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MODRP: Multipath on-Demand Routing Protocol for MANET

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ABSTRACT

The popularity and availability of portable wireless devices, which makes mobile ad-hoc networks, scalable with routing protocols. On-demand routing protocols adapt well with dynamic topologies of ad-hoc networks, because of their lower control overhead and quick response to route breaks. As the size of the network increases, static routing protocols perform weaker due to large routing overhead generated while repairing route breaks. We propose a multipath on-demand routing protocol (MODRP), which reduces the routing overhead occurred and also recovering from route breaks, by using secondary paths. MODRP computes fail-safe multiple paths, which provides all the intermediate nodes on the primary path with multiple routes (if exists to destination nodes) confirms that MODRP is scalable, and performs better even when compared to the disjoint multipath routing protocol (DMRP) and ad hoc at higher mobility and large traffic loads, on-demand distance vector (AODV) routing protocols.

Keywords: MODRP, DMRP, AODV, TORA

1.0 INTRODUCTION

Mobile ad hoc networks are self-configuring and self-organizing wireless networks, which operate without any fixed infrastructure or wired backbone. Proactive routing protocols [1–3] are based on either link-state [4] or distance-vector [5] routing scheme. Pei et al. [2] proposed fish eye state routing (FSR) based on link-state exchanges. Nodes typically communicate over multiple hops, while intermediate nodes act as routers by forwarding data. The topology of ad-hoc network is highly dynamic because of mobility and limited battery power of nodes. Routing protocols should adapt to such dynamic situation, and continue to maintain connections between the communicating nodes in the presence of path breaks caused by mobility and/or node failures, as the user of wireless devices increases.

Routing protocols need to adjust to networks with thousands of nodes. Typical examples of large ad-hoc networks are technical festivals in universities and military communication networks (which involve hundreds to thousands of devices). Maintaining routes of large networks becomes cumbersome due to longer path lengths between each node pairs. Longer the paths, more the number of nodes on the path and the possibility of route breaks is more because, any single node failure disconnects the source from destination. The limitations of existing ad-hoc routing protocols in supporting scalability are low. The proactive routing protocols are based on either link-state or distance-vector routing schemes. These protocols compute routes to all the nodes in the network, and maintain them in background by periodically exchanging routing updates. Hierarchical routing protocols [7–9] reduce the overhead generated by periodic updates, using clustering. Hierarchical state routing (HSR) [7] groups nodes into clusters based on their geographical proximity, and a node in the cluster is elected as cluster-head to represent that cluster.

Hierarchical routing protocols reduce the overhead generated by periodic updates, using clustering. On-demand routing protocols [10–13] are credited to be adaptive to the dynamic environment of ad-hoc networks, due to their low routing overhead and quick response to route disconnections. Temporally ordered routing algorithm (TORA) [13] uses link reversal technique to compute different paths, which requires reliable and in-order delivery of routing messages. The requirement causes high routing overhead, and makes the route convergence difficult in large networks. The TORA attempts to achieve a high degree of scalability using a "flat", non-hierarchical routing algorithm. The protocol performs three basic functions: Route creation, Route maintenance and Route erasure.

2. MULTIPATH ON-DEMAND ROUTING PROTOCOL (MODRP):

The multipath on-demand routing protocols [15,17,14] have been proposed for ad-hoc networks Multipath source routing (MSR) [15,16], uses DSR route discovery and route maintenance phase to compute multiple node-d is joint paths. The principle objective of MODRP is to reduce the amount of routing overhead generated by a unipath on-demand routing protocol, using multipath routing. Alternate paths to destination avoid the overhead generated by the additional routing discoveries and route error transmissions, during route break recovery. Reduction in routing overhead allows the protocol to scale to larger networks. Multiple paths between a source and a destination are of two types, namely node-disjoint and link-disjoint multiple paths. Node-disjoint paths do not have any nodes in common, except the source and destination, as shown in Fig. 1(a). Nodes labelled S and D are source and destination nodes, respectively. Multipath protocols [18–19] based on distance vector routing scheme have also been proposed for ad-hoc networks. AODV-BR [18] calculates multiple paths without any extra control overhead. Many disjoint multipath routing techniques [16,20,23,17,22,23,26] have been proposed for ad hoc networks, which have focused on improving the reliability of routing using path disjointness or redundancy.

It provides traffic load-balancing (by dispersing data over multiple paths), and fault-tolerance towards route breaks. The advantage of node- disjoint multiple paths is that they fail independent of each other. Breakage of any link on one path can be corrected by resuming the data session through one of the other paths. Link-disjoint paths do not have common links, but may have nodes in common. A set of link-disjoint paths are formed by a series of node-disjoint segments. Each segment is a node-disjoint path between any two nodes. For examples, Fig.1(b) shows link-disjoint multiple paths between S and D, formed with two segments. Although, link disjoint paths are more available than node-disjoint and fail-safe segment The bypasses node C on the primary path, and path at node B through the node K is a secondary path. MODRP uses the idea of fail-safe multiple paths. A path between source and destination is said to be fail-safe to the primary path if it bypasses at least the intermediate node on, the primary path. In other words, the fail- safe path can be used to send data packets in case the bypassed node(s) on the primary path move away.

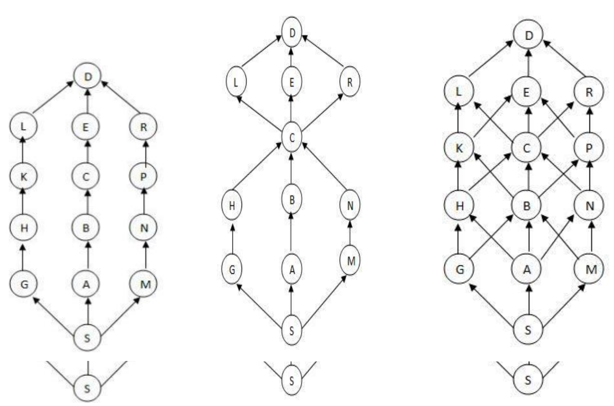

Figure1.(a) Node–disjoint **Figure1.(b) Link–disjoint** **Figure1.(c) Fail–safe paths**

Route Discovery Phase:
MODRP has three basic phases; namely route discovery, route reply and route maintenance. Source node initiates route discovery process, when it wants to communicate to a destination, for which it does not have a valid route. Valid route is a route to the destination, whose lifetime has not expired, i.e., the life time value of the route entry should be greater than the current time at the node. The source node inserts address of the destination without any destination sequence number into a route request packet and broadcasts it. An intermediate node receiving the route request replies by sending a route-reply Packet if it has a route to the destination. Otherwise, it rebroadcasts the route-request. Although, nodes accept multiple copies of route-request, only the first copy of the route-request is re-broadcasted. Nodes store all route-request copies in a table called request-revd table. Each entry in the request-revd table contains address of the previous node (last hop), that relayed to the route-request to it and the number of hops the route-request has traversed from the source node. Nodes use this information to relay route-reply packets back to source node. If none of the intermediate nodes possess a fresh route to the destination, the destination itself replies to the route-request, if it receives a copy of the route-request.

Route Reply Phase: Route replies follow the reverse paths stored in the request-revd table to reach the source node. The route-reply packet used by MODRP contains three extra fields, apart from some of the fields of AODV_s reply packet which are required for eliminating routing loops, and to compute fail-safe multiple paths. The node-list fields contains the list of all nodes that the reply packet has traversed so far. The reply-gen field is for storing address of the node form which that particular copy of the route-reply packet originated, and mul-reply is a Boolean variable. Before sending route-reply, The destination node initializes the node-list and reply-gen-fields to its address. The mul-reply field is set to TRUE for the first reply, or the extra replies that the destination generates. It sets the mul-reply value to FALSE. The nodes receiving the route-reply accept it, if it is the first reply for that destination and store the route information carried in it into the routing table, along with the full path destination are stored on reply-list of the routing entry. Each individual route has next hop, as the address of the neighbour through which the route goes to destination, hop counts as the distance to destination, hop counts as the distance to destination, and full paths as full path to destination. Precur-list is the list of last hops through which route-reply packet is relayed to source.

We limit the number of such multiple relies a node can relay to MAX_REPLY, in order to avoid
Route-reply storm. Nodes send the first copy of list without changing the values of mul-reply and reply-gen fields. Further, the reply-gen field is changed to the nodes address as this is the node origination is particular copy of the route-reply.

Eliminating Routing Loops: As MODRP allows nodes to accept multiple copies of route-request, loops can exist either on the primary path or fail-safe segments replay only one copy of the route-reply packet. The reply is sent through the node through which they have received the first route-request. Loops forms on the primary path, when an intermediate node replies to the route-request with a path, which goes through one or more of the nodes that have replayed the rout-request packet previously. The Loops form on the primary path, when an intermediate nodes replies to route-request with a path, which goes through one or more of the nodes that have relayed the route-request packet previously. Loops formed by fail-safe-segment are of two types. The first type has only one node of the primary path on the loop. The second type includes multiple consecutive nodes of the primary path on the loop.

Route Maintenance: Route maintence phase maintains the routes established during the route-reply phase for the time duration of session. The life time of routing entries is used for this purpose. The life time of route represents the time until when the route through next hop is valid. Nodes on the primary path refresh the life time of their routing table entries, each time data packet for the corresponding destination is forwarded. The life time of routes at the nodes on the secondary path is initiated to a sufficiently large value. This value can be decided based on the frequency of path breaks due to mobility and probability of node failures. We call this parameter as SEC_ROUTE_LIFETIME,of requirement for the secondary route arrives before this time, the secondary route is used for data transmission and then its life time is updated as long as data transmission happens through it Otherwise, Secondary routes are deleted from routing tables once their initial life time expires.

Processing of a route error packet: when a node receives a route-error packet, it invalidates the routes through the neighbour that sent the route-error packet, to all destination mentioned in the dest-list. If the node does not have any such routes, it simply discards the route error. In case routes to any of the destinations are invalidated; The node replaces the invalidated route with a secondary route if exists. It removes that destination from the dest-list of the route-error packet, as the routes to all the destinations are re-established with the secondary routes. If dest-list is still s some destinations left, the node relays the route-error packet through the precursors of the remaining sink in the dest-list. Finally, if the source node of the sessions receive the route-error packet, it initiates a fresh route discovery process to re-establish routes to disconnected destinations. If they do not have valid secondary paths. As most of the route disconnections are re-established at the intermediate nodes with secondary paths, the number of route errors communicated in the network drastically decreases.

3. PROPOSED MODRP ALGORITHM

PHASE-I

Step1: Establish source S, destination D and intermediate routers.
Step2: Send route request packets from source to adjacent routers which in turn send to their adjacent and so on till they find the destination D.
Step3: Send reply packets for the route request received from the source for confirming its existence.
Step4: Obtain shortest path from source to destination D and its length.

PHASE-II

Step1: Choose any 2 nodes along the different paths from source S to destination D for sample routing and send packets.
Step2: Disable any of intermediate routers and route packets. Now packets must ignore distances corresponding to the disabled nodes which simulate fail-safe route method.
Step3: Move any intermediate routers to any new place and obtain new lengths for its previously adjacent nodes. Now send the packets from source S to destination D.

PHASE-III

For each step in PHASE-II obtain the graph for total number of hops used against number of intermediate nodes to simulate Difference between Disjoint Multi paths Routing Protocol (DMRP) and Multipath On-demand Routing Protocol (MODRP).

Error handling: Sometimes error occurs while giving an input to the program so handling such error is handled efficiently by displaying the correct image format that program can be handles. Error while selecting the nodes to delete it should be handled carefully.
For example :- if we delete node 2,3 and 4 the routing from source to destination is not at all possible so this type of error should be handled with care.

4. RESULTS & DISCUSSIONS:

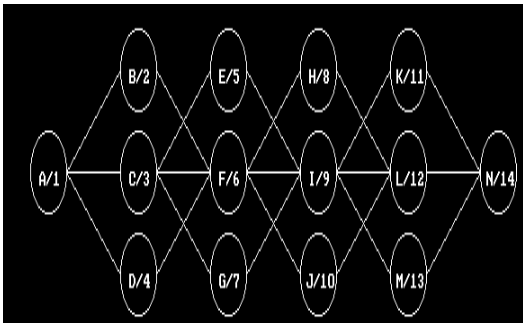

Figure 2: Multipath Graph

Consider the multipath network in which A/1 is the source node and M/13 is the destination node. In this graph none of the node is assigned with the weight. The objective is to send that data from source A/1 to M/13 with minimum cost path.

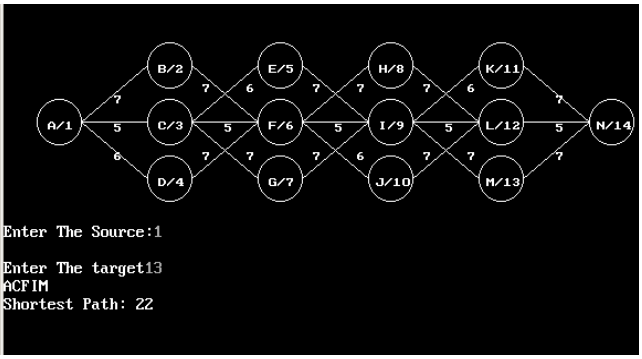

Figure 3: Multipath Graph with source A/1

In this graph every node is assigned with weight, in which source node is A/1 and the target node is M/13. The path target is ACFIM and shortest path is 22.

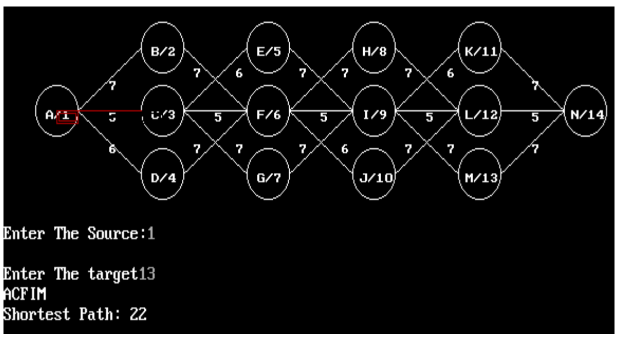

Figure 4: Multipath Graph with source Sending packet to destination

In this graph, the node A/1 (Source Node) is started transferring the data packet from A/1 to reach intermediate node.

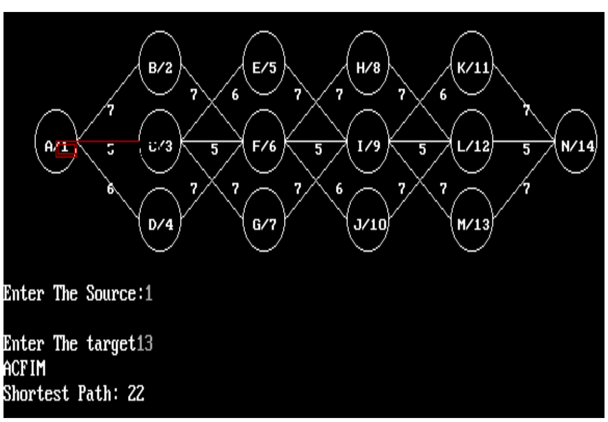

Figure 5: Multipath Graph with source Sending packet to intermediate node

In this graph, the node A/1 (Source Node) is started transferring the data packet from A/1 and reached the intermediate node C/3 with path is shown in red colour along with data packet.

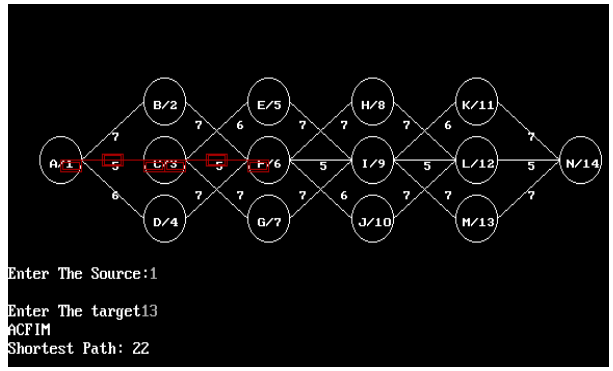

Figure 6: Multipath Graph with source Sending packet to intermediate node F

In this graph, the node A/1 (Source Nodes) started transferring the data packet from A/1 and reached the intermediate node C/3 then F/6 to reach the destination node.

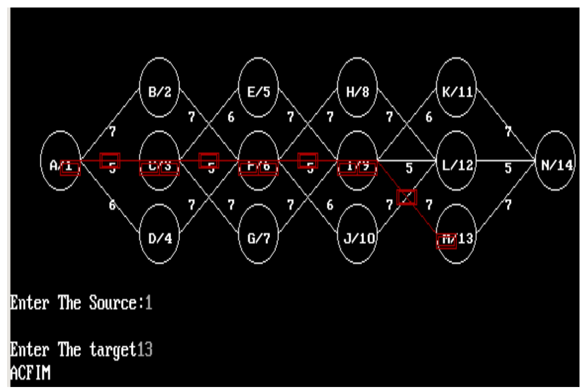

Figure7: Multipath with source Sending packet to destination M

In this graph, the node A/1 (Source Node) is started transferring the data packet from A/1 and reached the intermediate node C/3 then F/6 next I/9 and finally M/13. The path information is shown in red colour with the data packets along the shortest path.

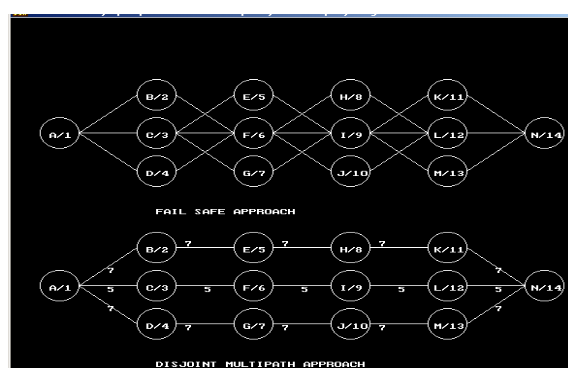

Figure 8: fail and disjoint graph

In this figure both fail safe approach and Disjoint Multipath approach is represented is shown above.

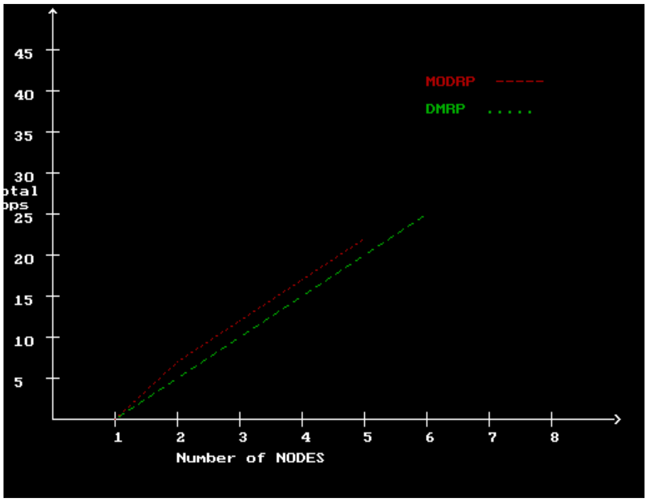

Figure 9: Graph showing MODRP is better than DMRP

In this figure MODRP (Red Curve) showing better approach compared to DMRP (Green Curve) in which number of hops taken along Y-axis and number of nodes in X-axis.

5.CONCLUSION:

In this work, our objective was to propose a multipath extension (MODRP) to a unipath on demand routing protocol, in order to improve its scalability. Intuitively, finding multiple paths in a single route discovery reduces the routing overhead incurred in maintaining the connection between source and destination nodes. Secondary paths can be used to transmit data packets, in case the primary path fails due to node mobility or battery failure, which avoids extra overhead generated by a fresh Route discovery. These multiple paths are more advantageous in larger networks, where the number of route breaks is high. We found through simulations that total number of node-disjoint multiple paths at all nodes on the primary path are scarce, even in large networks. We modified AODV protocol to compute a new class of multiple paths called fail-safe multiple paths, which are more abundant and hence provides better fault-tolerance to route breaks.

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