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Analyzing Multipath Routing Protocol in Ad Hoc Networks

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Abstract: A Mobile Ad Hoc Network (MANET) is a collection of mobile nodes that create a dynamic infrastructure-less communication network and an extremely challenging network. The design of robust routing algorithm for ad hoc networks is a big challenge, because network topology changes dynamically. In order to deal with the challenges such as fault tolerance, load balancing, minimizing end-to-end delay multipath routing strategy has been exploited. AOMDV is one of the multipath routing protocols. AOMDV is an extension to the unipath routing protocol i.e. AODV. This paper discusses routing strategies in mobile ad hoc networks, giving stress on multipath routing and compares the two protocols namely AODV (a unipath routing protocol) and AOMDV (a multipath routing protocol).

Keywords: Mobile Ad hoc Networks, Unipath Routing, AODV, Multipath Routing, AOMDV.

I. INTRODUCTION

A. Mobile Ad Hoc Networks (MANET)

A mobile ad-hoc network is a grouping of mobile nodes that create a dynamic infrastructure-less communication network of arbitrary topology. The lack of a fixed centralized system compels each and every communicating node in the network to perform routing. Quick and easy establishment of mobile ad-hoc networks makes them practical to use in disaster prone areas, military and in other environments where there is no infrastructure or it has already been destroyed due to any natural calamities. In such type of situations, Ad hoc Networks is a notable matter of study because mobile nodes may move freely in various directions, which can break the existing links and get connected with some other node in network, with change in time. The performance of routing protocols is affected by the mobility of nodes. Routes between two communicating nodes may consist of multiple nodes between source and destination. Thus, discovering and maintaining routes in MANET is significant [1], [3].

B. Routing Protocols in MANET

The existing routing protocols can be divided into two classes based on routing strategy.

1. Unipath Routing: In single path routing algorithms, only one path is saved between each source-destination pair.

2. Multipath Routing: In multipath routing algorithms, multiple paths are saved in the routing table for each source-destination pair.

The whole paper is divided into seven sections. Section 1 gives an introduction of MANETs and routing strategies used in them. Section 2 gives an overview of unipath routing protocols. Section 3 discusses about the key elements of multipath routing and its benefits. Section 4 presents the idea of ad hoc on-demand distance vector routing protocol (AODV). Section 5 gives a brief discussion of ad hoc on-demand multipath distance vector routing protocol (AOMDV). Section 6 compares the two protocols i.e. AODV and AOMDV. Section 7 is the conclusion of the paper.

II. UNIPATH ROUTING

Unipath Routing protocols are classified as in the figure below.

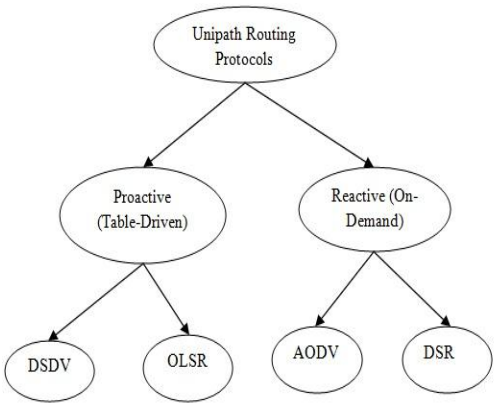

Fig 1: Classification of Unipath Routing Protocols in MANETs

The Proactive protocols are also known as table-driven routing protocols because each router has its own routing table. In this category routes are discovered in advance for each destination node in the network. So in this approach most of the efforts are wasted because it is not necessary that communication will take place between each source-destination pair and all routes are not utilized.

The Reactive protocols are also known as on-demand routing protocols because routes are not discovered in

advance. Routing is done on the demand basis which specifies that routes are created only when a node require to send packets to the other nodes [1].

III. MULTIPATH ROUTING

This section gives an overview of multipath routing and its advantages.

A. Advantages of Multipath Routing

Multipath Routing provides many advantages over previous single path routing: these are fault tolerance, reduced delay, load balancing and bandwidth aggregation [8], [9].

1. Fault Tolerance: In multipath routing protocols, redundant information is routed to the destination through alternate paths. It reduces the probability of communication failure in case of link failure.
2. Reduced Delay: In case of single path routing protocols, a route failure means that a new path discovery process needs to be initiated to find a new route. So it introduces the route discovery delay. But this delay is minimized in multipath routing because more alternate paths were discovered during route discovery process.
3. Load Balancing: If a link is congested or over utilized, multipath routing protocols can choose alternate paths to divert traffic to reduce the burden of congested link.
4. Bandwidth Aggregation: Data to the same destination are split into multiple streams and each stream is forwarded to a different path. In this way a huge amount of data may reach to its destination simultaneously through different paths that result in bandwidth aggregation.
5. Components of a Multipath Routing protocol: There are three major components of multipath routing.

1. Path Discovery

It is the process of finding available paths for a source-destination pair. A number of criteria are there to decide which subset of possible paths is to be discovered in discovery process. Path discovery procedure ensures path disjointness. Disjointness can be on the basis of node or link. If paths are link-disjoint, it means there would be no common link in any two paths where they may share some common intermediate nodes. But if paths are node-disjoint, then they have no common nodes except the source and the destination nodes.

2. Distribution of traffic over multiple paths

Different strategies may be used to allocate data traffic over discovered paths. A multipath protocol may use only one path with best metric to forward traffic and keep other available paths as backup paths while the multiple paths may be used concurrently. To select more than one path, quality of paths is considered. Hop-count is one of the preferred metric to use but there are other metrics also that are very effective in choosing subset of paths which are path reliability, path disjointness and available bandwidth.

3. Path Maintenance

In ad hoc networks, links are temporary, so paths may fail due to link or node failures or due to node mobility. So path maintenance involves reestablishment of paths after initial path discovery. It can be introduced after every path failure or when all paths have failed.

IV. AD HOC ON-DEMAND DISTANCE VECTOR ROUTING (AODV)

AODV is a reactive protocol and it uses destination sequence number for each route entry. The route with higher destination sequence number is the newer one, so with two routes to the same destination, the route with the higher destination sequence number is always used for communication and the route with the lower destination sequence number is discarded. AODV protocol uses Route Request (RREQ), Route Reply (RREP) and Route Error (RERR) messages for communication. When a node has any packet to send to the other node, it first discovers the route to the destination node by sending Route Request packet to its neighboring nodes. RREQ packets are always broadcasted. Each node that receives the RREQ packet stores a route back to the sender of the request, so that RREP packet can be unicasted back to the originator of the RREQ packet or to the intermediate nodes. Route Reply (RREP) packet in AODV contains only destination IP address and sequence number. If any link is broken in the network, then the connected nodes are notified with the RERR (Route Error) packet. AODV uses less memory space for storing routing information as only active routes are maintained [2], [4], [5].

V. AD HOC ON-DEMAND MUTIPATH DISTANCE VECTOR ROUTING (AOMDV)

Ad hoc on-demand Multipath Distance vector Routing (AOMDV) protocol is an enhancement to the AODV protocol for computing multiple loop-free and link disjoint paths. Routing table in AOMDV contain a list of paths for each destination node in wireless ad hoc network. The destination sequence number of all paths to a destination is same. If a node advertises a route with a higher sequence number, all old sequence number routes are removed. Hop-count and next hop fields are stored in the route entry.

Hop count keeps track of number of hops from source to destination node. So hop count is the metric which determine the quality of a route.

If hop count is less for any path as compared to other path between same source-destination pair, then that path is used for communication until any link or node failure occurs.

To guarantee link-disjointness of paths in routing table, path advertisement having common next hop or a common last hop as the one present in the route table is discarded by every node [6], [7], [10].

VI. COMPARISON BETWEEN AODV AND AOMDV

Due to availability of single path in AODV, problems of link failure and congestion may arise that can affect the communication between nodes. The drawback of using AODV routing protocol is that if a link is broken or congested, then the whole communication is failed because there is no backup path through which communication may take place.

This problem is overcome by AOMDV. It utilizes multiple source-destination paths. If a link or path is unavailable then one of the alternate paths can be used for communication. So AOMDV is more reliable than AODV for wireless ad hoc networks.

AOMDV is better than AODV in case of packet delivery also. The number of packets dropped in AODV is more than the number of packets dropped in AOMDV. In case of node failure, AODV drops all packets whereas AOMDV uses alternate or backup path for packet delivery. Also AOMDV offers a multipath, loop-free extension to AODV [11]. It ensures that alternate paths at every node are disjoint. In case of routing overhead AODV performs well as compared to AOMDV.

VII. CONCLUSION

The paper introduces the concept of Mobile Ad hoc Networks and discusses various routing strategies i.e. unipath and multipath routing. Multipath routing is used for building multiple communication paths between the nodes of the networks and at the end one of the effective multipath routing protocols i.e. AOMDV has been compared to unipath on-demand routing protocol i.e. AODV. It is clear from the discussion that AOMDV incurs more routing overhead but is better in case of packet delivery.

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