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Increasing Durability Path in Mobile Ad hoc Networks using Fuzzy-Based Routing Algorithm

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Abstract: A mobile ad hoc network (MANET) consists of a set of mobile hosts that can communicate with each other without the assistance of base stations. In MANETs, the dynamic nature of the network topology is a major reason for link failures. In this paper, we proposed the Ad hoc on-demand distance vector (AODV) routing (FLAODV) protocol for routing in mobile ad hoc networks to increase durability path. The performance of this routing protocol is studied using opnet10.5. The simulation results of the FLAODV show that the protocol is quite efficient and superior to AODV with the respects to the average Route Discovery Time, the average Packets overhead, average throughput and average end-to-end delay.

Keywords: Mobile ad hoc Networks (MANET), Fuzzy logic, Fuzzy- based Routing Algorithm and Routing rotocol.

Introduction

MANET consists of mobile nodes that autonomously establish connectivity via multi hop wireless communications. There is no use of a static network infrastructure such as base station or any centralized administration in MANET.

In ad hoc network, if two nodes are not within radio range, all message communication between them must pass through one or more intermediate nodes. All the nodes are free to move around randomly, thus changing the network topology dynamically (Sun et al., 2009). In MANET, The routing paths that consist of a number of wireless links are frequently blocked and then reestablished during the time period of packet transmission. Hence the quality of wireless links often fluctuates due to the channel fading and the interference from other communications. Owing to the unexpected congestion or block of routes and the limited of multicast A feasible method to overcome these defects is to establish multiple paths between a sender and receivers. AODV is an on-demand distance vector routing protocol. The protocol is well known for the use in ad hoc mobile networks.

In this paper, we present a new MANET protocol, the FLAODV protocol to enhance the stability of a network. The proposed scheme uses the fuzzy logic-based route strategy to select a stable route in order to enhance system performance.

FLAODV is On Demand protocol. It dynamically to adjust the routing traffic based on the network configuration and status (afandi, 2006). Like AODV, the FLAODV protocol includes of two stages: routing discovery and routing maintenance. When a source node has packets to deliver, it initiates the routing discovery stage to find routes to the select destination. In this stage the protocol FLAODV periodically monitors certain parameters and collects data reflect the network status. These promising factor values are used in making routing decisions that balance the network load. During the maintenance stage, the FLAODV algorithm adjusts its routing decision based on current and predicted network load and link stability. The paper is organized as follows: In section I, we review the AODV Routing Protocol, FUZZY SYSTEM discussed in section II. Section III describes the newly introduced protocol, fuzzy logic AODV routing protocol (FLAODV). Section IV presents the simulation results based on a mobile network example. In section V, we present our conclusion.

Ad-hoc on-demand distance vector (AODV) routing protocol OVERIEW

The AODV protocol is an on-demand routing protocol, which initiates a route discovery process only when desired by an originating node. When an originating node wants to send data packets to a destination node but cannot find a route in its routing table, it broadcasts a Route Request (RREQ) message to its neighbors. Its neighbors then rebroadcast the RREQ message to their neighbors if they do not have a fresh enough route1 to the destination node. This process continues until the RREQ message reaches the destination node or an intermediate node that has a fresh enough route. Every node has its own sequence number and RREQ ID.2 AODV uses sequence numbers to guarantee that all routes are loop-free and contain the most recent routing information. The RREQ ID in conjunction with the originator IP addresses uniquely identi.es a particular RREQ message. The destination node or an intermediate node only accepts the first copy of a RREQ message, and drops the duplicated copies of the same RREQ message. After accepting a RREQ message, the destination or an intermediate node updates its reverse route to the originating node using the neighbor from which it receives the RREQ message. The reverse route will be used to send the corresponding Route Reply (RREP) message to the originating node. Meanwhile, it updates the sequence number of the originating node in its routing table to the maximum of the one in its routing table and the one in the RREQ message. When the originator or an intermediate node receives a RREP message, it updates its forward route to the destination node using the neighbor from which it receives the RREP message. It also updates the sequence number of the destination node in its routing table to the maximum of the one in its routing table and the one in the RREP message. A Route Reply Acknowledgment (RREP-ACK) message is used to acknowledge receipt of a RREP message. Though not required, AODV may utilize the HELLO message to maintain the local connectivity of a node. Route maintenance is done with Route Error (RERR) messages. If a node detects a link break in an active route, it sends out a RERR message to its upstream neighbors that use it as the next hop in the broken route. When a node receives a RERR message from its neighbor, it further forwards the RERR message to its upstream neighbors. AODV is a stateless protocol; the originating node or an intermediate node updates its routing table if it receives a RREP message, regardless of whether it has sent or forwarded a corresponding RREQ message before. If it cannot find the next hop in the reverse routing table, it simply drops the RREP message. Otherwise, it unicast the RREP message to the next hop in the reverse route .In general, a node may update the route entries in its routing table whenever it receives RREQ, RREP, or RERR messages from its neighbors (Ning & Sun, 2004).

Fuzzy system

In MANETs, the high mobility of mobile nodes is a major reason for link failures. In this paper, the strategy used to overcome this problem was the fuzzy logic, proposed by Zadeh because it has the advantage that the solution can be cast in terms of human perception. Therefore, such perception can be used in the design of the routing solution. The idea of fuzzy sets is an extension of the traditional concept of sets (crisp) where one element belongs or not to a certain set. The fuzzy sets, in contrast, are defined from membership functions that are limited to an interval between 0 and 1, i.e., any value between 0 and 1 can express the membership degree of a certain element of the fuzzy set based on the inference functions used. Usually, the relevance degree of a value “x” regarding a function is represented by μ(x) (Gomes et al., 2011).

A fuzzy engine, as per figure 1, is typified by the following steps:

- Fuzzification: in this step is a procedure where crisp input values are represented in terms of the membership function, of the fuzzy sets. The fuzzy logic controller triangular membership functions are defined over the range of the fuzzy input values and linguistically describe the variable’s universe of discourse as shown in figure 2.
- Inference engine: In this step, inference engine determines the fuzzy output using fuzzy rules that are in the form of if then rules.
- Defuzzification: used to translate the fuzzy output to a crisp value.

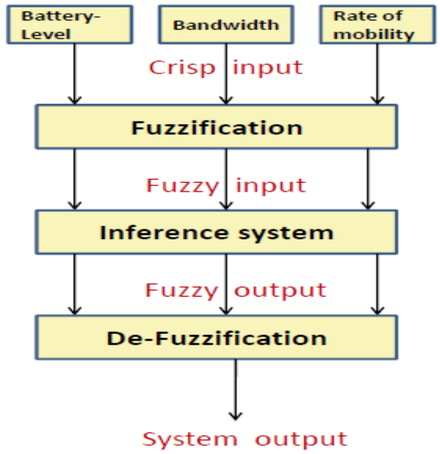

Figure 1. Fuzzy Logic System.

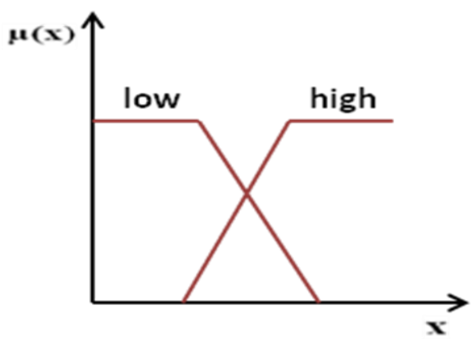

Figure 2. Fuzzy Input membership Function.

FLAODV

It is proposed here that nodes that appear in this table route should determine whether or not to update. Route metrics that are used to make this decision are Bandwidth, Power of battery and rate of mobility of nodes. Current routing protocols are typically optimized with regard to one of these metrics, for example AODV selects paths that consist of the shortest number of hops.

It is proposed here that the metrics Bandwidth, Power of battery and rate of mobility of nodes will be combined into a single decision thereby optimizing a routing protocol over a number of metrics and making it more robust. The decision to continue with a network broadcast will be determined via a fuzzy logic system with get the data of RREQ Packet being applied to a fuzzifier that translates them into fuzzy sets. The fuzzy sets are used to appraise each constraint as being Low, or High, assigning each a value between [0,1]. These evaluations are passed to a fuzzy inference engine that applies a set of fuzzy rules that determines if a link is suitable for updates neighbor connections table or not. If a link is deemed suitable hen the neighbor connections update. Fuzzy rules for both to update neighbor connections table and not To update neighbor connections table conclusions are presented in Table1. These rules are selected bases on a thorough understanding of the system. The inputs are combining using the and operator, by example:

If BL is high and BW is high and RM is low, then Update neighbor connections table.

If BL is low and BW is low and RM is high, then No Update neighbor connections table 1. Where BL is Battery-Level, BW is Bandwidth, RM is Rate of mobility.

Table 1. Fuzzy logic system rules.

TABLE 1
FUZZY LOGIC SYSTEM RULES

NO.	Input			Output
i	BL	BW	RM	Neighbor connections table
1	*low*	*low*	*low*	*No Update*
2	*low*	*low*	*high*	*No Update*
3	*low*	*high*	*low*	*No Update*
4	*low*	*high*	*high*	*No Update*
5	*high*	*low*	*low*	*No Update*
6	*high*	*low*	*high*	*No Update*
7	*high*	*high*	*low*	*Update*
8	*high*	*high*	*high*	*No Update*

Due to the broadcast nature of route discovery techniques network resources can be unnecessarily used in this network wide propagation that often leads to the selection of unstable paths. Unstable path are classified as paths that have a large associated signal loss, consists of low-energy nodes, high number of hops or paths spread over a large distance between source and destination [4]. So as to eliminate unsuitable paths from the route discovery/reply process and to optimize Update decisions broadcast floods are only continued if a node's fuzzy system indicates that it is valid to do so, path finding table structure FLAODV is like the AODV protocol. It is the working of this protocol that when a source node wants to send a data to an away node these steps must followed:

1. The source node considers its path finding table for finding a route to destination. If the route has considerable or have the minimum energy that needed for sending data or file then on that route send the data Packets
2. If there is not any route, the source node start a finding route procedure and create a RREQ Packet with the destination node address and parameters then broadcast the RREQ Packet on the network globally.
3. At the long side of the route each node that receives the RREQ Packet, first get the data of RREQ Packet and with using the fuzzy logic system and formula (1), specify the link that the Packet has received through this route is suitable or not ? It means that formula (1) be satisfied. At the end, if the link considered suitable (means that the formula (1) be satisfied) then the table of neighbor connections in middle node is update.
4. Also middle node determine that is there any route to the destination in the it's path finding table? If exist a route then create a route answering Packet and put its parameters and self-parameters in the Packet and send to the backward, else if there is not any route, broadcast generally the RREQ Packet again with putting parameters .
5. When the RREQ Packet reach to the destination, get the its parameters from RREQ Packet like the middle nodes and with using the fuzzy logic system and formula (1), determine the suitability of link and if the link is suitable save that.
6. Destination node create a route answering Packet and get the address fields of source and destination directly from RREQ Packet and copy it in the route answering Packet. Also add its parameters to the route answering Packet and send this to the source.
7. Each node at the long side of reversed route do the getting and putting its parameters on the route answering Packet for determining the suitability of link.
8. Source node with using the detected route, send the data to the destination.

Experimental Results

In this section, we show the network model that we use and compare our algorithm with the AODV protocol.

A. Simulation Model

To simulate our algorithm, we use the OPNET modeler 10.5. The initial positions of the nodes were uniformly distributed throughout the network. Node mobility was simulated according to the random waypoint mobility model, in which each node travels to a randomly selected location at a configured speed and then pauses for a configured pause time, before choosing another random location and repeating the same steps. Node transmission range was 250m. We ran simulations for constant node speeds from 0 to 10 m/s, with pause time fixed at 200 seconds. We simulated 20 CBR sessions in each run, with random source and destination pairs. Each CBR session generates 10 packets per second with data packets of 512 bytes. In the simulation, the network coverage area is a 2117m x 2117m square with 27 mobile nodes. We will use a simple topology, and node model, as shown in figure 3 and figure 4. Simulation time is 800 seconds.

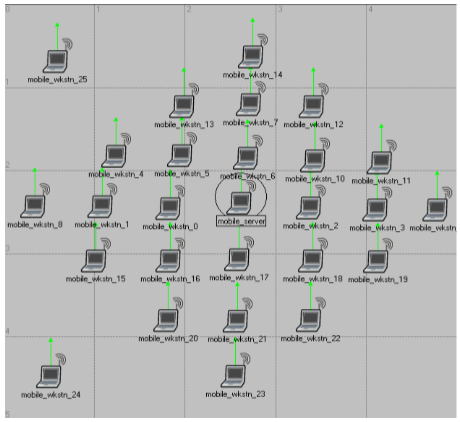

Figure 3. A sample topology for mobile ad hoc network (MANET).

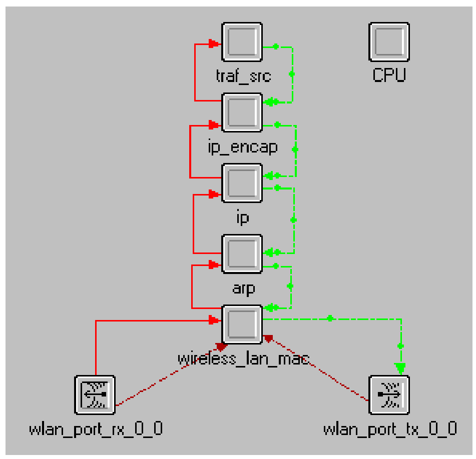

Figure 4. Node model for sample topology.

For the experimental evaluation, we have assumed the performance metrics in order to analyze the performance of the proposed FLAODV protocol for ad hoc routing:

Throughput*:* Also called packet delivery ratio in (Broch et al., 1998) and throughput in (Michiardi & Molva, 2002), this is the ratio of the number of packets received by the CBR sink to the number of packets sent by the CBR source, both at the application layer. Packets that are sent but not received are lost in the network due to malicious drops, route failures, congestion, and wireless channel losses.

Average delay: This is the average delay of all the packets that are correctly received. Lost packets are obviously not included in this measurement since their packet delay is infinity.

Route discovery time: a necessary time for route discovery

Results

In figure 5 we show the average performance in terms of throughput, according to the Simulation Time in a network of 27 nodes. X-axis represents the Simulation time and Y-axis represents the Throughput. The simulations of figure 3 show that FLAODV performs better from the AODV. Most of the ad hoc routing protocols presuppose the presence of bidirectional links between the nodes in the network. In reality, the ad hoc network may consist of heterogeneous nodes with different power capabilities and different transmission ranges. When this is the case, a given node might be able to receive the transmission of another given node but might not be able to successfully transmit data to the latter (Chung Wang et al., 2007). In FLAODV protocol with using the fuzzy logic system and formula (1) determine the suitability of link and if the link is suitable, a given node is able to successfully transmit data to the latter. Thus, throughput of our algorithm is higher than the AODV algorithm.

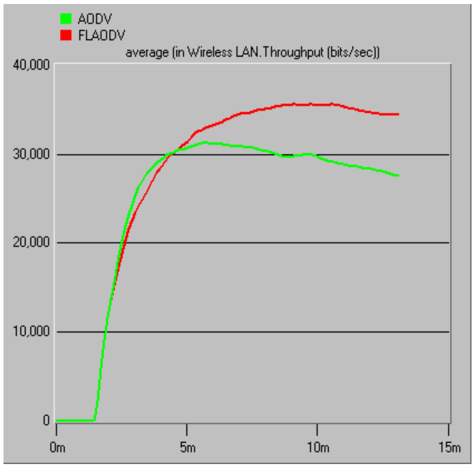

Figure 5. Throughput vs. Simulation time for 27 mobile nodes.

Figure 6 shows the average delay of FLAODV and AODV for different simulation Time. X-axis represents the Simulation time and Y-axis represents the Delay. By AODV in figure 6 can be explained by the fact that in AODV the number of dropped packets is larger than in the FLAODV protocols, and that such dropped packets are not taken into account in the average delay calculation. Then, when a packet is not dropped and is delivered with a large delay, the total average delay is increased. However, by the same fact, FLAODV increases the network reliability and average delay is reduced.

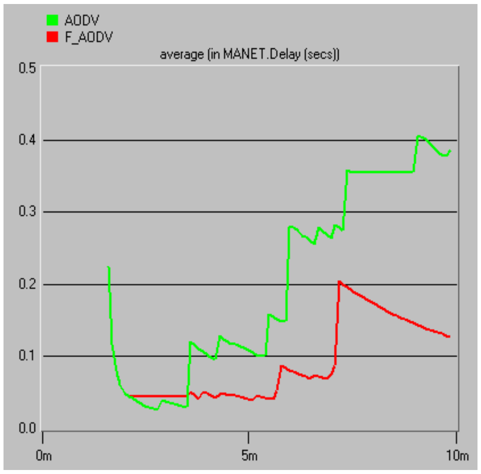

Figure 6. Delay vs. Simulation Time for 27 mobile nodes.

Figure 7 shows the number of RREQ (route requests sent) by both algorithms. X-axis represents the Simulation time and Y-axis number of RREQ. Our algorithm for Simulation Time 800, generates more requests because when a node receives a request and the sequence number is lower than the sequence number the reverse route entry table, it forwards the request up to date. Also the simulations of figure 7 show that finally, RREQ of FLAODV less than AODV.

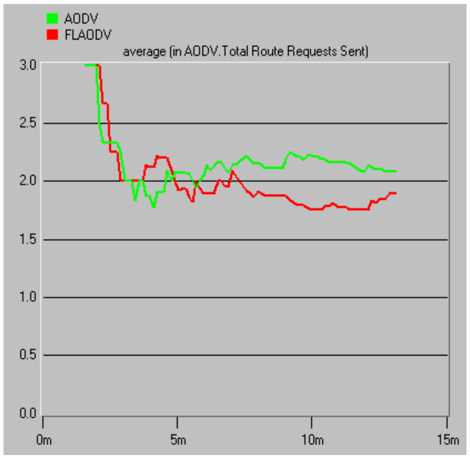

Figure 7. Packets control overhead.

Figure 8 shows the route discovery time by both algorithms. X-axis represents the Simulation time and Y-axis route discovery time. From figure 8, we can conclude that FLAODV algorithm can greatly decrease the route discovery time. It shows that the improvements become more significant with the increase of Simulation time.
with the increase of Simulation time.

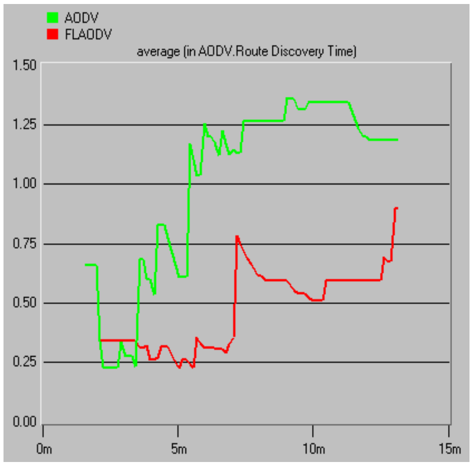

Figure 8. Route discovery time vs. Simulation Time for 25 mobile nodes.

Discussion and Conclusion

In this paper, we provided a centralized algorithm for routing in Ad hoc networks. Simulation results show that the FLAODV algorithm improves the throughput and delay significantly, and Packets control overhead and route discovery time and also improves the network performance. We show simulation results of our algorithm under random variation of the network. From a performance point of view, our heuristic gives a path with a higher throughput than the original AODV protocol. Moreover, it decreases the average delay and the route discovery time and overhead of Packets.

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