR) Protocol

Dynamic Source Routing (DSR) is a routing protocol for wireless mesh networks and is based on a method known as *source routing*. It is similar to AODV in that it forms a route on-demand when a transmitting computer requests one. Except that each intermediate node that broadcasts a route request packet adds its own address identifier to a list carried in the packet. The destination node generates a route reply message that includes the list of addresses received in the route request and transmits it back along this path to the source. Route maintenance in DSR is accomplished through the confirmations that nodes generate when they can verify that the next node successfully received a packet. These confirmations can be link-layer acknowledgements, passive acknowledgements or network-layer acknowledgements specified by the DSR protocol. However, it uses source routing instead of relying on the routing table at each intermediate device. When a node is not able to verify the successful reception of a packet it tries to retransmit it. When a finite number of retransmissions fail, the node generates a route error message that specifies the problematic link, transmitting it to the source node. When a node requires a route to a destination, which it doesn't have in its route cache, it broadcasts a *Route Request (RREQ)* message, which is flooded throughout the network. The first RREQ message is a broadcast query on neighbours without flooding. Each RREQ packet is uniquely identified by the *initiator's address* and the *request id*. A node processes a route request packet only if it has not already seen the packet and its address is not present in the route record of the packet. This minimizes the number of route requests propagated in the network. RREQ is replied by the destination node or an intermediate node, which knows the route, using the *Route Reply (RREP)* message. The return route for the RREP message may be one of the routes that exist in the route cache (if it exists) or a list reversal of the nodes in the RREQ packet if symmetrical routing is supported. In other cases the node may initiate it owns route discovery mechanism and piggyback the RREP packet onto it. Thus the route may be considered unidirectional or bidirectional. DSR doesn't enforce any use of periodic messages from the mobile hosts for maintenance of routes. Instead it uses two types of packets for route maintenance: Route Error (RERR) packets and ACKs. Whenever a node encounters fatal transmission errors so that the route becomes invalid, the source receives a RERR message. ACK packets are used to verify the correct operation of the route links. This also serves as a passive acknowledgement for the mobile node. DSR enables multiple routes to be learnt for a particular destination.DSR does not require any periodic update messages, thus avoiding wastage of bandwidth.

2.4 Ad-Hoc On-Demand Multipath Distance Vector (AOMDV) Routing Protocol

The AOMDV is an on demand routing protocol based on distance vector concept and uses hop-by-hop routing approach to carry out transmission. In AOMDV, route request packet (RREQ) propagation from the source towards the destination establishes multiple paths both at intermediate nodes as well as the destination. Multiple route reply packet (RREPs) traverse these reverse paths back to source at the destination and intermediate nodes. AOMDV guarantees loop freedom and disjoint of multiple paths by formulating certain rules in which every node in the network must observe. In order to maintain multiple paths for the same sequence number, AOMDV uses the notion of an "advertised hop count". Every node is required to maintain this variable for each destination. This variable is set to the length of the longest available path for the destination at the time the first advertisement for a

particular destination sequence number. The advertised hop count remains unchanged until the sequence number changes. The use of the longest allows more number of alternate paths to be maintained while enforcing the route advertisement rule. Apart from maintaining multiple loopfree paths, AOMDV ensures that alternate paths are disjoint so that they are more likely to fail independently. First, confirm that you have established connection from destination and maintained multiple routes for alternative option.

3. COMPARISON OF ROUTING PROTOCOLS

The comparison of different routing protocols discussed above, is as follows based on their characteristics:

Protocol Property	DSDV	DSR	AODV	AOMDV
Source Routing	No	Yes	No	Yes
Loop Free	Yes	Yes	Yes	Yes
Multicast	No	No	Yes	Yes
Periodic Broadcast	Yes	No	No	No
Route Maintained	Routing Table	Route Cache	Routing Table	Routing Table
Reactive	No	Yes	Yes	Yes

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