A Routing Algorithm for Mobile Ad Hoc Networks

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***Abstract*—A mobile ad hoc network is a set of mobile nodes that are dynamically located and connected by wireless links. The network is self-configuring and provides end-to-end communication. In order to facilitate communication within the network, a routing protocol is used to discover routes between source and destination nodes. Routing in the mobile ad hoc networks is a challenging task and has received a tremendous amount of attention from researches. This has led to development of many different routing protocols. Therefore, it is quite difficult to determine which protocols may perform best under a number of different network scenarios, such as increasing node density and traffic. In this paper, we present concept, characteristics and functionality of a simple routing protocol, based on packet delivery rate and distance from the destination node.**

I. Introduction

Wireless mobile ad-hoc networks have no fixed infrastructure. A dynamic routing protocol is needed to function properly on a frequently changing network topology. Here the node itself acts as both client and server, forwarding and receiving packets to or from other nodes. Routing in ad-hoc networks has become a challenging issue. There are many protocols already developed for mobile network environments. All these protocols can be classified in different ways. Based on the network structure the routing protocols can be classified as flat routing, hierarchical routing and geographic position assisted routing [1]. In flat routing, nodes communicate directly with each other. The flat routing protocols can be classified in three categories such as proactive, reactive and hybrid. Proactive protocols follow the strategies which are mostly followed by conventional routing protocols. On-demand routing is a new emerging technology in ad-hoc networks. Hybrid protocols are incorporating the properties of both proactive and reactive types. Hierarchical routing plays a major role in large size networks where flat routing protocols are struggling with constraints. Now-a-days geographical location information also provides better routing performance in ad-hoc networks.

In proactive scheme, a very small delay is needed to determine the route but a significant amount of delay is needed for creating a route by reactive routing protocols. Pure proactive scheme is not appropriate for the ad-hoc networking environment, because it has to keep the current routing information in a large network. Reactive protocols require significant control traffic due to the long delay and excessive control traffic. As a result pure reactive routing protocols are not suitable for large network implementations.

The focus of this paper is the concept of a new ad hoc network routing protocol based on following data: (1) the source - neighboring nodes packet delivery rate, and (2) the distance between destination and source neighboring nodes.

II. Related Work

The history of wireless networks started in the 1970s and the interest has been growing ever since. A new generation is the construction of temporary networks with no wires, no communication infrastructure and no administrative intervention required. Such interconnection between mobile computers is called an ad hoc network. Ad hoc networks are defined as a collection of mobile nodes forming a temporary (spontaneous) network without the aid of any centralized administration or standard support services. [2]. Routing protocols for Mobile ad hoc networks can be broadly classified into two main categories: (1) proactive or table-driven routing protocols and (2) reactive or on-demand routing protocols. In proactive or table-driven routing protocols, each node continuously maintains up-to-date routes to every other node in the network. Routing information is periodically transmitted throughout the network in order to maintain routing table consistency. Certain proactive routing protocols are Destination- Sequenced Distance Vector (DSDV), Wireless Routing Protocol (WRP), Global State Routing (GSR) and Clusterhead Gateway Switch Routing (CGSR). In contrast to proactive approach, in reactive or on demand protocols, a node initiates a route discovery throughout the network, only when it wants to send packets to its destination. Some reactive protocols are Cluster Based Routing Protocol (CBRP), Ad hoc On-Demand Distance Vector (AODV), Dynamic Source Routing (DSR), Temporally Ordered Routing Algorithm (TORA), Associatively-Based Routing (ABR), Signal Stability Routing (SSR) and Location Aided Routing (LAR) [3]. Till now many routing protocols are used in mobile ad hoc networks. Each routing protocol has unique features. Based on network environments, we have to choose the suitable routing protocol. Protocol behavioral study is conducted very intensively. Proactive routing protocols are best suited in small networks. In large and dense network, proactive routing protocols cannot perform well. Proactive routing protocols are table driven. Maintaining thousands of routing tables properly in large network degrades the efficiency. So for large and dense networks reactive routing approach plays a major role. Reactive routing protocols use destination sequence number and feasible distance to ensure a loop free routing. Hybrid routing protocols use reactive and proactive approach in routing operations [4]. Some works consider the routing task, in a way that a message is to be sent from a source node to a destination node, where the destination node is known and addressed by means of its location. Routing is performed by a scheme based on this information, generally classified as a position-based scheme [5]. There are many challenges to be faced in routing protocols design. A central challenge is the development of the dynamic routing protocol that can efficiently find routes between two communication nodes. Also, in order to analyze and improve existing or new MANET routing protocols, it is desirable to examine other metrics like power consumption, fault tolerance, number of hops, jitter, etc. in various mobility and traffic models [6].

III. THE PROPOSED NEW ROUTING PROTOCOL

Here we present a new on-demand, localized, and packet delivery rate based Ad Hoc routing protocol. Localized algorithms are distributed in nature and resemble greedy algorithms, where simple local behavior achieves a desired global objective. In a localized routing algorithm, each node makes a decision to which neighbor to forward the message based solely on the location of itself, its neighboring nodes, and the destination. On the other hand, the primary goal of every routing scheme is to deliver the message, and the best assurance one can offer is to design a routing scheme that will guarantee delivery. Wireless networks normally use a single-frequency communication model where a message intended for a neighbor is heard by all other neighbors within the transmission radius of the sender. Collisions normally occur in medium access schemes, such as IEEE 802.11. This protocol is based on guaranteed delivery in routing (i.e., eventual delivery), which is conditional on the ability of the medium access layer to always transmit a message between any two neighboring nodes, possibly with retransmissions.

In proposed routing protocol, a routing is constructed only when a node needs to communicate with another node. Assume that a source node S wants to send a packet to some destination node D. Then, the routing algorithm follows the next nine rules:

1. The algorithm is running on the S node, when it has a data packet for delivering to D node, where S and D are nodes of an ad hoc network;
2. The algorithm input data are address and location of D node, and the minimum packet delivery rate between nodes on the route from S to D (PDRmin);
3. The S node determines the neighboring nodes (nodes within the range);
4. The S node determines or measures packet delivery rate to the neighboring nodes (with 10 short ping messages, for example);
5. The S node selects the neighboring nodes with PDR≥PDRmin;
6. The S node obtains locations of neighboring nodes with PDR≥PDRmin;
7. The S node calculates distance from nodes with PDR≥PDRmin to the D node;
8. The S node selects the node with the shortest distance to the D node (next hop node);
9. The S node starts the data transmission to the next hop node.

Figure 1 shows selection of the next hop node by proposed routing algorithm, with PDRmin=90%. The next hop node has PDRmin≥90% and the distance from D node R1min.

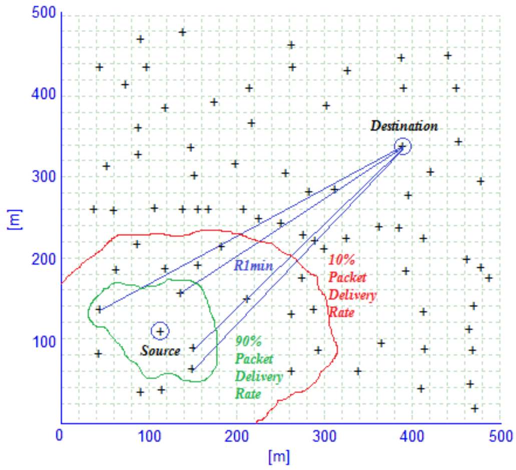

Figure 1. Next hop node selection

Now, the next hop node becomes S node and it applies the same routing algorithm. The algorithm proceeds until the destination is reached or no closer node to the destination exists. Varying PDRmin different nodes will be selected to form S-D route. Figure 2 shows two routes with two different packet delivery rates between two consecutive nodes, PDRmin≥0.9 and PDRmin≥0.75. Obviously, a lower packet delivery rate gives a route with fewer hops. However, this does not mean better efficiency. Generally, we can conclude that in low mobility and low load scenarios our proposed protocol finds S-D route for different network topologies and different packet delivery rates between nodes. But, there are many other challenges to be faced in the proposed protocol evaluation and implementation.

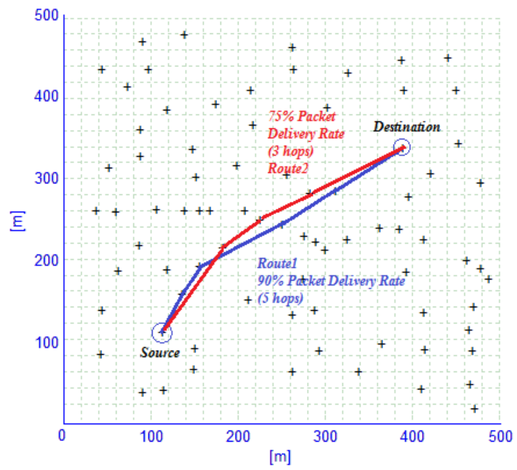

Figure 2. Network routes with different packet delivery rates

In order to analyze and improve this new mobile network routing protocol, it is desirable to examine other metrics like node mobility, power consumption, fault tolerance, jitter, etc. in various traffic models. Preliminary results show robustness of the proposed algorithm, it handles the position deviation due to the dynamicity of the network, and has the ability to deliver a message when the communication model deviates from the unit graph, due to obstacles or noise.

IV. Protocol Simulation

In order to present which are the results of the proposed routing algorithm in practice, a small simulation application is made using programming environment MS Visual C # 2010 Express. The basis for the program was a pseudo code shown in Fig 3, which was written according to the routing algorithm given in the previous section.

```
procedure RoutingProtocol(Destination, Package, PDRmin)
NextHop = Source;
while NextHop ≠ Destination do
begin
foreach  Node ∈ AdHocNetwork
   begin
          PDR[NodeId]
          = FindPDRofNode(NextHop, PingMessage, Node);

          If  (Node.PDR>=PDRMin)
                  AddNodeToRangeList(Node);
   end
foreach Node ∈ RangeList
   begin
          Distance[NodeId]
          = FindDistanceFromDestination(Destination);

          MinimumDistanceNode
          = FindMinimumDistanceNode(Distance[NodeId]);

          sendPackage(NextHop, MinimumDistanceNode);
          NextHop = MinimumDistanceNode;
          ClearRangeList();
   end
end
```

Figure 3. Routing algorithm pseudo code

The appearance of the application for the simulation, after running of an routing example, is shown in Fig 4. Input data are the number of nodes in ad hoc networks, the source position, the destination position and minimum PDR. After that, nodes are deployed randomly in the diagram, and the PDR for each of them is assigned based on distance. In conditions of applying the algorithm in the real network, the PDR will be determined by sending a certain number of short ping messages.

The application operates as follows. After entering the position of the source and the destination in given text boxes, those positions are plotted on the diagram, and after the election of the PDRmin, the diagram is marked with a green area which consists of nodes that satisfy the condition that the PDR >= PDRmin (range). Then, the next hop (the node to which the packet will be forwarded) is selected as node from the range nearest to the destination. It will be, in the next step of simulation marked as a new source (a black triangle symbol). In next step of the simulation, the diagram shows the range of the new source, and the next hop is marked with symbol x black. This procedure will be repeated until the packet reaches the destination.

Based on this simulation, it is shown that the package will be delivered to the destination, and which route will be selected, and the number of nodes that package will pass through, depending on the area of the range, that is the determined by value PDRmin. All this is recorded in the log and report in the application for the routing algorithm simulation.

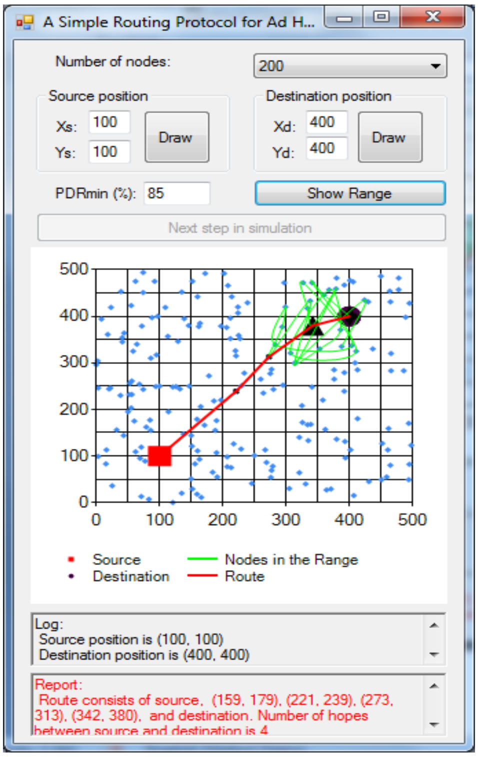

Figure 4. Application for the algorithm simulation

The example shows the route found using the routing protocol in condition when the source position is (100, 100), the destination position is (400, 400), and PDRmin is 85%, and other nodes in an ad hoc network are placed as it is shown in Fig 4.

V. Conclusions

In this paper, we present a new on-demand routing protocol based on the packet delivery rate between source and neighboring nodes, and the distance between source neighboring nodes and the destination node. Preliminary results show that the proposed protocol algorithm is able to quickly find a source destination route for different network topologies and different required packet delivery rates between nodes. The algorithm also exhibit the properties of robustness, it has the ability to deliver a message when the communication model deviates from the unit graph due to obstacles or noise, but influence of node mobility has to be evaluated through different scenarios.

Acknowledgment

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