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Proposing a new method for routing improvement in wireless ad hoc networks (optional)

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Abstract. In recent few years, many efforts have been done in order to present a reliable routing algorithm in mobile ad hoc networks. However, lack of an efficient algorithm is still an issue; although many routing protocols exist for improving efficiency. In this paper, we analyze AODV routing protocol and then a method is proposed for AODV routing which greatly improves the efficiency of this protocol. Finally, the proposed method with AODV is simulated in a network simulator with a scenario containing variable number of nodes and the optimum protocol is introduced based on the simulation results.

Keywords: routing, distance, geographical location, ad hoc networks

INTRODUCTION

Ad hoc networks are spontaneous or temporary networks which are created for a particular purpose. The main difference of ad hoc networks with usual wireless 802.11 networks is that in ad hoc networks a set of mobile wireless nodes are connected to each other without any central infrastructure, access point, or base station for sending wireless information in a specified interval. In such networks, nodes continuously change their locations. Such action itself reveals the need for a routing protocol which has the ability to adapt to these changes [5]. Routing and security is one of today's challenges in these networks. Ad hoc networks have two types: Intelligent sensor networks and mobile ad hoc networks. This expression, which is adopted form Latin, means for proprietary usage.

In mobile ad hoc networks, routing can be performed in many ways [2], which depends on the routing strategy and the network structure. Regarding the routing strategy, routing protocols are divided into two groups: proactive routing protocols and reactive routing protocols [3]. Proactive routing protocols record routing information before it is needed. Routing information is generally kept in routing tables, and nodes update their routing tables by periodic exchanging with each other. In addition, with the change of network topology, existing routing tables in nodes are updated.

AODV ROUTING PROTOCOL

It is a request-based routing protocol [6] which allows mobile computers or nodes to communicate directly in order to transfer messages between their neighbors. AODV, like all reactive request

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protocols, performs routing operation when a path is needed. Of course when the path is found, it is reserved as long as needed. After that, it is not reserved anymore and next time the path should be found again. AODV assures that the paths do not contain loops and tries to find the shortest possible path. Furthermore, AODV can do manual changes in paths and if there is an error, it can create new paths.

This protocol tries to adapt quickly to dynamic line conditions and the algorithm needs a little processing and memory. This protocol uses destination order number to make sure loops do not appear and also solves the problem of counting to infinity which existed in classic distance vector protocol. In AODV, each node has its own order number which increases uniformly. This number increase when the corresponding node notices a change in the network topology. AODV has another important feature and that is its usability in all 3 types of communications: single-cast, multicast and broadcast [8].

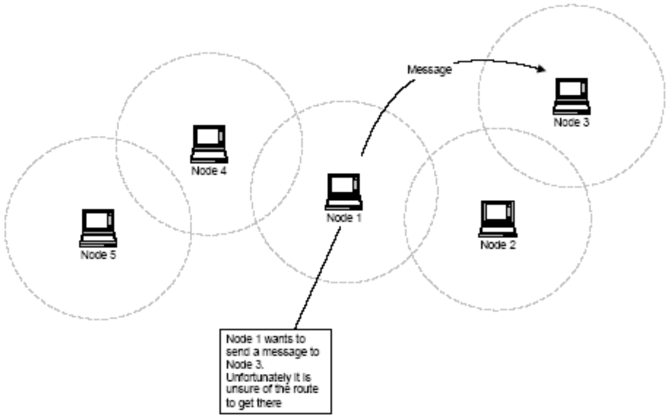

Figure 1. A 5-node network in an ad hoc network.

THE PROPOSED METHOD

In the classic AODV algorithm, each node deletes the next received rreqs for a destination as soon as it receives a rreq from one of the neighbors. This leads to just one path request through this node from all neighbors and at the end just one path through this node to the destination is discovered. In the proposed method, if rreq messages are received by the destination or any node aware of that destination, all of them are responded by separate rreqs and none are deleted. Just those rreqs are deleted which are received from one neighbor for the same destination and more than once. This causes the creation of several paths between the source node and the destination node. In the new method, during the process of path discovery, the distance between the source node and the destination node is calculated and is available for the node which requests the path. The requesting node chooses the shortest path (which has the shortest length) as the optimum one and stores it in its routing table or updates its routing table. It is assumed all nodes are equipped with Global Positioning system and know their longitude and latitude in each moment. By applying the proposed method to AODV algorithm, two new fields called geographical position are used in order to calculate the distance between nodes in each hop to the next intermediate node toward source. Each node which begins to send rreq message, set the distance field to zero and the geographical position to its own longitude and latitude in the rreq message; then it sends the message to the next intermediate node toward source. The node which receives the rreq, calculates the distance by using equation 1 based on its own and the sender's longitude and latitude, then adds it to the existing value in the distance field, and sends this message and its longitude and latitude to the next intermediate node toward source. This process continues until the rreq is received by the source node. Therefore, in each intermediate node, the value of the distance field shows the distance between the destination node and this intermediate node. So when the rreq message arrives at the source node, the source node has the distance between itself and the destination node. In other words, it has the length of the discovered path. Thus, since the lengths of discovered paths are available to the source node, it is clear the source chooses the path which not only has the lowest number of hops but also has the shortest length.

(1) The distance between two nodes= $\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$

In equation 1, (x1, y1) is the geographical position of the node which sends rreq message, and (x2, y2) is the geographical position of the intermediate node toward source which receives that message in each hop. Besides the added fields to rreq message, another new field called path length is added to each node record in the node routing table, and its value is the path length for each path. This field is used to keep the length of each path stored in the routing table.

SIMULATION

The main purpose of simulation is to analyze the performance of AODV routing protocol with the proposed method. Simulation has been done be NS simulator [7]. This application allows the simulation of wireless networks and open source software. In simulation, we considered a network with variable number of nodes (50, 60, 70, 80) and the nodes were randomly located in a 1500*1500 m^2 area and operate longer than 2000 s. Several runs with different number of nodes are calculated and the average of collected data is computed. To calculate the performance of different routing protocols, we need both quantitative and qualitative measures. Some of the quantitative measures which are used for comparing the performance of different routing protocols are:

-packet delivery ratio: this is the total number of packets successfully delivered to the destination nodes to the total number of packets sent by the source nodes. It is practically the number of nodes received by destination.

-average end to end delivery: the whole time consumed in which all packets are received by destinations.

Table 1. Simulation parameters.

Name	Value
Simulation environment	1500*1500
Simulation duration	2000 s
Routing protocol	AODV
Queue type	DropTail
Mac standard	802.11
Number of nodes	50, 60, 70, 80
Node stop time	0 s
bandwidth	10 Mbps
Transfer range	255 m

Simulation Results

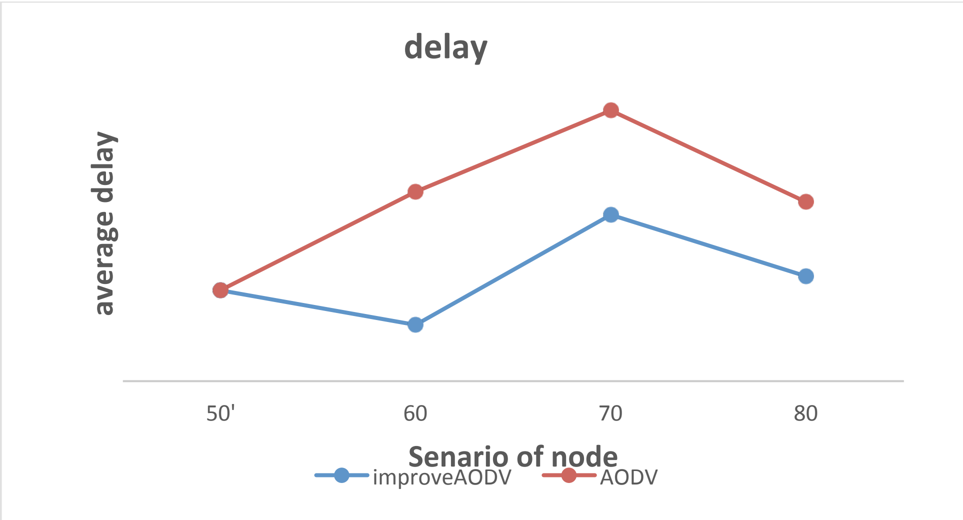

Figure 2. End to end delay.

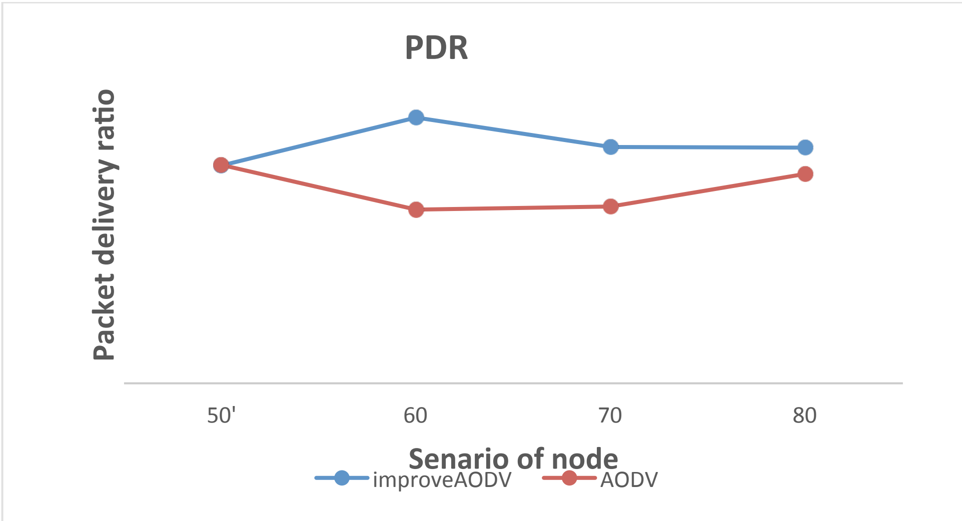

Figure 3. Average packet delivery ratio to number of nodes.

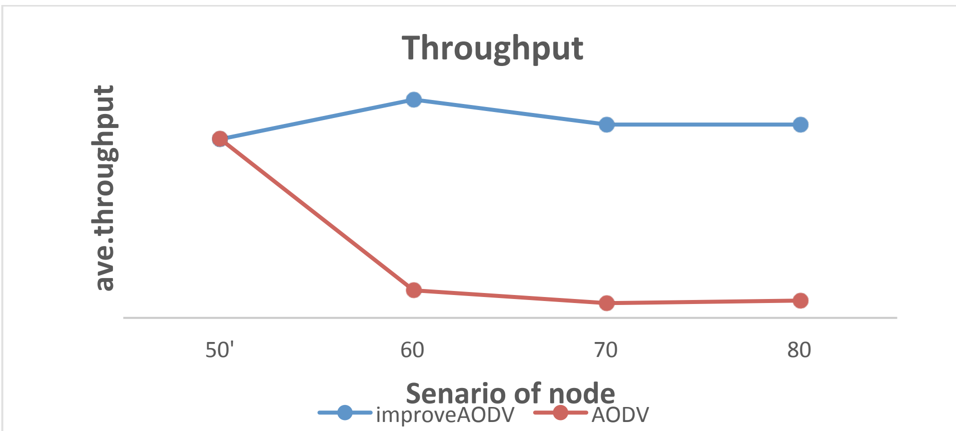

Figure 4. Operational power to number of nodes.

CONCLUSION

In the presented diagrams, operational power, average packet delivery ratio, and average end to end delay were shown in a mobile ad hoc network with variable number of nodes. As you can see, as the number of nodes increases, end to end delay decreases while operational power and packet delivery ratio increase. The results show that the proposed protocol has a better performance than AODV in all diagrams. Thus, it can be concluded that compared to AODV, the proposed method is superior since it chooses the better path for sending and receiving data.

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