AD-AODV:A Improved Routing Protocol Based on Network Mobility and Route Hops

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***Abstract*—In order to alleviate the node mobility problem which cause frequent link ruptures between source and destination nodes and data packets loss during transmission in Mobile Ad hoc Networks, we propose a new routing protocol called AD-AODV based on the famous AODV protocol. By introducing a novel metric M whose value depends on the hop number and average mobility of a given route, we improve the routing mechanism of AODV and enable AD-AODV to select the most stable route.A lot of simulations are operated based on the variation of node number and node speed to evaluate the performance of AD-AODV protocol. Simulation results compared with AODV protocol indicate our protocol's superiority in terms of packet delivery ratio therefore AD-AODV's enhancement of routing reliability is proved.**

I. Introduction

As technology advances, portable wireless communication devices spread around the world at a amazing speed. The density of wireless devices has reached a applicable level and there is need to unite them for information propagation. A Mobile Ad hoc Network(MANET) could provide a solution for this increasingly demand. MANET is a collection of communication devices that wish to communicate, but have no fixed infrastructure available, and have no pre-determined organization of available links. Individual nodes are responsible for dynamically discovering which other nodes they can directly communicate with [1]. MANET could be applied in wherever a temporary communication network is requested such as battlefields, search and rescue missions, forest industry and academic conferences.

Nodes in MANET serve as not only hosts but also routers. In most cases a source node exchanges packets with the intended destination node obliquely with the help of intermediate nodes. MANET's topology changes frequently in consequence of the unrestricted movement of the mobile nodes. Due to this feature, data transmission is often suspended because of the break of the route between the source node and the destination node. Therefore setting up a steady route for data transmission is such a important process especially for MANET with high speed nodes.

Node mobility is a significant factor that influences our AD-AODV protocol's route decision. We need to quantify mobile nodes' mobility to distinguish high speed nodes and low speed nodes. More nodes move in and out of a high speed node's radio range than those move in and out of a low speed node's range during a certain period of time. Based on this point AD-AODV protocol takes advantage of a mobile node's neighbor information to calculate its relative mobility. There could be several routes with different hops between source node and destination node. In some cases long routes with low speed nodes could provide better performance than short routes with high speed nodes. Our protocol takes both node mobility and route hops into account to select the most suitable path for data transmission.

The reminder of this paper is organized as follows: Section 2 overviews the related works which aim at alleviating node motion problems in MANET. Section 3 illustrates our routing protocol's mechanism. Simulation environment and the experiment results are demonstrated and analysed in section 4. In section 5 we conclude this paper and discuss our future work.

II. Related Works

More and more improved routing protocols focus on nodes' mobility as it is so crucial a characteristic in MANET. In [2], the author proposed a method to quantify the relative mobility of the mobile nodes in MANET. This method use the exchange of hello packets to find out how many nodes join and leave a given node's communication range during a period of time. In the route discovery part, the destination node collects RREQ packets and calculate two parameters: the average and variance mobility along this route. The combination of the two parameters is regarded as the threshold on selecting a route. Intermediate nodes between the source and destination node use the mobility metric to establish a new route in advance towards the destination if a intermediate node becomes dangerous(high mobility). In this way, there is less chance to re-initiate the route discovery process and it reduces the RRER packets. It is a efficient means to calculate a node's relative mobility while to assure the apt threshold for a particular MANET environment is difficult.

In [3], every node computes its own mobility periodically. Once the route discovery process is initiated, individual node decides whether to participate in the route by comparing its mobility with a given mobility criteria. A node becomes a intermediate node along the route through relaying the RREQ packet under such circumstance that its mobility is smaller

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than the criteria. When the RREQ reaches the destination node in the end, a route that conforms to the criteria emerges for the destination node to send RREP back. Another protocol in this paper is named Agg-AODV. During the dissemination of RREQ packets, a recipient adds its own mobility to the RREQ if it is not the intended node and then forward this RREQ towards the destination node. The destination node calculates the sum of each intermediate node's mobility in a route then compares different routes' aggregated mobility to select the one whose aggregated mobility is the least. This strategy makes comparison between routes with the same hop and excludes longer routes.

Mobility aware agents and modified hello packets are introduced to work out the mobility of the nodes in [8]. GPS coordinate information is embedded in modified hello packets so that a node could calculate the its neighbors' absolute mobility through the comparison of its two sequential hello packets. Once the RREQ reaches the destination node it sends a RREP packet to its best neighbor whose mobility is the lowest. Every intermediate node proceeds this best neighbor selection process until the RREP arrives at the source node at the same time a relative steady path is established.

III. Methodology

In this section,we will illustrate our protocol's routing mechanism.

A. Node Relative Mobility

Based on our protocol,each node's mobility is quantified periodically and represented by different numbers which indicate nodes' mobility degree. This process is accomplished while nodes exchange hello packets with their neighbors. Every node in a mobile Ad-hoc network counts the number of nodes that join and leave its range respectively in a certain period of time(hello interval). Taking advantage of these two numbers and the amount of this node's neighbors,we obtain every node's relative mobility:

$$Q = \frac{J+L}{N} \tag{1}$$

where:

Q is a certain node's relative mobility.

J is the number of nodes that join this node's coverage area during a hello interval.

L is the number of nodes that leave this node's coverage area during a hello interval.

N is the number of this node's neighbor calculated from its neighbor list.

Node's relative mobility is more crucial than node's absolute mobility as far as predicting route's breakage is concerned. There is a great possibility that a route consisting of high relative mobility nodes will rupture.

B. Route Average Mobility

Ad-Hoc On-demand Distance Vector(AODV) is a very important routing protocol in MANET. When nodes demand to communicate, the source node broadcasts a RREQ packet to its neighbors which duplicate RREQ and rebroadcast RREQ packets to their neighbors until it reach the destination node or a intermediate node which has a fresh enough route entry towards the destination node. The famous AODV routing protocol choose the shortest route as the transmission route via dropping all the RREQ packets that come from other routes [4]. This mechanism works well in MANET with static or low speed nodes but it seems unwise for those with high speed nodes. A route containing high speed nodes is not suitable to be the transmission route even if it has the least hops.

In the case of figure 1,route 1 and route 2 both have the shortest hop 3. The number on each node shows its relative mobility. According to the traditional AODV, The destination node will select route 2 or 1 as the transmission channel regardless of the 4 hops route 3 although there is a big probability that route 3 will perform better.

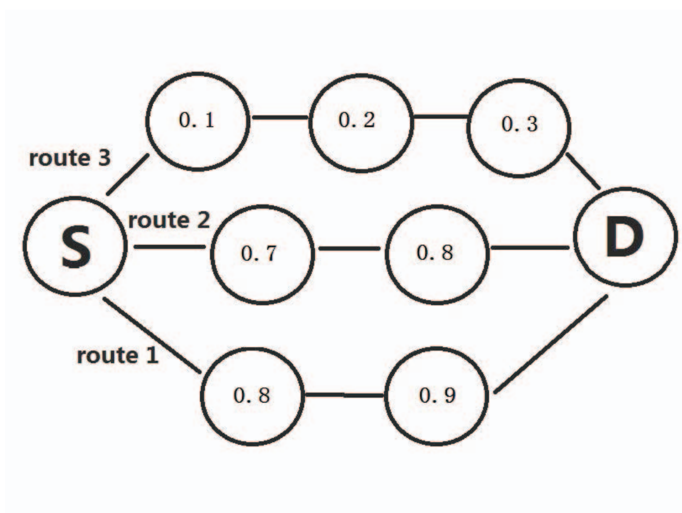

Fig. 1. route decision

Route average mobility is a important parameter that assists the destination node to make a rational decision. While a RREQ packet travels along a route,it records the information of this route including intermediate nodes' relative mobility and the number of hops it has traversed. Once a RREQ packets arrive at the destination finally, the destination node calculates the average mobility($avr_{(route)}$) of the route from which the RREQ comes.

$$avr_{(route)} = \frac{\sum_{i=1}^{D+1} Q_i}{D+1} \tag{2}$$

in which Q_i signifies the quantified relative mobility of a certain node. D is the number of hops between source node and the destination node.

C. Metric M

To take both route hop and route average mobility into consideration,we define a new parameter M by following formula:

$$M = avr_{(route)} + \lambda * hops \quad (3)$$

This formula means a comprehensive measurement for a specific route. In this formula, λ is an weighting factor which denotes to what degree a route could sacrifice its hops for better performance in route reliability respect. If the value of λ becomes larger, it becomes harder for a long route to replace a short one as the transmission path unless its $avr_{(route)}$ is small enough. By our strategy the destination node calculates each route's M and select the smallest one for data transmission so the destination node D in figure 1 will select route 3 through which it send RREP back. A destination node will refresh the routing table and note down the smallest value of M. We assign the weighting factor λ as 0.5 in our simulation experiments.

IV. Performance Evaluation

In order to evaluate our protocol's performance,we use Network Simulator(Version 2.34) [5] to simulate AD-AODV's operation in real network environment.We compare it with the famous AODV protocol and the method proposed in [2].

A. Experiment Setup

We set up a 1000m $\times$ 1000m network field in which mobile nodes could move freely towards any direction. We choose Random Way Point model as the mobility model and Two Ray Ground as radio propagation model. Nodes' transmission range is 250 m. CBR traffic generator is applied in the application layer to produce data packet at the rate of 1Mbps while the bandwidth between wireless nodes is set as 2Mbps. The time for each simulation is 100s. Every node could store as much as 50 packets in its queue buffer. In order to imitate the ruleless movement in the real world, the setdest implement embedded in Network Simulator is used to generate a random movement scenario for all the mobile nodes. Nodes' velocities range from 5m/s to 30m/s and are unified as a specific value for every time simulation.

B. Simulation Results and Discuss

Aiming at assessing protocols' reliability, packet delivery ratio which manifests the ratio between packets received by destination node and packets sent by source node is chosen as the performance indicator. Packet delivery ratio could reflect routing protocol's reliability precisely. For each movement scenario, we simulate for 30 times and the outcomes are averaged as the final result.

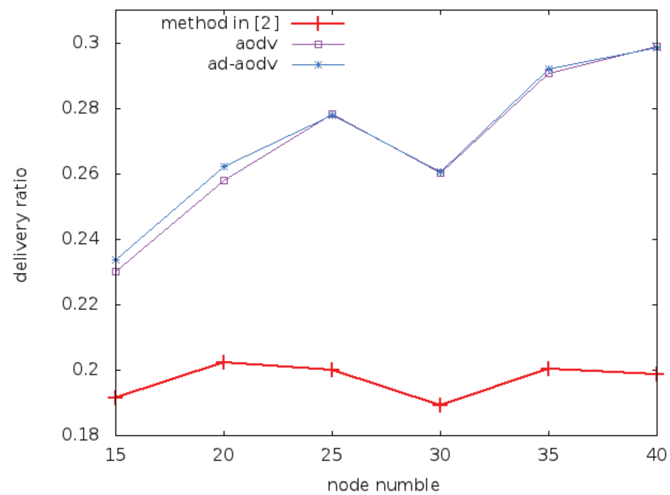

Fig. 2. delivery ratio vs node number

According to figure 2, AD-AODV protocol's performance excels the other two with node number varying from 15 to 40. When node number is relatively small, for instance, from 15 to 25, the superiority of ad-aodv protocol to aodv protocol is obvious. AD-AODV protocol's outperformance is still discernable although the two curves begin to approach as node number aggrandized so that our protocol's effectiveness is proved. The general trend of these two curves is that delivery ratio becomes higher with nodes increasing. This is reasonable because there is more probability for a source node to institute a path to the destination node on condition that node density is enhanced. Method in [2] didn't behave well and it was likely due to the inappropriate constraint assignment. The same constraint thresholds of the experiment in [2]($avr_{(route)} < 0.9, var_{(route)} < 0.45$) were used while the experiment environment changed.

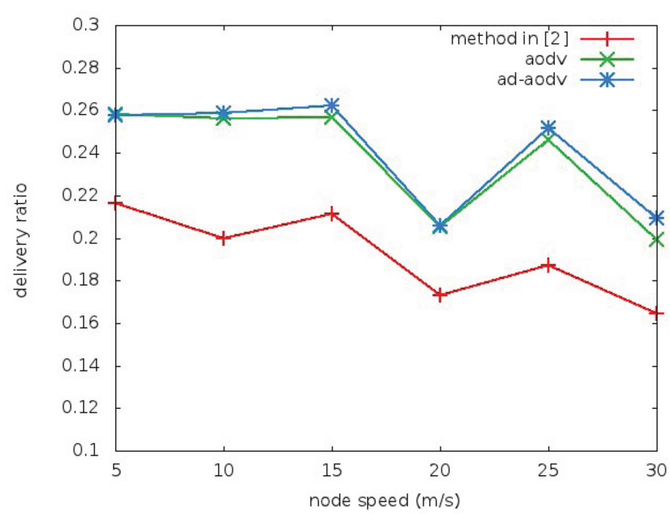

Fig. 3. delivery ratio vs node speed

Figure 3 shows that the relationship between node speed and delivery ratio. There is 10 nodes in this network scenario. Node speed ranges from 5m/s to 30m/s. At almost any speed, our ad-aodv protocol shows a advantage compared with the other two protocols. Our protocol's consideration about both the route hops and the mobilities of intermediate nodes along the route accounts for this transcendence. These three curves substantiates the effectiveness of our protocol's route selection mechanism and the assignment of λ. Delivery ratio generally becomes lower as the node speed increases in consequence of that drastic movement of the nodes leads to frequent link breaks which cause the loss of data packets.

V. Conclusion and Future Work

In this paper, we proposed a new routing selection mechanism based on the measurement of the important metric M which is used by destination node to select a stable route for communication. M is influenced by both the path hop and intermediate nodes' average mobility. The weighting factor λ in equation (3) is used to constrain the degree to which we could tolerant more hops for the smaller $avr_{(route)}$. AD-AODV protocol selects the route which has the smallest M. The experiment results compared with AODV and the routing method in [2] demonstrate that our protocol has achieved improvement in routing reliability respect.

There are still several research points within our AD-AODV protocol. We could extend out method to the route maintenance process. That is, before an active route ruptures, besides informing the related nodes, the intermediate node upstream the risky node(high relative speed) should choose an alternative downstream route based on the M metric.

Acknowledgment

This research was supported in part by the Natural Science Foundation of Jiangsu Province Grant(BK2010391) and Industry Supporting Plan of Jiangsu Province Fund(BE2011169).

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