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Location Aided Routing in Mobile Ad hoc Networks

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ABSTRACT: *A mobile ad hoc network consists of wireless hosts that may move often. Movement of hosts results in a change in routes, requiring some mechanism for determining new routes. Several routing protocols have already been proposed for ad hoc networks. This paper suggests an approach to utilize location information (for instance, obtained using the global positioning system) to improve performance of routing protocols for ad hoc networks. By using location information, the proposed Location-Aided Routing (LAR) protocols limit the search for a new route to a smaller "request zone" of the ad hoc network [1]. This results in a significant reduction in the number of routing messages. We present two algorithms to determine the request zone, and also suggest potential optimizations to our algorithms .Further decrease in the overhead can be made by using previous information for routing. ALARM (Anonymous Routing Framework) can also be used to achieve data integrity, anonymity and traceability. Location information of current node can be also get from handheld devices [3].*

Keywords : *Flooding , Expected zone , Request zone.*

I.INTRODUCTION

Mobile ad hoc networks consist of wireless mobile hosts that communicate with each other, in the absence of a fixed infrastructure.1 Routes between two hosts in a Mobile Ad hoc NETwork (MANET) may consist of hops through other hosts in the network. Host mobility can cause frequent unpredictable topology changes. Therefore, the task of finding and maintaining routes in MANET is nontrivial. Many protocols have been proposed for mobile ad hoc networks, with the goal of achieving efficient routing .These algorithms differ in the approach used for searching a new route and/or modifying a known route, when hosts move.

In the next generation of wireless communication systems, there will be a need for the rapid deployment of independent mobile users. Significant examples include establishing survivable, efficient, dynamic communication for emergency/rescue operations, disaster relief efforts, and military networks. Such network scenarios cannot rely on centralized and organized connectivity, and can be conceived as applications of Mobile Ad Hoc Networks. A MANET is an autonomous collection of mobile users that communicate over relatively bandwidth constrained wireless links. Since the nodes are mobile, the network topology may change rapidly and unpredictably over time. The network is decentralized, where all network activity including discovering the topology and delivering messages must be executed by the nodes themselves, i.e., routing functionality will be incorporated into mobile nodes.

The set of applications for MANETs is diverse, ranging from small, static networks that are constrained by power sources, to large-scale, mobile, highly dynamic networks. The design of network protocols for these networks is a complex issue. Regardless of the application, MANETs need efficient distributed algorithms to determine network organization, link scheduling, and routing. However, determining viable routing paths and delivering messages in a decentralized environment where network topology fluctuates is not a well-defined problem. While the shortest path (based on a given cost function) from a source to a destination in a static network is usually the optimal route, this idea is not easily extended to MANETs. Factors such as variable wireless link quality, propagation path loss, fading, multiuser interference, power expended, and topological changes, become relevant issues.

The network should be able to adaptively alter the routing paths to alleviate any of these effects. Moreover, in a military environment, preservation of security, latency, reliability, intentional jamming, and recovery from failure are significant concerns. Military networks are designed to maintain a low probability of intercept and/or a low probability of detection. Hence, nodes prefer to radiate as little power as necessary and transmit as infrequently as possible, thus decreasing the probability of detection or interception. A lapse in any of these requirements may degrade the performance and dependability of the network.

II. ROUTE DISCOVERY USING FLOODING

We explore the possibility of using location information to improve performance of routing protocols for MANET. As an illustration, we show how a route discovery protocol based on flooding can be improved. The route discovery algorithm using flooding is described next.

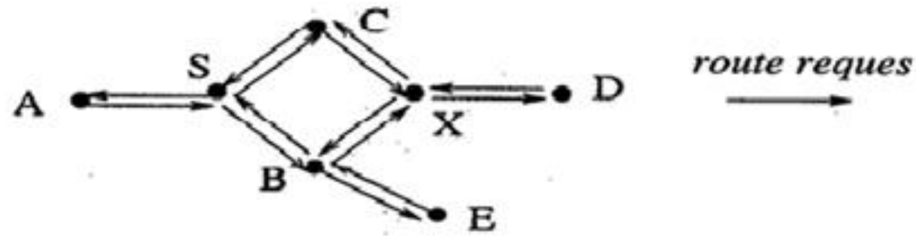

Fig. 2.1 Illustration of flooding

When a node S needs to find a route to node D, node S broadcasts a route request message to all its neighbors - hereafter, node S will be referred to as the sender and node D as the destination. A node, say X, on receiving a route request message, compares the desired destination with its own identifier. If there is a match, it means that the request is for a route to itself (i.e., node X). Otherwise, node X broadcasts the request to its neighbors - to avoid redundant transmissions of route requests, a node X only broadcasts a particular route request once (repeated reception of a route request is detected using sequence numbers). Figure 2.1 illustrates this algorithm. In this figure, node S needs to determine a route to node D. Therefore, node S broadcasts a route request to its neighbors. When nodes B and C receive the route request, they forward it to all their neighbors. When node F receives the route request from B, it forwards the request to its neighbors. However, when node F receives the same route request from C, node F simply discards the route request.

As the route request is propagated to various nodes, the path followed by the request is included in the route request packet. Using the above flooding algorithm, provided that the intended destination is reachable from the sender, the destination should eventually receive a route request message. On receiving the route request, the destination responds by sending a route reply message to the sender - the route reply message follows a path that is obtained by reversing the path followed by the route request received by D (the route request message includes the path traversed by the request).

When node S sends a data packet along a particular route, a node along that path returns a route error message, if the next hop on the route is broken. When node S receives the route error message, it initiates route discovery for destination D. When using the above algorithm, observe that the route request would reach every node that is reachable from node S (potentially, all nodes in the ad hoc network). Using location information, we attempt to reduce the number of nodes to whom route request is propagated.

III.EXPECTED ZONE AND REQUEST ZONE

For implementation of LAR two terms are required-

1) Expected zone
2) Request zone

3.1. Expected Zone

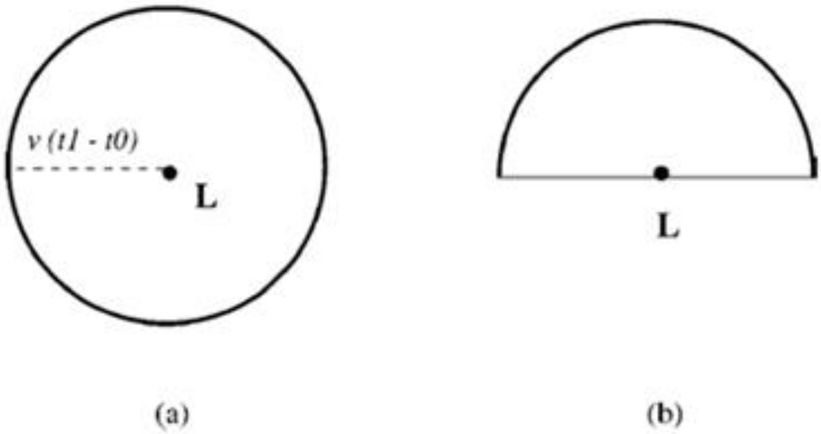

Fig3.1-Example of Expected zone

Consider a node S that needs to find a route to node D. Assume that node S knows that node D was at location L at time t0, and that the current time is t1. Then, the "expected zone" of node D, from the viewpoint of node S at time t1, is the region that node S expects to contain node D at time t1. Node S can determine the expected zone based on the knowledge that node D was at location L at time t0. For instance, if node S knows that node D travels with average speed v, then S may assume that the expected zone is the circular region of radius v(t1 + t0), centered at location L (see figure 3.1(a)). If actual speed happens to be larger than the average, then the destination may actually be outside the expected zone at time t1. Thus, expected zone is only an estimate made by node S to determine a region that potentially contains D at time t1. In general, it is also possible to define v to be the maximum speed (instead of the average) or some other measure of the speed distribution. If node S does not know a previous location of node D, then node S cannot reasonably determine the expected zone - in this case, the entire region that may potentially be occupied by the ad hoc network is assumed to be the expected zone. In this case, our algorithm reduces to the basic flooding algorithm. In general, having more information regarding mobility of a destination node, can result in a smaller expected zone. For instance, if S knows that destination D is moving north, then the circular expected zone in figure 3.1(a) can be reduced to a semi-circle, as in figure 3.1(b).

3.2 Request zone

Again, consider node S that needs to determine a route to node D. The proposed LAR algorithms use flooding with one modification. Node S defines (implicitly or explicitly) a request zone for the route request.
A node forwards a route request only if it belongs to the request zone (unlike the flooding algorithm in section 3.1).To increase the probability that the route request will reach node D, the request zone should include the expected zone (described above). Additionally, the request zone may also include other regions around the request zone. There are two reasons for this:

_ When the expected zone does not include host S, a path from host S to host D must include hosts outside the expected zone. Therefore, additional region must be included in the request zone, so that S and D both belong to the request zone (for instance, as shown in figure 3.2(a)). The request zone in figure 3.2(a) includes the expected zone from figure 3.2(a). Is this an adequate request zone?

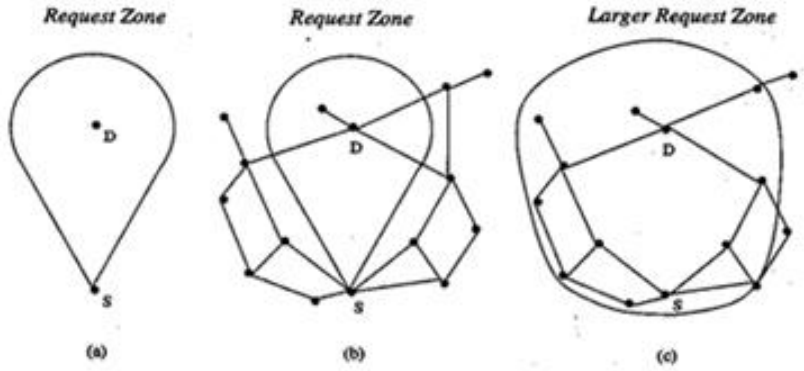

Fig3.2-Example of Request Zone

In the example in figure 3.2(b), all paths from S to D include hosts that are outside the request zone. Thus, there is no guarantee that a path can be found consisting only of the hosts in a chosen request zone. Therefore, if a route is not discovered within a suitable timeout period, our protocol allows S to initiate a new route discovery with an expanded request zone - in our simulations, the expanded zone includes the entire network space. In this event, however, the latency in determining the route to D will be longer (as more than one round of route request propagation will be needed).

Note that the probability of finding a path (in the first attempt) can be increased by increasing the size of the initial request zone (for instance, see figure 3.2(c)). However, route discovery overhead also increases with the size of the request zone. Thus, there exists a trade-off between latency of route determination and the message overhead. As noted above, our LAR algorithms are essentially identical to flooding, with the modification that a node that is not in the request zone does not forward a route request to its neighbors.4 Thus, implementing LAR algorithm requires that a node be able to determine if it is in the request zone for a particular route request.

IV. LAR SCHEME

Our first scheme uses a request zone that is rectangular in shape (refer to figure 4). Assume that node S knows that node D was at location (Xd, Yd) at time t0. At time t1, node S initiates a new route discovery for destination D. We assume that node S also knows the average speed v with which D can move. Using this, node S defines the expected zone at time t1 to be the circle of radius R = v(t1-t0) centered at location (Xd, Yd). (As stated before, instead of the average speed, v may be chosen to be the maximum speed or some other function of the speed distribution).

In our first LAR algorithm, we define the request zone to be the smallest rectangle that includes current location of S and the expected zone (the circular region defined above), such that the sides of the rectangle are parallel to the X and Y axes. In figure 4.1, the request zone is the rectangle whose corners are S, A, B and C, whereas in figure 4.2, the rectangle has corners at point A, B, C and G - note that, in this figure, current location of node S is denoted as (Xs, Ys).

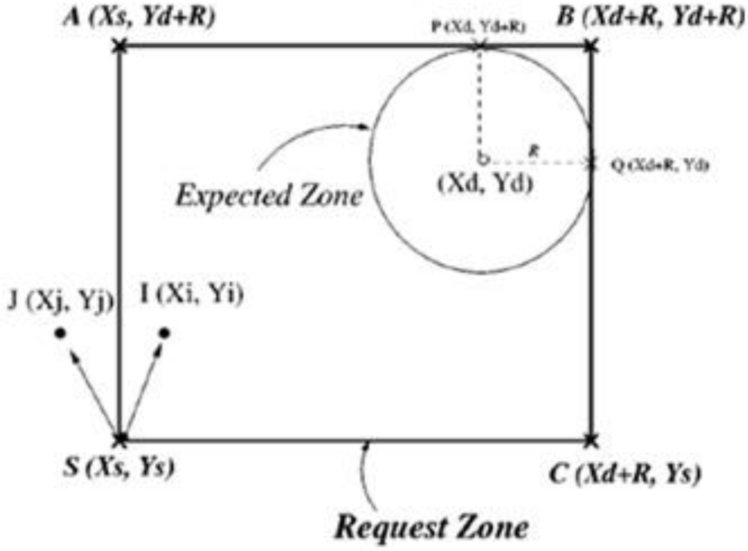

Fig4.1-Source node outside the expected zone

The source node scan, thus, determine the four corners of the request zone. S includes their coordinates with the route request message transmitted when initiating route discovery.

When a node receives a route request, it discards the request if the node is not within the rectangle specified by the four corners included in the route request. For instance, in figure 4.1, if node I receives the route request from another node, node I forwards the request to its neighbors, because I determines that it is within the rectangular request zone. However, when node J receives the route request, node J discards the request, as node J is not within the request zone (see figure 4.1). When node D receives the route request message, it replies by sending a route reply message (as in the flooding algorithm). However, in case of LAR, node D includes its current location and current time in the route reply message.

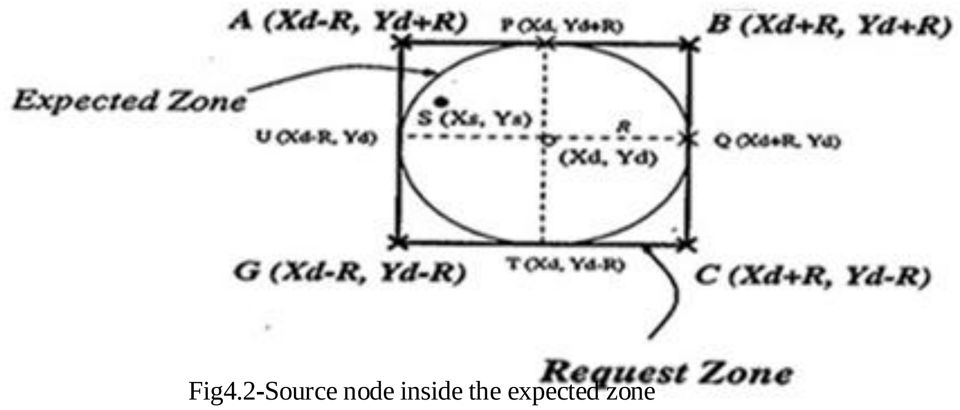

Fig4.2-Source node inside the expected zone

When node S receives this route reply message (ending its route discovery), it records the location of node D. Node S can use this information to determine the request zone for a future route discovery. (It is also possible for D to include its current speed, or average speed over a recent time interval, with the route reply message. This information could be used in a future route discovery. In our simulations, we assume that all nodes know each other's average speed.)

V.CONCLUSION

This paper describes how location information may be used to reduce the routing overhead in ad hoc networks. We presented two location-aided routing (LAR) protocols. These protocols limit the search for a route to the so-called request zone, determined based on the expected location of the destination node at the time of route discovery. Simulation results indicate that using location information results in significantly lower routing overhead, as compared to an algorithm that does not use location information. We also suggest several optimizations on the basic LAR schemes which may improve performance. Further work is required to evaluate efficiency of these optimizations, and also to develop other ways of using location information in ad hoc networks, or instance to improve performance of reactive algorithms such as TORA, or to implement location-based multicasting.

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