A New Approach to On-demand Routing Protocols in Mobile Ad hoc Networks

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Abstract: A mobile Ad hoc network is a collection of wireless mobile nodes serving as hosts and routers, connected by wireless links that can dynamically form a network to exchange information without any centralized administration or using any pre-existing fixed network infrastructure.

The unique characteristics of mobile ad hoc networks pose a number of nontrivial challenges to routing protocols design, such as Mobility, power consumption, Bandwidth-constrained, and Dynamic topologies. Hence, many different routing protocols have been developed for MANET over the past several years, based on different salient characteristics and properties.

Mobility in ad hoc networks is an obligation that cannot be obviate, and the information used for routing by traditional routing protocols becomes obsolete due to node mobility.

In this paper, we are introducing new purely on-demand protocol, depending on Axis-mapping technique, to select the nodes that will forward a message in the network. The proposed protocol is reducing the overhead and the effect of flooding technique in finding the destination, and increasing the robustness of the path from a source to a destination.

1. Introduction.

A mobile ad hoc network "unlike a static network has no infrastructure (e.g. Base stations)" is a collection of mobile nodes that are dynamically and arbitrarily located in such a manner that the interconnections between nodes are capable of changing on a continual basis, and each mobile host acts as a host and a router, relaying information from one neighbour to others.

Depending on how a route is determined, existing routing protocols for ad hoc networks can be classified into three groups: Periodic/Proactive protocols, On-demand/Reactive protocols, and Hybrid protocols. The proactive protocols depend on periodic dissemination in the network to exchange routing information about all the nodes continuously, as examples DSDV [2]. While reactive protocols designed to reduce the overheads in proactive protocols by maintaining information for active routes only such as AODV [3]. Hybrid routing protocol are combination of the previous two groups (Proactive/Reactive) as in ZRP [4] for example. More details can be obtained from [1].

The global positioning system (GPS) receivers allow users to obtain their physical location information, velocity, and even the current "global" time with extremely high precision. Geographical routing protocols utilize geographical location of the nodes to discover the route or to forward the message. Recent work on this kind of approaches includes DREAM [5] and LAR [6], both schemes do not take the direction of motion of a node into account when attempting to establish a route from a source to a destination.

Rakesh KumarBanka and Xue in [7] introduce a scheme to reduce the flooding and overhead involved in the route discovery to the destination knowing its location information by forwarding packets to certain nodes, which fall into a determined region. These nodes are selected based on the location of the final destination and the location of the intermediate node. This scheme did not consider the direction of nodes' motion for establishing long-lived route.

Samarth and Nahrsted in [9] present a location-delay prediction scheme, based on a location-resource update protocol, which assists a QoS routing protocol. This scheme used geometric coordinates, direction of motion, velocity, and resource information pertaining to the node that is used in QoS routing. However, the update protocol in this scheme involves flooding of location and resource information pertaining to a node to all the other nodes in the network. Such a full flooding of the network involves a very large overhead.

In our proposed On-Demand Protocol, we are subjecting nodes mobility to be beneficial for establishing a route from a source to a destination using the heading direction information for the mobile hosts, and rough information about the position of destination.

2. Design of Protocol.

We have assumed that each mobile node in the network is equipped with a digital compass (digital advanced compasses with magnetoresistive (MR) technology), that provide the heading direction angle of the mobile device hosting it. It can easily be integrated into systems via a simple communication interface, which makes it ready for use in applications like automobile GPs systems, cars, and mobile nodes [8]. Moreover, each node received a message from its neighbour nodes containing neighbour's IP and heading direction angle, will store its neighbour's IP and heading direction angle in one of the eight zones ranges in its cache regardless of their actual position. Furthermore, the source node knows rough information about the position of destination (e.g. a monitoring node, a gateway to fixed wired network, a destination in a specific area, etc.).

2.1 Approach Architecture.

In this scheme, each mobile node in the network will classify its neighbour's nodes into eight different zone ranges areas (d1… d8) according to the heading direction of those neighbours; theoretically, the nodes are categorised within the eight zones ranges, regardless of their actual relevant positions to the node. Figure 1 shows the eight basic heading directions ranges and depict how the node can assort each neighbour in one of these ranges.

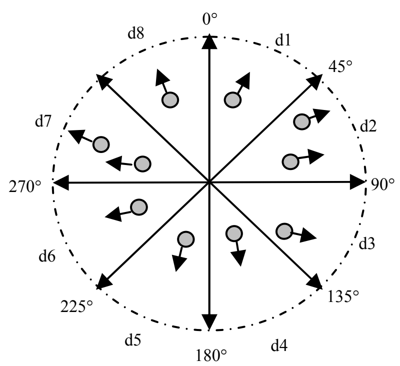

Figure 1: The eight basic heading directions ranges and assorting neighbours in these ranges.

After the source S categorizes its neighbours in its cache table as shown in Figure 1 and S needs to propagate a packet to neighbour, S will choose that neighbour such that it has an angular heading direction of one of the eight axis angular value (0, 45, 90, …315) $\pm \delta$, where δ is an angular value that represents the range of angles that are considered near to an axis. Using the eight heading direction will ensure that route request will be well distributed over a wider area. This will result in less computational overheads and minimized bandwidth use, since not all neighbouring nodes need to react to a route request. If the node did not find a neighbour that fulfils the heading angle condition, expanding the search will apply by adding or subtracting δ from the axis being considered. Figure 2 delineates the idea of this technique that developed in this paper; this technique is called "Axis Mapping".

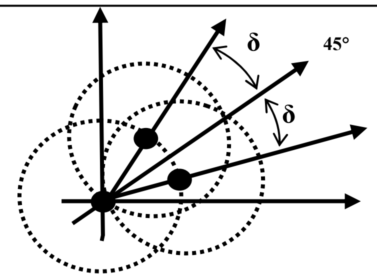

Figure 2: Axis Mapping technique, δ added along 45° axis

2.2 Route Request.

At the source node, when a source S request route to a destination D, and D node is not found in the source cache, a time Td will start, where Td is the time required to find destination, and S start looking into its cache for a neighbour that has a reference or near reference angle match to or close to the heading direction angle of the source, in order to the route lasting for long period of time, (hence this protocol performs well in a network where nodes form groups, and each group moves together in one direction such as in military, vehicles on highway, and so on), here we have two possibilities, if S did not find a neighbour with a reference or near reference angle in S cache; axis mapping will be applied with increment ±δ to widen the search in a new direction. While if S found a neighbour; the list of route records is initiated. Each record has the fields (Node IP, Node heading angle, Zone range area, Td), then the route request message will be propagated along chosen heading angle of a neighbour node (the second record in the list).

At intermediate node, only the intermediate node that the message is propagated to, and has a record in the list of route records, will deal with the message, if D is not found in the cache, the node start looking into its cache for a neighbour that has a reference or near reference angle, if the node find a neighbour in its cache, it will update the list of route records by adding the neighbour's IP and its heading direction, and forward the message along the selected neighbour with the list. If the node did not find a neighbour in its cache; axis mapping will be applied. Basic case is illustrated in Figure 3.

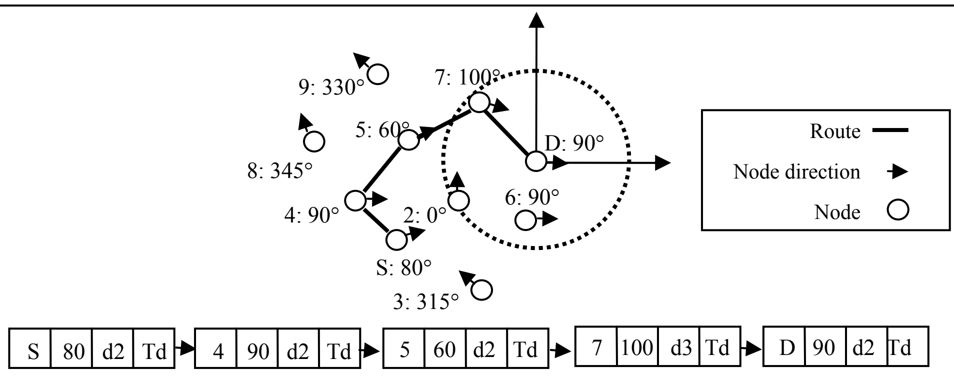

Figure 3: Propagating a route request from the source S to the destination D

2.3 Route Reply.

Route reply message would be initiated by the destination itself, or by the intermediate node which has received the route request message and has information about the destination in its cache. Route reply message will piggyback the list of route records in the replied message and send the message along the reversed path determined by the nodes recorded in the list.

315°

2.4 Route Error.

Route breaks could result from node mobility, fading environment, signal interference, high error rate, and packet collisions. Breaking of link can be detected if a node receives a link layer feedback signal from the MAC protocol, or it does not receive passive acknowledgments (MAC protocols such as MACAW and IEEE 802.11 have this capability). A route error message is raised when Td expired, Tn expired, and a broken route (at route reply and sending data).

3. Simulation Results.

The network simulator ns-2 is used to perform extensive simulations and to evaluate our protocol. Results are expected to show how this protocol reduced the flooding impact in comparison with other On-Demand routing protocols such as AODV [3]. Moreover, to show the longevity of route live, the percentage of successful route establishments, and percentage of error message to number or routes established. Due to the constraint of the time, the simulation results will be provided at the symposium.

4. Conclusion.

In this paper, we have presented a new Routing Protocols for Mobile Ad hoc Networks. Our approach is fully On-Demand Protocol and depends on Heading-direction angle routing protocol to overcome the effect of flooding technique and overhead in the network by doing selective forwarding, and elongate the route live. This protocol utilises Axis-Mapping techniques to propagate a message in the network. The ways nodes are selected, exploit the mobility to be beneficial, instead of being obstruction, by knowing the directions of nodes motions, and this achieved by equipping each mobile node in the network with a digital compass with magnetoresistive (MR) technology.

References.

[1] Mehran Abolhasan, Tadeusz Wysocki, Eryk Dutkiewicz, “A review of routing protocols for mobile ad hoc networks”, in: Ad Hoc Networks 2 (2004) 1-22.

[2] C.E. Perkings, and P.Bhagwat, “Highly Dynamic Destination-Sequenced Distance Vector Routing (DSDV) for mobile Computers”, Proceedings of ACM SIGCOMM’94, pp. 234-44 London, UK, September 1994.

[3] C.E. Perkings, and E.M. Royer, “Ad-hoc On-Demand Distance Vector Routing”, Proceedings of 2nd IEEE Workshop on Mobile Computing Systems and Applications, pp.90-100, February 1999.

[4] Z.J. Hass, R. Pearlman, “Zone routing protocol for ad-hoc networks”, Internet Draft, draft-ietf-manet-zrp-02.txt, 1999.

[5] Stefano Basagni, Imrich Chlamtac, Violet R. Syrotiuk, and Barry A. Woodward, “A Distance Routing Effect Algorithm for Mobility (DREAM)”, In Proc. ACM/IEEE MobiCom, pages 76-84, October 1998.

[6] Young-Bae Ko and Vaidya Nitin H, “Location-Aided Routing (LAR) in mobile ad hoc networks”, In Proc. ACM/IEEE MobiCom, pages 66-75, October 1998.

[7] Rakesh Banka and Guoliang Xue, "Angle Routing Protocol: A new Ad-Hoc wireless protocol using Dynamic Angle Selection.", IEEE Milcom'2002 Conference, 2002.

[8] Solid State Electronics Center, http://www.ssec.honeywell.com/magnetic/, home page

[9] Samarth H., and Klara Nahrstedt, "Predictive Location-Based QoS Routing in Mobile Ad Hoc Networks", In Proceedings of IEEE International Conference on Communications, 2002.