Routing Update in Ad Hoc Networks

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Abstract. Contrary to cellular networks, ad-hoc networks are a form of mobile networks that function without any fixed infrastructure. This paper proposes a method which improves routing success rates in mobile ad hoc networks. This method is based on the density of the nodes in the neighborhood of a route and on the availability of this neighborhood. The results obtained are encouraging: the data packet loss rate is significantly reduced and the time required to complete a local repair route following a failure decreased significantly.

Index Terms: mobile ad hoc networks, route repair, AODV

1 Introduction

An *ad hoc network* is a mobile wireless network composed of several mobile nodes, likely to communicate together without the required intervention of any centralized management or existing infrastructure. The nodes of these networks must be able to cooperate among themselves to allow communication. The deployment of ad hoc networks is thus largely simplified compared to other forms of mobile networks.

This paper suggests a method which improves the probabilities of success of a local route repair in mobile ad hoc networks (MANETs) by accelerating the process of route reparation after the departure of a node included in the route. Section 2 introduces some background information and related work. Section 3 describes the solution suggested to improve route repairs. Finally, Section 4 presents and analyzes simulation results.

2 Background and Related Work

A routing protocol is a mechanism by which user traffic is directed and transported through a network from a source node to its destination node. It aims to maximize network performance from an application point of view while minimizing the cost imposed on the network in terms of capacity. QoS (Quality of Service) routing protocols search routes with sufficient resources for QoS requirements [3, 7].

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2.1 Best Effort Protocols

DSDV (Destination Sequenced Distance Vector) is a best effort protocol designed specially for MANETs [4]. It belongs to the class of proactive protocols and uses a version of the distributed Bellman-Ford algorithm which is adapted to ad hoc networks. The routing information associated to each node of the network is recorded in a routing table by each mobile station.

AODV (Ad hoc On Demand Vector) represents an improvement of DSDV [5]. In fact, to synthesize, it takes the advantages of DSDV but limits bandwidth consumption.

2.2 QoS Routing Protocols

In MANET, a route is defined as set of mobile units that contributes to data transmission from source to destination. Quality of service (QoS) consists of a set of characteristics or constraints (bandwidth, hop count, delay, throughput, packet loss rate, etc.) that a connection must guarantee between a source and a destination during the communication to meet the requirements of an application [1].

With the increasing number of applications requiring a certain QoS, the success of mobile ad hoc networks relies heavily on their ability to provide routing protocols that take into account QoS [2, 6].

3 Routing Protocol in Ad Hoc Networks

The routing protocol used here is based on a routing algorithm initiated by the source that takes into account QoS in terms of bandwidth consumption. If a failure occurs during the communication between two nodes, two scenarios can be used to repair the route: a *global route repair* and a *local route repair. A global route repair* starts from the source of communication. Although it requires significant time and consumes much bandwidth, this solution is used in most routing protocols. A *local route repair* starts from a node in the neighborhood of the link where the failure occurred. This latter solution offers two advantages: its speed and its low bandwidth consumption.

3.1 Protocol for Route Repair

Our objective aims to ensure the selection of the most easily reparable route among those extracted from the route discovery phase. To achieve this goal, we recommend taking into account the nature of the neighboring nodes composing the network, more particularly the node *density* and their *availability*. The reparation of a route in case of failure can be carried out through local route repair.

We use the availability parameter to establish the ability of a Node A to replace Node B. The availability of a node depends on the nature of the node, the number of packets forwarded by the node as well as their capacity.

We define the density of a node λ as the number of direct neighbors of λ whose available bandwidth is higher than that required by the connection. The density parameter is completely specified by a node and the bandwidth associated with that node.

The discovery phase: We use the route discovery phase as described in the AODV protocol for which we add provisions for the availability and density parameters. These two parameters need to be taken into account in order for our protocol to provide QoS. Thus, in our protocol, the source initiates the routing process upon receiving a connection request. Then, it sends a route request for this connection to all its neighbors. The nodes that receive the message for the first time and that fulfill the QoS requirements propagate the request message towards the destination after the following scenario :

The request message is gradually propagated towards the destination following the aforementioned scenario. Finally, when it arrives at its destination, the destination node initiates a countdown and records all of the incoming request messages.

To *select a route*, we need the parameters contained in each request message that arrived at the destination. It is important to mention that a route containing long sequences of high density nodes will be easier to repair with the local route repair procedure than a route that does not hold that property.

4 Implementation and Results

The modifications to the AODV protocol were implemented using *Opnet Modeler*. The protocol defines four types of packets that can be exchanged between the topology nodes: RERR, REEQ, RREP and DATA.

4.1 Example

Here is a specific example which illustrates the rationale for such modifications to the initial protocol (Figure 1).

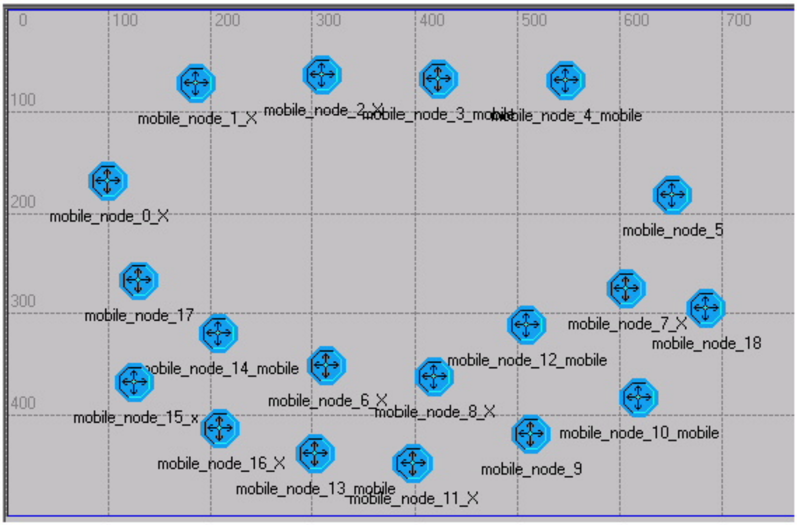

Fig. 1. Topology used

In the configuration presented in Figure 2, Node 0 seeks to establish a communication with Node 5. All of the other nodes behave as routers. Several routes are possible. Among these routes, the route passing through Nodes 1, 2, 3 and 4 is the shortest one from source to destination.

For the sake of clarity, we will only detail the results concerning the departure of Node 12. The data collected for Cases 1 and 2, and in particular the end-to-end (ETE) delays, reveal that no route repair is undertaken following the departure of Node 12 from the network, since this node does not belong to the route used in these cases. On the other hand, we can clearly see that for Case 3, the departure of Node 12 strongly affects the results. Indeed, the ETE delay increases from 0.014 to 0.016 second after the departure of Node 12.

5 Conclusion

The routing method presented in this paper aims to improve QoS management in MANETs by taking into account the *density* of a node, defined as the number of mobile units available in the radio range of the node. Our approach was based on a thorough analysis of the available mechanisms and tools that take into account quality of service in ad hoc networks. We then introduced the concept of density and described how the network could exploit this information to improve the QoS offered.

The described route selection mechanism aims to select the route whose maintenance is the easiest to realize among several routes. The protocol was tested with a given configuration. The results obtained are encouraging: the data packet loss rate is strongly reduced compared to the initial version. In addition, the time required to complete a local route repair following a failure is reduced significantly.

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