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Mobility Based Proactive and Reactive Routing Algorithm in Mobile Ad hoc Networks (MANETs)

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Abstract: **A Mobile Ad hoc Network (MANET) is a self-configured, infrastructure less network. In MANETs wireless mobile nodes form a dynamic temporary network Due to mobility of nodes routing is a very critical issue in MANETs. Finding and selecting an optimal and reliable path that can exist as long as possible is a complex task. In the process of path selection and path failure, most of the routing protocols perform blind flooding. In blind flooding (broadcasting) resource utilization is a critical parameter. In this paper, for limiting the number of broadcast control packets, we will use mobility as a limiting parameter. By using speed of node mobility as parameter for route discovery, approach of route discovery become more distributed and localized. In this paper we will propose one proactive and one reactive routing algorithm which are based on speed of route mobility as a selection criterion for making independent decision for route discovery. This process is termed as route discovery through self selection.**

*Keywords-***Mobile Ad hoc Network (MANET), Hybrid Routing, Dynamic Source Routing**

I. INTRODUCTION

A Mobile Ad hoc Network (MANET) or Ad hoc Network is a new paradigm for wireless communication that allows for nodes to communicate with or without existing infrastructure. An ad hoc network may operate in isolation or be connected to a fixed network (such as the Internet) via a base station (gateway). Ad hoc networks are seen as the next step towards designing networks, which are instantly deployable and self manageable. Consequently, in an ad hoc network each end-user node is capable of sending, receiving and routing data packets in a distributed manner. Moreover, such networks can be configured to allow for mobility and perform routing over multiple hops. Constraints such as low bandwidth, limited energy, mobility, non-deterministic topology and the broadcast nature of wireless communication make the efficient routing of data a critical element of ad hoc networks.

Flooding forms the basis of nearly all communications in ad hoc networks and is fundamental to routing protocols. Routing protocols allow peer-to-peer communications between nodes in an ad hoc network. To initiate a peer-to-peer connection between two nodes, a routing protocol may either proactively determine the best path or discover the path reactively.

Proactive protocols periodically disseminate link state or route table information throughout an ad hoc network. This information is then used by nodes to determine routes between nodes. Proactive routing protocols may benefit greatly from optimizing the process of flooding as this can significantly reduce overhead associated with disseminating link state or route table information. In the reactive approach routes are only discovered when required, therefore nodes do not need to periodically disseminate link state or route table information. However, this may lead to intervals of very high network activity due to flooding when multiple nodes perform route discovery.

Existing research in ad hoc network routing has contributed significantly to improved routing through maximizing the usage of prior knowledge of nodes, improving stability of routes and creating a collaborative environment between nodes (Hybrid routing). However, little work has been done in improving the process of route discovery when no prior node or topology knowledge is available. In the case of reactive routing, improving the efficiency of route discovery is one key to providing higher scalability as network density increases. More importantly, if only a blind flood is performed then the route determined is generally the shortest path (as all routes are determined in parallel during a blind flood) and is not necessarily the best route in terms of resources. In this paper, we present a number of different self-selecting route discovery strategies, which allow for intermediate nodes to selectively participate in route discovery. The aim of these strategies is to reduce the Broadcast Storm problem [1] in terms of the number of control packets and the level of medium contention in the network. Thereby, achieving higher levels of scalability. Additionally, such strategies are able to provide more control to individual nodes to better manage their limited resources (such as battery power) and to determine more effective routes between end nodes.

The rest of this paper is organised as follows. Section II describes and summaries routing algorithm in mobile ad hoc networks. Section III, describes mobility and self-selection based route discovery strategies. Section IV presents a discussion and conclusions of the paper.

II- LITERATURE REVIEW

In ad hoc networks, routing protocols are responsible for delivering packets between nodes not within broadcast range. This requires the use of cooperative intermediate nodes that are able to act as routers in a distributed manner, thus allowing for data packets to be forwarded towards their destination. Ad hoc network routing protocols may be classified based upon how they determine routes into three groups: proactive, reactive and hybrid. In this section, routing protocols are briefly described with an emphasis on how they disseminate control information and perform route discovery.

Proactive routing was the first attempt at designing routing protocols for MANETs. Early generation proactive protocols such as DSDV [2] and GSR [3] were based on the traditional distance vector and link state algorithms, which were originally proposed for wired networks. These protocols periodically maintain and distribute route information to all nodes with in the network. The disadvantage of these strategies was their lack of scalability due to exceedingly large overhead produced due to blind flooding. Blind flooding is shown to result in the Broadcast Storm Problem [1] and is thus not efficient. Other proactive routing protocols such as Fisheye State Routing (FSR) [4] limit the rate at which they update route information depending on the distance. Routes to closer nodes are maintained more regularly, whereas routes to remote nodes are maintained less regularly. Source-Tree Adaptive Routing (STAR) [5] eliminates periodic dissemination of control information in favour of conditional dissemination, thus reducing the constant overhead. However, blind flooding is still required. In Cluster-head Gateway Switch Routing (CGSR) [6] a hierarchy is created based upon node clustering. Clusterheads control the flow of route information within their cluster and between clusters, thus reducing the amount of route information and limiting the dissemination of route information. More recent attempts at reducing control overhead in proactive routing can be seen in protocols such as OLSR [7] and TBRPF [8]. These protocols attempt to reduce the control overhead by reducing the number of rebroadcasting nodes in the network through optimised flooding.

Reactive (on-demand) routing protocols attempt to reduce the amount of control overhead disseminated in the network by determining routes to a destination only when it is required. This is usually achieved through a two-phase route discovery process initiated by a source node. The first phase of route discovery starts by the propagation of Route Request (RREQ) packets throughout the network using a simple Blind flooding approach. The second phase is initiated when a RREQ packet reaches a node, which is the destination or has a route to the destination, in which case a Route Reply (RREP) packet is generated and transmitted back to the source node. Reactive routing protocols produce significantly lower amounts of routing overhead when compared with proactive routing protocols when the numbers of flows in the network are low. However, for large number of flows reactive protocols experience a significant drop in data throughput. This is because routing control packets are usually blind flooded (globally) throughout the entire network to find a route to the destination resulting in the Broadcast Storm Problem.

To limit the effects of blind flooding in reactive routing a number of different strategies have been proposed. The Routing On-demand Acyclic Multi-path (ROAM) [9] protocol limits the effects of flooding by using directed acyclic subgraphs based upon distance between the source and destination for the propagation of a flood. This eliminates the propagation of a flood in a direction along a subgraph if the destination is not reachable along that subgraph. In Relative Distance Micro-discovery Ad-hoc Routing (RDMAR) [10], overhead associated with route discovery is reduced and localised by limiting each RREQ packet to a certain number of hops. However, this localisation of route requests can only occur if the source and destination node have communicated before and exchanged position information. If the nodes have not communicated before, then the route request is not localised. Location Aided Routing (LAR) [11] requires that nodes have a GPS device and therefore are aware of their location. Thus limiting the direction and scope of flooding reduces overhead associated with route discovery. This protocol defines zones specifying which direction a RREQ packet may travel towards. Therefore RREQ packets only travel in the approximate direction of the intended destination. In LPAR [12] a combination of prior location knowledge and unicasting is used to reduce the number of re-broadcasting nodes within a search zone. Cluster-Based Routing Protocol (CBRP) [13] is a hierarchal routing protocol based upon clustering. Clusterheads are defined and responsible for the nodes within each cluster.

To reduce the effects of route discovery, only clusterheads exchange and propagate RREQ packets. Both Dynamic Source Routing (DSR) [14] and Ad hoc On-Demand Distance Vector Routing (AODV) [15] protocols utilise blind flooding as a means of performing route discovery. However, they differ in the way they maintain routes to destination nodes and also in the amount of information required to route packets. To reduce the effects of blind flooding, these protocols use route caching as well as limiting the number of hops for route discovery. In AODV the source nodes use Expanding Ring Search (ERS) to search nearby nodes first, thereby reducing the number of globally propagated control packets.

Hybrid routing protocols such as the Zone Routing Protocol (ZRP) [16] and SHARP [17] combine both reactive and proactive routing characteristics to achieve high levels of scalability. Generally in hybrid routing protocols, proactive routing is used within a limited region. These regions can be a cluster, a tree or a zone, which may contain a number of end-user nodes. Reactive routing is used to determine routes, which do not lie within a source node's local region. The idea behind this approach to routing is to allow nearby nodes to collaborate and reduce the number of re-broadcasting nodes. Therefore, during a route discovery only a selected group of nodes within the entire network may rebroadcast packets.

III Mobility Based Routing Algorithms

In this section we are discussing and proposing two different (one proactive and one reactive) routing algorithm which using mobility as a parameter for limiting the number of broadcasting packets over the mobile ad hoc network.

A. Distance Routing Effect Algorithm for Mobility (DREAM)

For maintaining the information of location service used in the Distance Routing Effect Algorithm for Mobility (DREAM) approach [18], each node stores location information for each other node of the network. It can therefore be classified as an all-for-all and proactive approach.

A node broadcasts position update packets to update the position information maintained by the other nodes. A node can control the accuracy of its position information available to other nodes by

(1) Modifying the frequency with which it sends position updates and
(2) Indicating how far a position update packet is allowed to travel before being discarded.

The temporal resolution of the updates is coupled with the mobility rate; the higher the speed of a node, the more frequent the updates it sends.

Location updates with a high maximum hop count are sent less frequently than updates that only reach nearby nodes. Thus, a node provides accurate location information to its direct neighborhood and less accurate information (because of fewer updates) for nodes farther away. The reasoning for this update strategy is that "the greater the distance separating two nodes, the slower they appear to be moving with respect to each other" (termed the distance effect) [18]. The distance effect is a reasonable paradigm when intermediate hops are allowed to update the position information contained in the destination address of a packet. The closer the packet gets to its final destination, the more accurate the position information contained in the packet header.

Compared to periodically flooding the network with location information, DREAM achieves a substantial reduction in the communication overhead it produces. Nevertheless, nodes need to flood the network occasionally to provide faraway nodes with their location, and thus the update complexity is O(n). Since a node that wishes to communicate with another node already knows approximately where the target node is located, there is no need to send location queries. However, the storage requirements for keeping a list with entries for each node at all the nodes are very high. This, together with the necessary flooding of the whole network, limits the scalability of DREAM to small networks.

In a variance of distance routing effect algorithm for mobility (DREAM), the source or any intermediate node A calculates the direction of destination D and, based on the mobility information about D, chooses an angular range. The message m is forwarded to all neighbors whose direction belongs to the selected range. The range is determined by the tangents from A to the circle centered at D and with radius equal to a maximal possible movement of D since the last location update. Based on partial or full flooding some recovery procedures are proposed, to start flooding if the given algorithm fails to find the route within a timeout interval. In DREAM, the moving nodes send location update messages, which are limited to the two-hop neighborhood if the node remains local or are flooded if the node moves further.

B. Routing Discovery through Self-Selection

In this section, we propose route discovery strategies that improve upon existing route discovery strategies by incorporating self-selection into the rebroadcast process. The use of self-selection enables intermediate nodes to make effective localised rebroadcast decisions about whether or not to participate in a route discovery. Importantly, this approach provides a more effective and efficient search strategy than the use of traditional blind flooding and allows for a reduction in the number of redundant route requests rebroadcast in the network. We propose two self-selection based route discovery approaches: Source-Driven Self-Selection (SDSS) and Pure Self-Selection (PSS).

The use of self-selection allows for us to implement a more effective search strategy. However, its important to note that in order to ensure the search strategy covers all nodes in the network, that it is necessary to incorporate a process akin to the expanding ring approach utilised in AODV, where the scope of the search is expanded if a route is not successfully found. This results in a significantly different propagation pattern of RREQs during route discovery.

In SDSS, the source node is responsible for specifying a required utility metric in each RREQ packet. All nodes that do not meet this metric may then elect not to participate in route discovery. In PSS, each intermediate node calculates its own utility to determine whether or not take part in route discovery.

To illustrate simply the benefits of self-selecting strategies, assume a node S **(see Fig. 1)** is required to discover a route to node D without any prior knowledge (e.g. hop count, location information). Now, assume each node maintains a utility function, U, (e.g. based on mobility, topology and power). To minimize the number of route request retransmissions, we can modify the route discovery procedure to allow the nodes with the highest levels of utility to rebroadcast in the first route discovery attempt. Let's assume in this case, only nodes with a utility level greater than 4 may rebroadcast. In this scenario, only five nodes rebroadcast whereas using a pure flooding approach 21 nodes may rebroadcast. Hence, a reduction of 17 nodes is achieved. In networks with high node density and traffic, such strategies may significantly improve data throughput and allow each node to conserve resources if required.

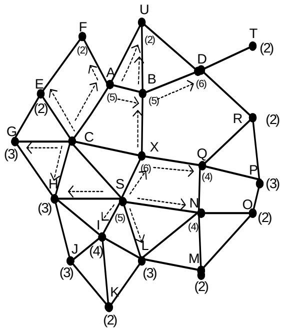

Fig.1 Illustration of Utility –based Self Selection for Route Discovery

C. SDSS Based On Mobility (SDSS-M)

As we discuss in section III-A that the idea of using mobility to minimise the number of control packets was introduced in DREAM [18]. DREAM is a proactive routing strategy, which optimises the frequency at which route updates are sent by nodes to the speed at which they travel. Therefore, the nodes, which travel at high speeds, send update packets more frequently. In this strategy, we use mobility to reduce route discovery redundancy in on-demand routing. To do this, we modify the route discovery strategy to restrict the RREQ rebroadcasts packets to occur over more stationary nodes first.

Self selection criteria for forwarding RREQ-

- Stable nodes provide more reliable paths and these paths are supposed to be available for long duration.
- Stable nodes forward more RREQ messages compare to mobile nodes means rate of dissemination of control packets (number of RREQs transfer in unit time) is depended on mobility (speed of a node).
- A threshold value of speed of mobility is selected and a node moving with the speed greater than threshold value will not forward RREQ messages.

A utility function is introduced, which determines a maximum allowable node speed during each route discovery phase. Therefore, only those nodes, which are travelling at a lower speed than the one specified in the utility function, will rebroadcast. The benefits of the SDSS-M strategy include:

- Increased route stability over blind flooding as selecting least mobile nodes results in fewer route failures.
- Reduction in Broadcast Storm Problem due to fewer rebroadcasting nodes during route discovery.
- Total number of control packets may be reduced significantly, especially in dense networks.

In the following proposed algorithms, P is used to vary the utility functions, which is used to limit the number of re-broadcasting nodes. In our study we used five different values for P to investigate the effectiveness of the self-selecting strategies. In future studies, we plan to study how adjusting P according to known levels of mobility and reachability at each node influences performance. The SDSS-M route discovery algorithm is outlined below:

Algorithm SDSS-M
(*SDSS based on Mobility algorithm*)
1. RREQmax ← Maximum number of route request retries
2. Vmax ← τ Maximum speed at which a node can travel
3. Vu ← Maximum allowable node speed
4. VNoM ax ← Flag used for pure flooding
5. P ← {0.125, 0.25, 0.5, 0.75, 1.0} (Used to select different speed levels)
6. RREQmax ← 6
7. **for** i ← 0, i = RREQmax, i + +
8. Vu ← Vmax .Pi
9. Forward RREQ(Pi, Vu)
10. wait for reply
11. **if** Route = found
12. initiate data transmission
13. break loop
14. **endif**
15. **endfor**
16. **if** Route = notfound
17. Forward RREQ (0,VNoMax)
18. wait for reply
19. **if** Route = found
20. initiate data transmission
21. **else**
22. return route not found
23. **endif**
24. **endif**

In the SDSS-M algorithm, the source node begins by calculating the mobility utility function (Vu), which selects a value for maximum allowable velocity at each intermediate node during a route discovery phase. This value is then passed to the Forward RREQ function where it is attached to the RREQ packet and disseminated to the network. When an intermediate node receives a RREQ packet and it does not have a route to the required destination, it checks to see if its current speed (obtained via GPS) is less than Vu. If yes, then it will rebroadcast the RREQ packet. Note that in the SDSS-M algorithm, we have selected 5 different mobility levels (defined in P), which are used to increase Vu when a route discovery fails to determine a route. If a route is still not found, then a final route discovery is initiated, which allows all nodes to rebroadcast resulting in a Blind flood.

IV DISCUSSIONS AND CONCLUSIONS

In this paper, we are discussed that how we can use mobility as a parameter for limiting Blind flooding and have proposed new search strategies for reactive route discovery. These strategies utilise self-selection to enable a more distributed and localised approach to route discovery by allowing each intermediate node during route discovery to make forwarding decisions using localised knowledge. Proposed strategies provide more effective and efficient search strategy than the use of traditional brute force blind flooding.Thus; the overall performance of the reactive routing protocol is improved.

Two variations of self-selection (source driven and pure self selection) are suggested. Source driven allows each node to make RREQ forwarding decisions based upon a utility metric specified by the source node at the start of reactive route discovery. Here we explored Source Driven Self Selection strategy based on mobility as selection criteria for rebroadcast control packets over the ad hoc network. A SDSS-M algorithm is proposed. The simulation of proposed algorithm can be done as further work.

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