MODRP: Multipath on-Demand Routing Protocol for MANET

ABSTRACT

The popularity and availability of portable wireless devices, which makes mobile adhoc networks, scalable with routing protocols. On-demand routing protocols adapt well with dynamic topologies of adhoc 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 occured 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 at higher mobility and large traffic loads, when compared to the disjoint multipath routing protocol (DMRP). and ad hoc on-demand distance vector (AODV) routing protocols.

1. 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 fisheye 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 adhoc 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 base of wireless devices increases.

Routing protocols need to adjust to networks with thousands of nodes. Typical examples of large adhoc networks are technical festivals in universities and military communication networks (which involve hundreds to thousands of devices). Maintaining routes in 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. 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. Hierarchical state routing (HSR) groups nodes into clusters based on their geographical proximity, and a node in the cluster is elected as cluster-head to represent each cluster. 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 differnt paths, which requires reliable and in-order delivery of routing messages. This requirement causes high routing overhead, and makes the route convergence difficult in large networks.

2.Multipath on-demand routing Protocol (MODRP): Recently, some multipath routing protocols [15,17,14] have been proposed for adhoc networks . Multipath source routing (MSR) [15,16], extends DSRÕs route discovery and route maintenance phases to compute multiple node-disjoint 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 labeled S and D are source and destination nodes, respectively. Node-disjoint multiple paths are used. 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.

For traffic load-balancing (by dispersing data over multiple paths), and provide 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 fail-safe segment that bypasses the 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 one intermediate node on the primary path. In otherwords, the fail- safe path can be used to send data packets in case the bypassed node(s) on the primary path move away. Many disjoint multipath routing techniques [16,20,23,17,22,25,26,29] have been proposed for ad hoc networks, which have focused on improving the reliability of routing using path disjointness or redundancy.

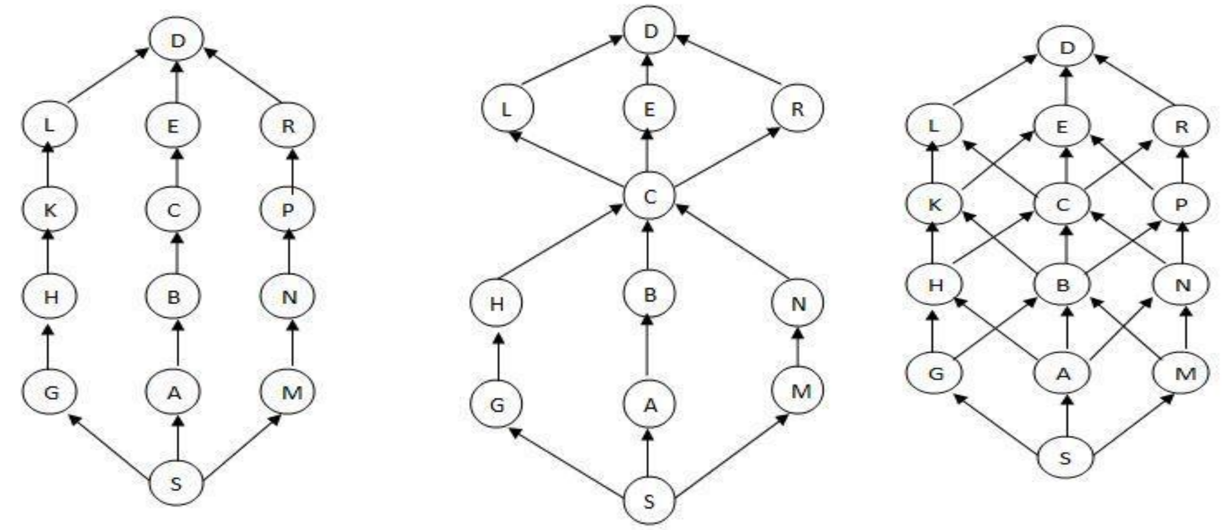


Figure 1.(a) **Figure.1(b)** **Figure.1(c)**
Node–disjoint multiple
Link–disjoint multiple paths **Fail–safe multiple paths**
paths only at source.

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 lifetime 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 coppies of route-request, only the first copy of the route-request is re-broadcasted. Nodes store all route-request copipes 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 tpaths stored in the request-reved 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 whch are required for eliminating routing loops, and to compute fail-safe multiple paths. The node-list fields contains the list o f 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 ofiginated, and mul-reply is a blllean variable.Before sending route-reply, The destination node initializes the node-list and reply-genfields to its address. The mul-reply field is set to TRUE for the first reply.For 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 om rpite-list of the routing entry.Each individual route has nexthop, as the address of the neighbour through which the route goes to destination,hopcounts as the distance to destination, hopcounts 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 rellies a node can relay to MAX_REPLY, in order to avoid

route-reply storm.Nodes send the first copy of the without changing the values of mul-reply and replygen fields.Further, the reply-gen field is changed to the node_s address as this is the node origination theis 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 rekay nl one cipy of the route-reply packet. The reply is sent through the node threough which they have received the first route-request. Koops form on the primary path,when an intermediate node replies to the route-request with a path,which goes throughh one or more of the nodes that have replayed the rout-request packet previously.Loops form on the primary path,when an intermediate nodes replies to route-request with a path,wich goes through one or more of the modes that have relayed the route-request packetr 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: Rote maintence phase manitains the routes established during the route-reply phase for the time duration of session.The lifetime of routing entries is used for this purpose. The lifetime of toute represents the time umtil when the route through nexthop is vlid.Nodes on the primary path refresh the lifetime of their routing table entries,each time a data packet for the corresponding destination is forwarded. The lifetime 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 breadks due to mobility and probability of node failures. We call this parameter as SEC_ROUTE_LIFETIME. If a requirement for the secondary route arrives before this time, the secondary route is used for data transmission and then its lfietime is updated as long as data transmission happens through it .Otherwise,Secondary routes are deleted from routing tables once their initial lifetime 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 destinatin 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 one exists. It removes that desination from the dest-list of the route-error packet,as the routes to all the deinatins are re-established with the secndary routes. If dest-list still has some destinations left, the node relays the route-error packet through the precursors of the remaining destinations in the dest-list.Finally, if the source nodes of the sessions receive the route-error packet , They initiate a fresh route discovery process to re-establish routes to disconnected destinations , if they too 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.

MODRP Algorithm

PHASE-I

Step 1: Establish source S, destination D and intermediate routers.

Step 2: 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.

Step 3: Send reply packets for the route request received from the source for confirming its existence.

Step 4: Obtain shortest path from source to destination D and its length.

PHASE-II

Step 1: Choose any 2 nodes along the different paths from source S to destination D for sample routing and send packets.

Step 2: Disable any of intermediate routers and route packets. Now packets must ignore distances corresponding to the disabled nodes which simulates fail-safe route method.

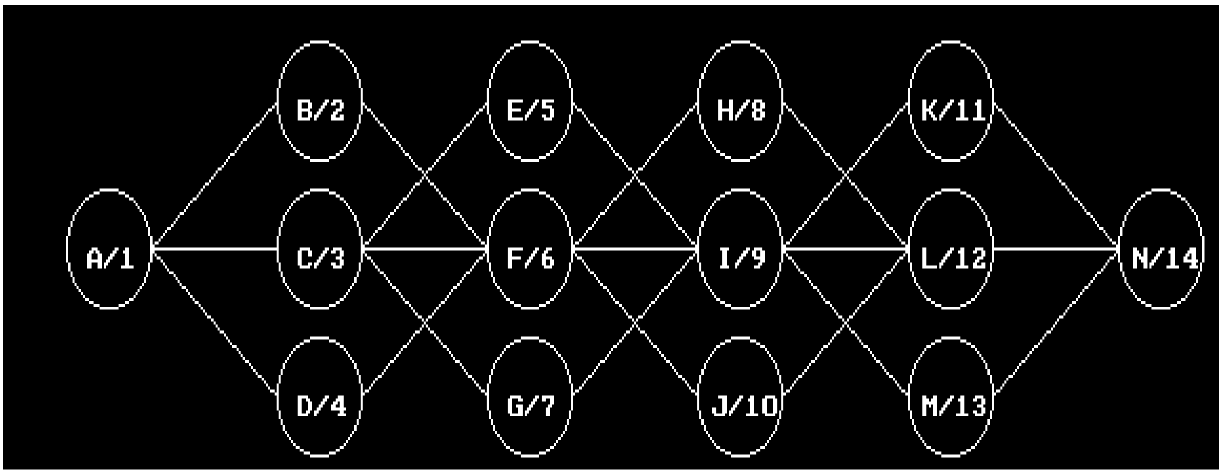
Step 3: Move any intermediate routers to any new place and obtain new lengths for its previously adjacent nodes. Now send packets from source S to destination D.

PHASE-III

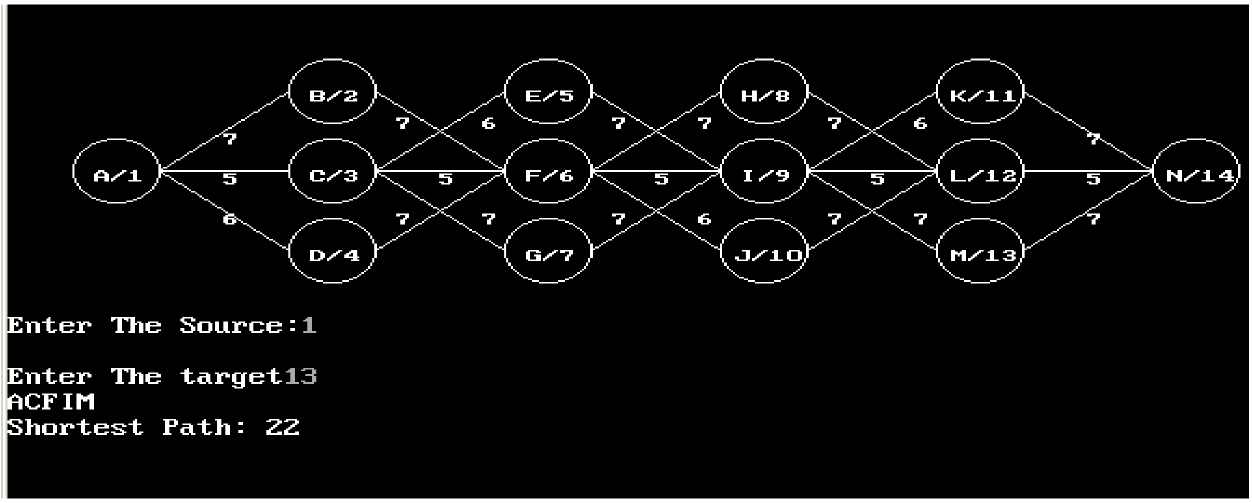
For each step in PHASE-II obtain the graph for total number of hops used against number of intermediate nodes to simulate difference between Disjoint Multipath Routing Protocol (DMRP) and Multipath On-demand Routing Protocol (MODRP).

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.

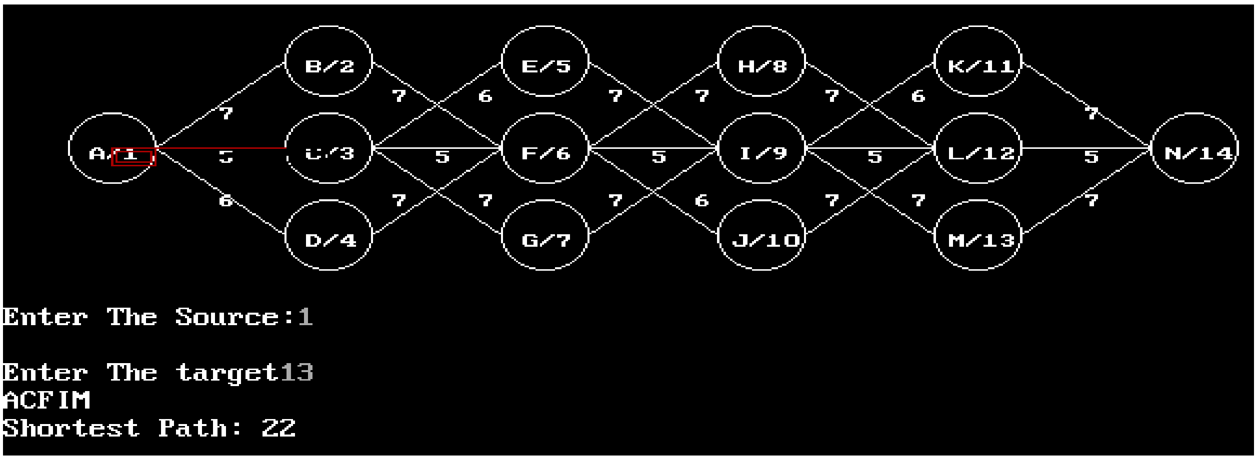
SNAPSHOTS:



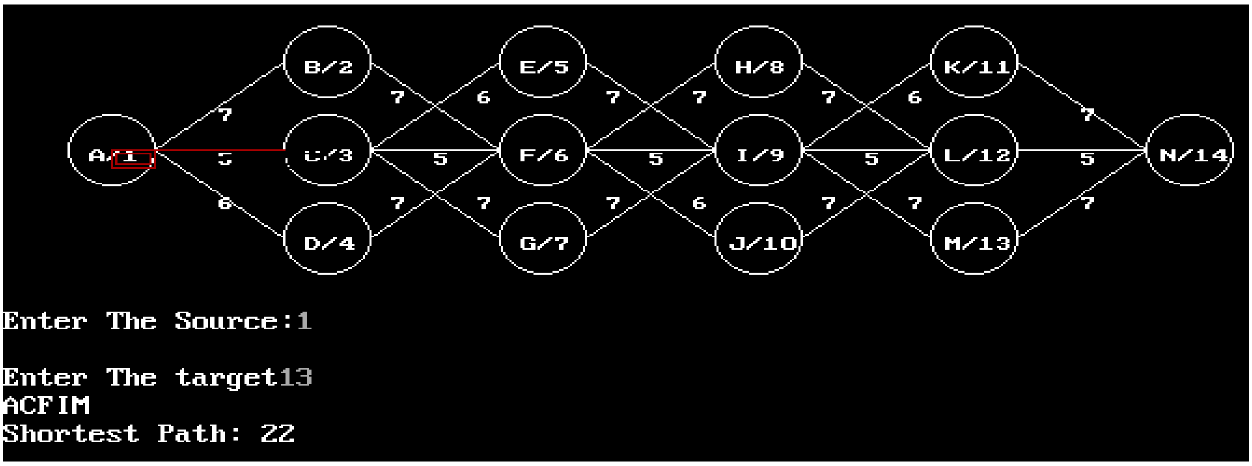
Consider the multipath network in which A/1 is the source node and M/13 is the destination node. In this graph none of the node is assinged with the weight.



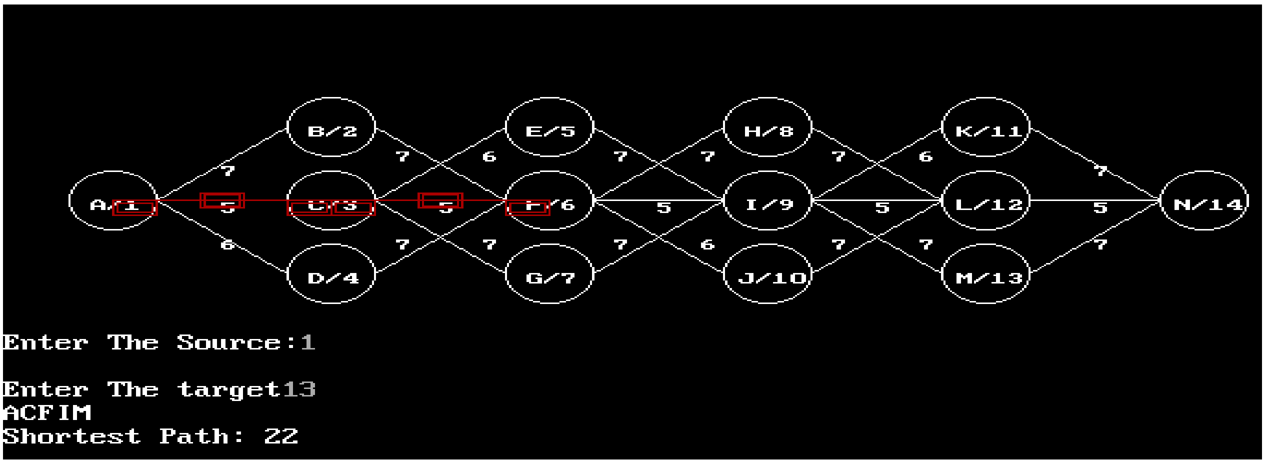
In this graph every node is assigned with the weight, in which source node is A/1 and the targe node is M/13. The path target is ACFIM and shortest path is 22.



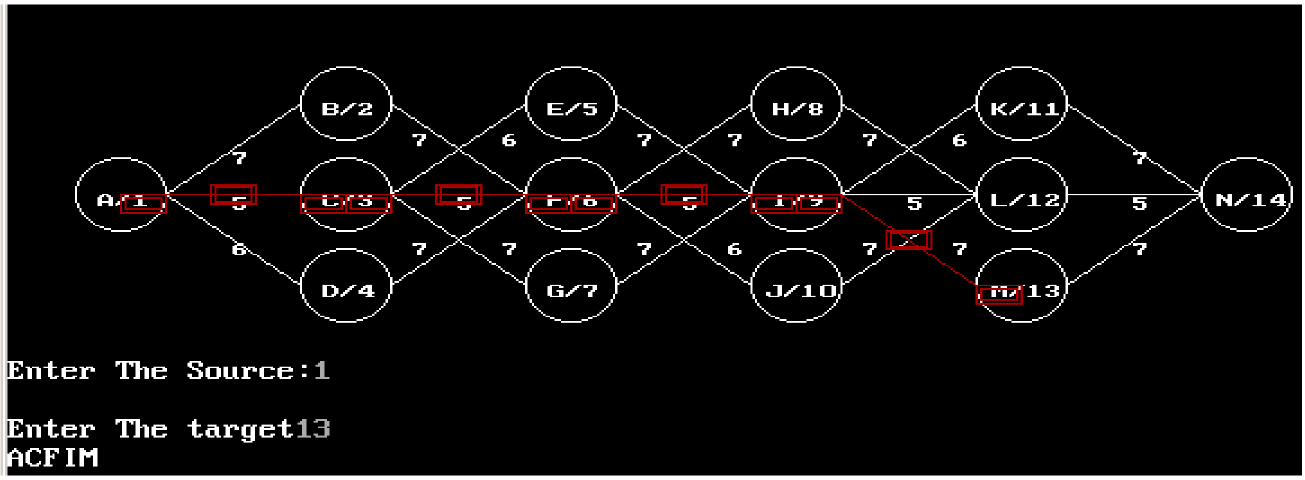
In this graph, the node A/1 (Source Node) is started transferring the data packet from A/1



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

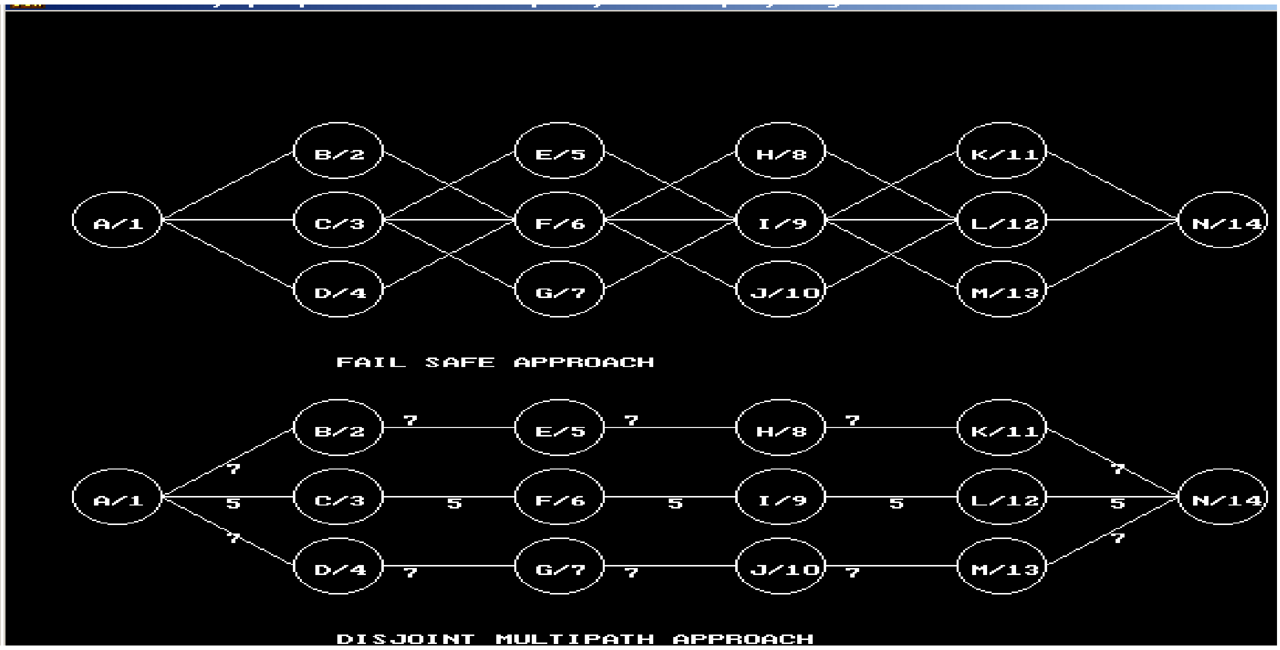


In this graph, the node A/1 (Source Node) is started transferring the data packet from A/1 and reached the intermediate node C/3 then F/6.

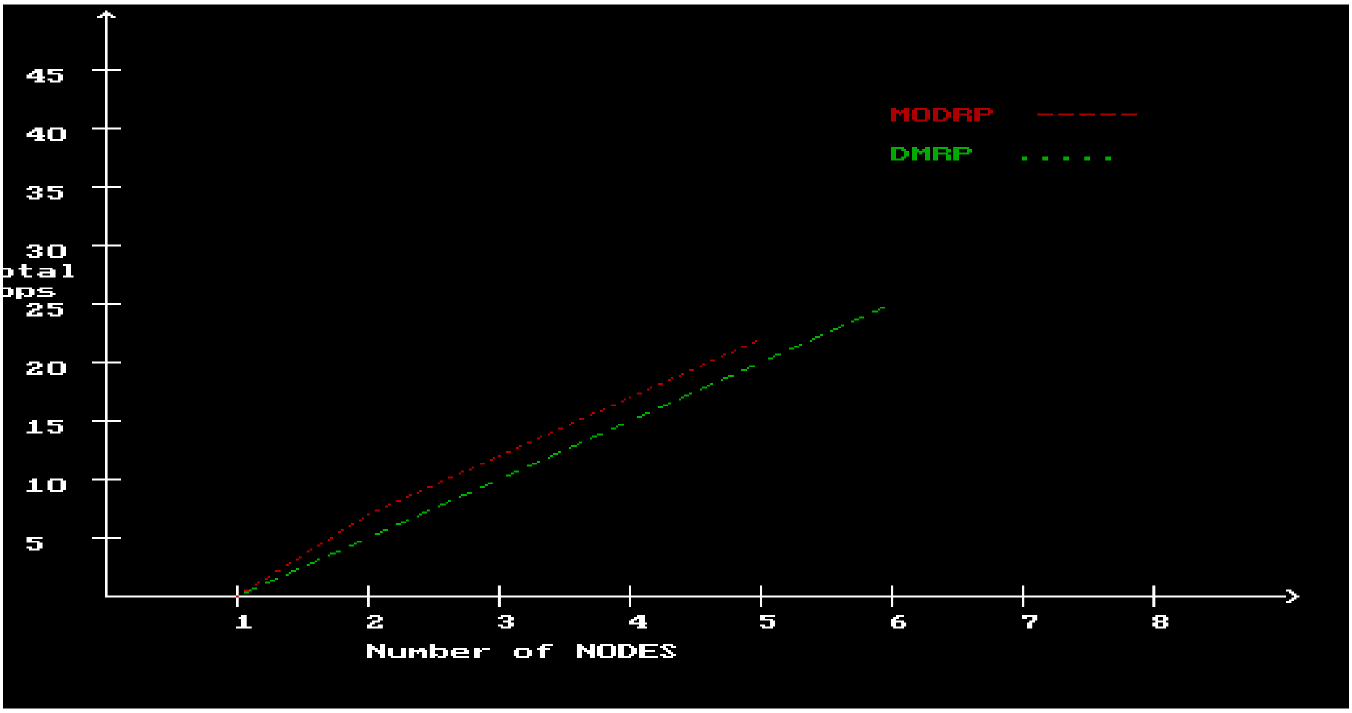


In this graph, the node A/1 (Source Node) is started transferring the data packet from A/1 and

reached the intermediate node C/3 then F/6 next I/9 and finally M/13.



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



In this figure MODRP (Right Curve) showing better approach compared to DMRP (Green Curve)

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 are 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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