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Extended DSR for MANET: Preemptive Switching over Multiple Routes to Reduce Route Discovery Overhead

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Abstract : A mobile ad-hoc network (MANET) is a self configuring network of mobile routers (and associated hosts) connected by wireless links, the union of which forms an arbitrary topology. The routers are free to move randomly and organize themselves arbitrarily; thus, the network's wireless topology changes rapidly and unpredictably. The Dynamic Source Routing (DSR) protocol is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes. It is based on the concept of source routing, a routing technique in which the sender of the packet determines the complete sequence of the nodes through which to forward the packet. The sender explicitly lists this route in the packet's header, identifying each forwarding "hop" by the address of the next node to which to transmit the packet on its way to the destination host.

The objective of this paper is Extension of DSR in such a way to provide the best path for communication between nodes in a wireless network within a highly dynamic network. The main purpose is to reduce the time delay for the discovery of the communication path. It is achieved by switching through the alternative path's for nodal communication when breakage occurs.

Keywords: Alternative path, DSR, Route Maintenance, Route Discover, Preemptive Switch, Route Repair, Link breakage.

I. INTRODUCTION

A mobile ad-hoc network (MANET) is a self configuring network of mobile routers (and associated hosts) connected by wireless links, the union of which forms an arbitrary topology. The routers are free to move randomly and organize themselves arbitrarily; thus, the network's wireless topology changes rapidly and unpredictably.[3][4]

Proactive MANET protocols are table driven and will actively determine the layout of the network. Through a regular exchange of packets meant for network topology between the nodes of the network, a complete picture of the network is maintained at every node. Hence there is minimal delay in determining the route to be taken.

Reactive MANET protocols only find a route to the destination node when there is a need to send data. The source node will start by transmitting route requests throughout the network. The sender will then wait for the destination node or an intermediate node (that has a route to the destination) to respond with a list of intermediate nodes between the source and the destination. This is known as the global flood search, that in turn brings about a significant delay before the packet is transmitted. Since each of the proactive and reactive routing protocols suits well in oppositely different scenarios, there is good reason to develop hybrid routing protocol that is a mix of both proactive and reactive routing protocols. The hybrid protocol is applied to find a balance between the proactive and the reactive protocols.

II. RELATED WORK: DSR

The Dynamic Source Routing (DSR) protocol is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes. It is based on the concept of source routing, a routing technique in which the sender of the packet determines the complete sequence of the nodes through which to forward the packet. The sender explicitly lists this route in the packet's header, identifying each forwarding "hop" by the address of the next node to which to transmit the packet on its way to the destination host. [1]

The DSR protocol consists of two mechanisms: Route Discovery and Route Maintenance. When a mobile node wants to send a packet to some destination, it first checks its route cache to determine whether it already has a route to the destination. If it has one, it will use this route to send the packet. Otherwise it will initiate route discovery by broadcasting route recovery packet.

When receiving a request packet, a node appends its own address to the route record in the route request packet if it did not receive this request message before, and re-broadcasts the query to its neighbors. Alternatively, it will send a reply packet to the source without propagating the query packet further if it can complete the query from its route cache. Furthermore, any node participating in route discovery can learn routes from passing packets and gather this routing information into its route cache. [1][2]

When sending or forwarding a packet to a destination, Route Maintenance is used to detect if the network topology has changed such that the link used by this packet is broken. Each node along the route, when transmitting the packet to the next hop, is responsible for detecting if its link to the next hop has broken.

When the retransmission and acknowledgement mechanism detects that the link is broken, the detecting node returns a Route Error packet to the source of the packet. The node will then search its route cache to find if there is an alternative route to the destination of this packet.

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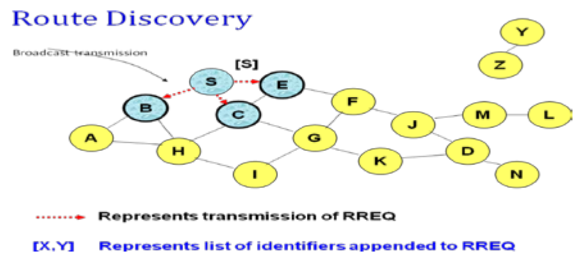
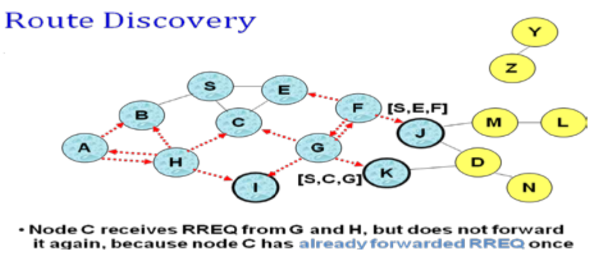
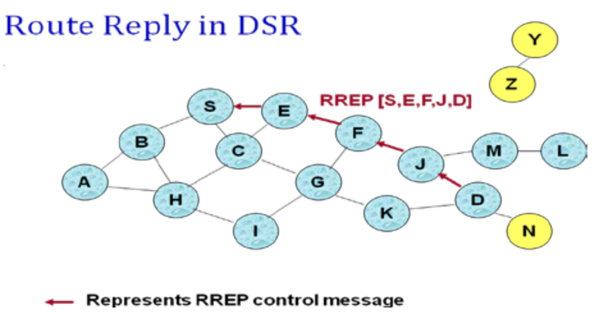
If there is one, the node will change the source route in the packet header and send it using this new route. This mechanism is called “salvaging” a packet.

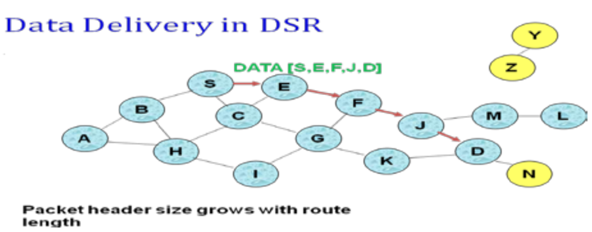
When a Route Error packet is received or overheard, the link in error is removed from the local route cache, and all routes which contain this hop must be truncated at that point. The source can then attempt to use any other route to the destination that is already in its route cache, or can invoke Route Discovery again to find a new route.

In Dynamic Source Routing, each source determines the route to be used in transmitting its packets to selected destinations. There are two main components, called Route Discovery and Route Maintenance. Route discovery determines the optimum path for a transmission between a given source and a destination. Route Maintenance ensures that the transmission path remains optimum and oscillation/loop-free as network conditions change, even if this requires changing the route during a transmission.









III. PROPOSED WORK

In the proposed approach we intend to reduce the number of times the Route Discovery process is to be initiated thereby increasing the efficiency of the routing protocol. In the proposed approach we find a best route from a source to a destination in terms of number of hops and a second best route (backup route). The second best route is stored in the route cache as a backup route. When any node in a first best route fails, the source starts transmitting packets through the backup route. Meanwhile, the first best route (now disconnected) is repaired. When repaired, it is stored in the route cache as backup route. By the process of swamping between route under used and backup route, the number of times the route discovery process is initiated is reduced considerably.

A. Route Discovery:

a. When a source node, say A wants to send a data packet, it broadcasts the RREQ packet to its neighboring nodes.
b. When an intermediate node on the route to the destination receives the RREQ packet, it appends its address to the route record in RREQ and rebroadcasts the RREQ.
c. When the destination node, say D receives the first RREQ, it starts a timer and collects RREQ from its neighbors until a quantum of time has expired.
d. The destination node D finds the best route as well as the second best route between source and destination.
e. The destination node D sends back a RREP to the source node along with the best route (Primary route) and the second best route (Secondary route).
f. As the source node receives the RREP it starts transmitting packets through the best route (Primary route) and keeps the second best route (Backup route) in the Route Cache.[7]

B. Route Maintenance:

a. Route Monitoring:

i. Each intermediate node in the route through which transmitting is going on starts monitoring their signal strength. If signal strength falls below a specified threshold, it will send a warning message to the source node. The warning message signals about the possible breakage of route.
ii. On receiving the warning message from the intermediate node, the source node picks the backup route from the Route Cache and starts transmitting through the backup route. [6][7]

b. Route Repairing:

i. As transmission goes on through the back up route (now primary route) the nodes in the previous primary route (now broken route) are examined in order to locate the particular node node(s) that had failed.
ii. The DSR protocol is used to find out a route between the previous node and any of the next (succeeding) nodes that had failed.

c. New Algorithm:

In our above stated work, stability of the route was not analyzed. Neither was the consideration of common links or node in a route addressed. In considering these issues, a new algorithm for route selection was proposed.

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d. Route Selection:

The stability of a route used for routing depends on the mobility of the intermediate nodes constituting the route from the source node to the destination node. High mobility of the intermediate nodes implies that the nodes will stay at their current positions for a relatively small duration of time and therefore there is a high probability that the route will break at some intermediate position "very soon". On the other hand, if intermediate nodes are less mobile, they are likely to stay at their current positions for a relatively greater interval of time and that would make the route more stable. Thus, we see that mobility of nodes directly affects the stability of a path.

e. Multiple Routes:

Use of multiple routes simultaneously, instead of a single route at a time, would help to improve the ongoing communication between the two ends. In our algorithm, if multiple routes are found to have the same minimum value that would prove to be advantageous for the source node. The source node will use each of these routes alternatively to send packets to the destination node. Use of multiple routes reduces the dependency on a single route, which results in more stable communication. This is because, If a single route fails, we need to again initiate the Route Discovery process. However, if multiple routes are used, when one route fails, another route can be used. Only when all the routes fail, the Route Discovery is to be done to search a new route. We note that the use of multiple routes is different from the backup route theory of DSR.

In the backup route approach, the source node uses the primary route for communication and keeps a backup (secondary) route in its route cache. Whenever the primary route fails, the backup route is used. The problem with this approach is that, while the source is still using the primary route, the backup route might fail and the source would remain unaware of that. If after some time the primary route fails and the source node switches to the backup route, it discovers that the backup route has been already broken.

But if multiple routes are used in parallel, the source node will be informed of the route failure immediately whenever it occurs. Thus, the source node will never attempt to use a stale route. Even if multiple routes having the same minimum value of (Lk, $1-\varphi k$) are not found, routes having close values to the minimum value can be used. Below, we show that if multiple routes are used, the probability of communication breakage decreases.

IV. PERFORMANCE EVALUATION & SIMULATION RESULTS

In order to minimize the discovery time, routing algorithms provide route caches that keep discovered overhead paths for future use. For example, the current DSR implementation provides two caches: the primary cache is intended to store routes that were learned first hand, while the secondary cache stores routes that are "overheard" by snooping. The current implementation of DSR does not discriminate between these caches, it simply searches both caches when looking for a route. Moreover, paths that reside in caches are not "aged"; thus, a path in the cache may become invalid by the time it is called upon. In addition, nodes may reply from their caches when a path request is received, propagating these stale paths.

To illustrate the effect of stale paths, we conducted a simple experiment using the NS-2 simulator. The experiment consisted of 20 nodes in a 700x700 area using CBR communication. Each node randomly picks a point in the simulation area and starts moving towards it; when the point is reached, another is picked with no pause time.

Scenarios with two different speeds and two different numbers of communicating node pairs were studied. We studied two configurations of DSR: conventional DSR and DSR with the route cache size reduced to 1 entry per path. The communication between the source node and the destination node reduces exponentially. That is, greater the number of parallel routes, the more stable the communication becomes. This is due to the fact that when multiple routes are used, dependency on a single route is reduced. Therefore, even if a single route fails, we have other routes in hand to use for transmitting packets. If a very long time period is considered, the fluctuation in the probability values stops and reaches a saturation level.

To select the best backup path for recovering from failures, each node needs to rank among permitted backup paths. In [3] an effective technique is employed to sort permitted backup paths by avoidance levels. The idea of using the avoidance levels is based on counting the number of steps in a path. To utilize the avoidance levels in path selection, a non-negative function $\kappa(P)$, called avoidance classifier that is step aware for a backup path P, is devised. The value of an avoidance level is within the range of κ. In principle, an avoidance classifier κobeys the rules below.

As a path traverses additional edges, its avoidance level increases; for instance, if X, Y, and YX are permitted paths,then $\kappa(YX) \geq \kappa(X)$.

κ is step aware; for any P permitted at v and $(xuv)P$ permitted at x and $(xuv)P$ being one of the above four types of peer-peer backup paths, we have $\kappa((xuv)P) > \kappa((uv)P)$.

An extensive simulation model having scenario of n mobile nodes and n UDP/TCP connections is used to study inter-layer interactions and their performance implications. The other parameters used in this model are as under:

Software for simulation: Network simulator 2.
Channel : wireless
Simulation runs time : 500 seconds.
Area in which nodes move: 670 X 670
Packet size : 512bytes
Speed : 1m/s to 10 m/s
Pause time : 100s to 500s
Bandwidth for transmitting data: 5Mb

It has been shown that even though wireless sensor networks share a similar on-demand behavior, the differences in the protocol mechanics can lead to significant performance differentials. The performance differentials are analyzed using packet delivery ratio with respect to varying mobility (1m/s to 10m/s) and pause time (100s to 500s). The packet delivery ratio has been evaluated using pause time as a parameter on n mobile nodes having n UDP connections. Pause time varies 0 to 500. The results are on the basis of n mobile nodes and n UDP connections. Speed variation is from 1m/s to 10 m/s. The PDR values, computed using received and dropped packets, range from 97.81% to 98.47%.

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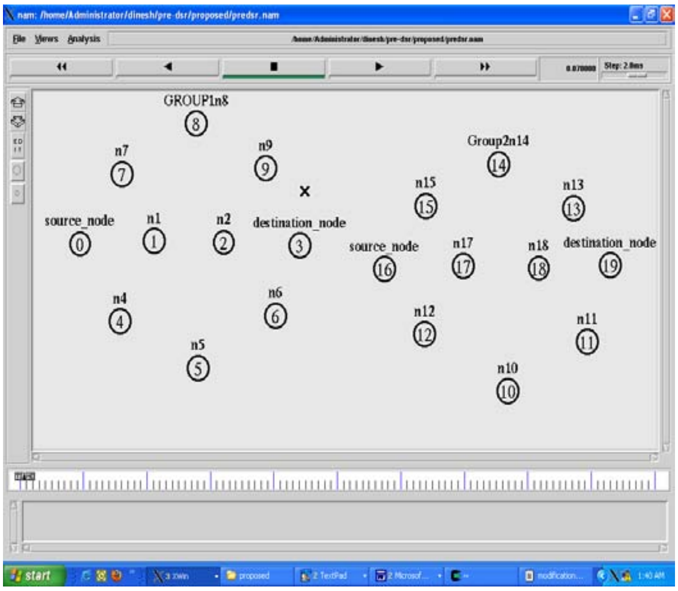

Figure 1: Initial Position of the Network

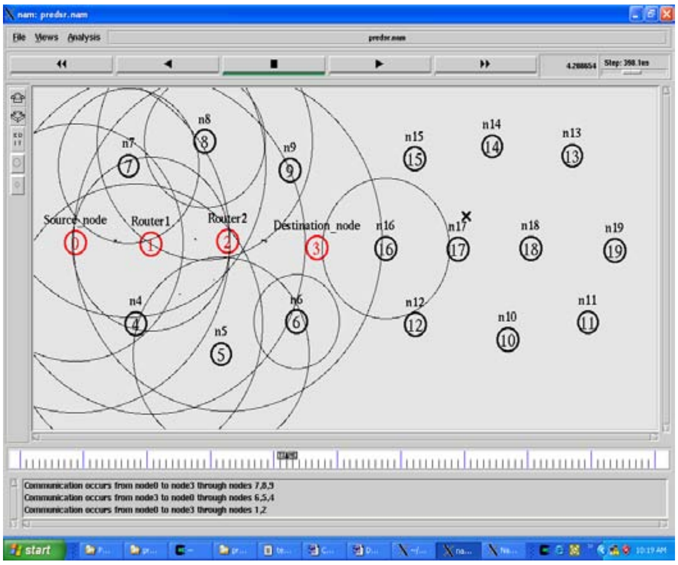

Fig 2: Communication occurs between Source node 0 and Destination node 3 through Router nodes 1,2.

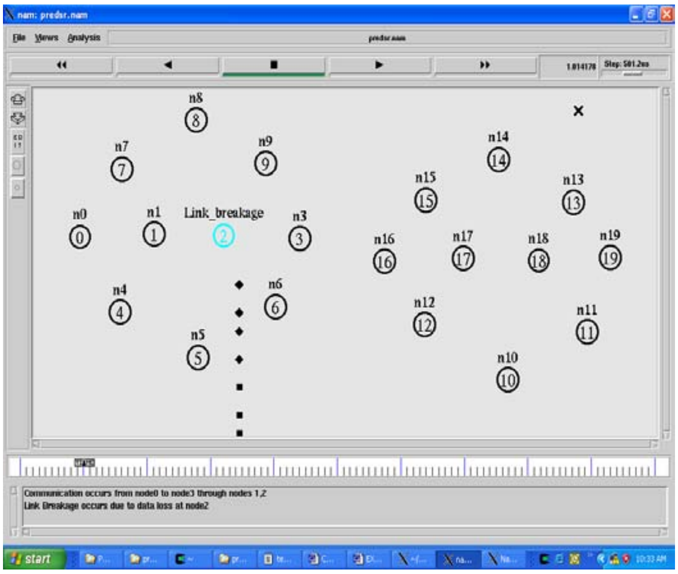

Figure 3: Link breakage occurs due to data loss at node 2 and the communication terminated.

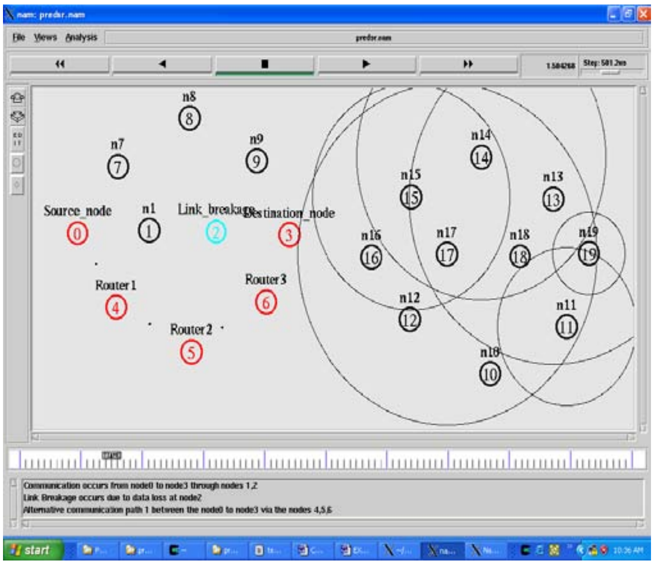

Figure 4: Preemptive Switching over the alternative path

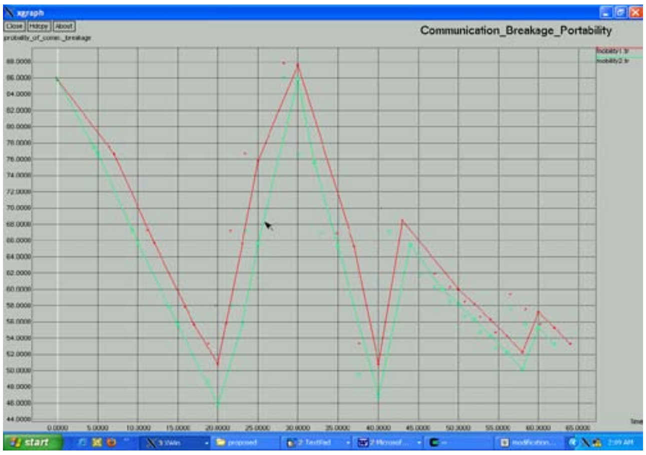

Figure 5: Communication breakage probability.

V. FUTURE WORK

Future research may be carried out over the calculation of the optimum value of the threshold (T). Since the environment is highly dynamic by nature, there is a high probability that the backup route will fail by the time the primary route breaks. Route selection algorithm provides a stable and alternative (flexible and reliable) route selection compared to simple repaired backup scheme.

VI. CONCLUSION

Reactive routing protocol initiates discovery only when the route breaks. It needs significant overhead for detecting the disconnection and the reconstruction of a new route. Repaired backup-based DSR detects early the link breakage, but may prove to be fatal if false warnings are generated. So the efficiency of the algorithm depends much on the selection of the value of the threshold (T). An inappropriate selection of the values of threshold (T) may reduce the efficiency of the algorithm. DSR with Reactive mechanism detects early about the link that is likely to break soon, and hence it uses a backup path before executing link fails. The project explains the preemption of Primary to Backup route by the source node S, whenever the signal strength of the primary route falls below the threshold value T. The modified DSR will improve the communication reliability

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between the source and destination node even if the mobility is high. In addition, Reactive routing improves the overhead of rediscovering route whenever the primary route fails.

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