FUZZY LOGIC BASED ROUTING SCHEME FOR WIRELESS ADHOC NETWORKS

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ABSTRACT

Mobile ad hoc networks consist of mobile nodes that communicate without an infrastructure. It is a self configuring network connected by wireless links. All the nodes move around randomly, thus changing the network topology dynamically. The primary challenge in building a MANET is equipping each device to continuously maintain the information required to properly route the traffic. In this paper a routing algorithm based on Fuzzy Logic is proposed which is having low communication overhead and storage requirements. The proposed algorithm takes three input variables: signal power, mobility and delay. The absolute value of each parameter can take a large range at different points on the network.

Keywords

Mobile ad hoc Networks, Fuzzy Logic, Fuzzification, Defuzzification, wireless routing.

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1. INTRODUCTION

A mobile ad hoc network (MANET) also called a mesh network, is a self configuring network of mobile devices connected by wireless links [1]. It consists of mobile nodes that autonomously establish connectivity via multi-hop wireless communications. There is no use of static network infrastructure such as base station or any centralized administration in MANET. They can set up anywhere. These types of networks have many advantages, such as self configuring and adaptability to highly variable mobile characteristics like transmission, conditions, propagation channel, distribution characteristics and power level. They are useful in many situations such as military applications, conferences, emergency search, and rescue operations. However, such benefits come with new challenges which mainly reside in the unpredictability of the network topology due to mobility of nodes and the limited available bandwidth due to the wireless channel. These characteristics demand a new way of designing and operating these types of networks. For such networks, an effective routing protocol is critical for adapting node mobility as well as a feasible path for data transmission. [2, 3, 4].

2. RELATED WORK

There are two classes of protocols: one is based on the preparation of information tables i.e. Pro-active or Table Driven routing protocols and the other is without them called Reactive or On Demand routing protocols.

2.1 Proactive or Table Driven routing Protocol:

These protocols attempt to maintain consistent, up-to- date routing information from each node to every other node in the network. Each node maintains one or more table to store routing information and respond to changes in the network topology. Routing is continuously updated regardless of the network traffic.

2.1.1 Destination Sequenced Distance Vector Routing Protocol (DSDV)

DSDV protocol [5, 6] has been specifically targeted for mobile networks. Every mobile station needs to maintain a routing table, the no. of hops to reach the destination and the sequence no. assigned to the destination node. The main drawback of DSDV is that it requires a regular update of its routing tables, thus reducing the bandwidth efficiency. It is not suitable for very large network i.e. less scalability and it is not also suitable for highly dynamic network.

2.1.2 Wireless Routing Protocol (WRP)

WRP [7] belongs to the class of path finding algorithms. It avoids count to infinity problem. Each node in the network maintains four tables: distance table, routing table, link cost table and message retransmission list.

2.1.3 Clusterhead Gateway Switch Routing Protocol (CGSR)

CGSR elects a node as a cluster head using a distributed algorithm within the cluster.

2.2 Reactive or On Demand Routing Protocol:

This type of protocol creates rote only when desired by the source node. When a node requires a route to a destination, it initiates a route discovery process within the network

2.2.1 Dynamic Source Routing Protocol

In DSR [8] the packet contains the full route to destination and the intermediate nodes do not have to make any routing decisions. It is not scalable to large networks and even requires significantly more processing resources than other protocols. Basically, In order to obtain the routing information, each node must spend lot of time to process any control data it receives, even if it is not the intended recipient.

2.2.2 Ad hoc On Demand Vector Routing Protocol (AODV)

AODV [9] is based on DSDV but it minimizes the no of required broadcasts by creating routes on the demand basis. It broadcasts a route request packet to its neighbors, and so on, until the destination is located. In AODV as the network size increases the performance metrics begin to decrease. It is vulnerable to various kinds of attacks as it requires the cooperation of other nodes.

2.2.3 Temporarily Ordered Routing Algorithm (TORA)

TORA is highly adaptive loop-free distributed routing algorithm based on the concept of link reversal [10]. It is designed to minimize reaction to topological changes. It guarantees that all routes are loop free and typically provides multiple routes for any source/destination pair. It depends on synchronized clocks among nodes in the ad hoc network.

2.2.4 Associativity Based Routing Protocol (ABR)

ABR [11] is totally different routing protocol for ad hoc wireless network which is free from loops, deadlocks and packet duplication and defines a new routing metric for the same.

3. PROPOSED SCHEME

3.1 The proposed fuzzy logic based routing scheme

The proposed routing algorithm takes three input variables – signal power, mobility and delay. We take normalized values of each parameter. Crisp normalized values are converted into fuzzy values. For this, three fuzzy sets are defined for each variable:

Signal power:

(1) low (from 0 to 0.4)

(2) medium (from0.2 to 0.8)

(3) high (from 0.6 to 1.0)

Delay:

(1) Poor (from 0 to 0.4)

(2) Average (from0.2 to 0.8)

(3) Excellent (from 0.6 to 1.0)

Mobility:

(1) low (from 0 to 0.4)

(2) medium (from0.2 to 0.8)

(3) high (from 0.6 to 1.0)

The normalized value of each parameter is mapped into fine sets. Each value will have some grade of membership function for each set. The memberships that have been defined for each of the fuzzy set for any particular input variable are triangular in shape. Next the inference rules are written. The crisp value of input variable is given and a defuzzified crisp value for selected variable is calculated from the derived algorithm. An output linguistic variable is used to represent the route.

Proposed optimal routes are based upon the fuzzy rules for different ranges of the metric availability. The routes are defined as

- below optimal (from 0 to 0.4)
- suboptimal (from 0.2 to 0.8) and
- optimal (from 0.6 to 1.0)

between two mobile hosts.

The below optimal indicates not optimal path, the sub optimal indicates good path and the optimal path indicates the best path. The proposed routing algorithm can apply to different routing metrics. These routes have to satisfy the mobility, signal power and delay requirements of the network. The grade of membership function can be any where between 0 and 1 for each fuzzy set. The defuzzified crisp value for selected variable is calculated from the derived algorithm.

3.2 Fuzzy Inference Rules

1. If (signal power is low) and (mobility is low) and (delay is poor) then the route will be below optimal.

2. If (signal power is low) and (mobility is low) and (delay is average) then the route will be below optimal.

3. If (signal power is low) and (mobility is low) and (delay is excellent) then the route will be sub optimal.

4. If (signal power is low) and (mobility is medium) and (delay is poor) then the route will be below optimal.

5. If (signal power is low) and (mobility is medium) and (delay is average) then the route will be sub-optimal.

6. If (signal power is low) and (mobility is medium) and (delay is excellent) then the route will be sub optimal.

7. If (signal power is low) and (mobility is high) and (delay is poor) then the route will be below optimal.

8. If (signal power is low) and (mobility is high) and (delay is average) then the route will be below optimal.

9. If (signal power is low) and (mobility is high) and (delay is excellent) then the route will be sub-optimal.

10. If (signal power is medium) and (mobility is low) and (delay is poor) then the route will be sub- optimal.

11. If (signal power is medium) and (mobility is low) and (delay is average) then the route will be optimal.

12. If (signal power is medium) and (mobility is low) and (delay is excellent) then the route will be optimal.

13. If (signal power is medium) and (mobility is medium) and (delay is poor) then the route will be below optimal.

14. If (signal power is medium) and (mobility is medium) and (delay is average) then the route will be sub optimal.

15. If (signal power is medium) and (mobility is medium) and (delay is excellent) then the route will be optimal.

16. If (signal power is medium) and (mobility is high) and (delay is poor) then the route will be below optimal.

17. If (signal power is medium) and (mobility is high) and (delay is average) then the route will be sub optimal.

18. If (signal power is medium) and (mobility is high) and (delay is excellent) then the route will be optimal.

19. If (signal power is high) and (mobility is low) and (delay is poor) then the route will be sub-optimal.

20. If (signal power is high) and (mobility is low) and (delay is average) then the route will be optimal.

21. If (signal power is high) and (mobility is low) and (delay is excellent) then the route will be optimal.

22. If (signal power is high) and (mobility is medium) and (delay is poor) then the route will be sub-optimal.

23. If (signal power is high) and (mobility is medium) and (delay is average) then the route will be sub-optimal.

24. If (signal power is high) and (mobility is medium) and (delay is excellent) then the route will be optimal.

25. If (signal power is high) and (mobility is high) and (delay is poor) then the route will be below - optimal.

26. If (signal power is high) and (mobility is high) and (delay is average) then the route will be sub-optimal.

27. If (signal power is high) and (mobility is high) and (delay is excellent) then the route will be optimal.

4. CONCLUSION

There are number of qualitative and quantitative metrics that can be used to compare reactive routing protocols. Most of the existing routing protocols ensure the qualitative metrics. Therefore, the following different quantitative metrics have been considered to make the comparative study of these routing protocols through simulation.

1. **Routing Overhead**: This metric describes how many routing packets for route discovery and route maintenance need to be sent so as to propagate the data packets.
2. **Average Delay:** This metric represents average end-to-end delay and indicates how long it took for a packet to travel from source to the application layer of the destination. It is measured in seconds.
3. **Throughput**: This metric represents the total number of bits forwarded to higher layers per second. It is measured in bps. It can also be defined as the total amount of data a receiver actually receives from sender divided by the time taken by the receiver to obtain the last packet.
4. **Media Access Delay:** The time a node takes to access media for starting the packet transmission is called as media access delay. The delay is recorded for each packet when it is sent to the physical layer for the first time.
5. **Packet Delivery Ratio:** The ratio between the amount of incoming data packets and actually received data packets.
6. **Path Optimality:** this metric can be defined as the difference between the path actually taken and the best possible path for a packet to reach its destination.

5. FUTURE WORK

In this paper, an effort has been made to concentrate on the comparative study and performance analysis of various reactive/proactive routing protocols on the basis of the performance metrics. AODV is still better in Route updating and maintenance process. It has been further concluded that due to the dynamically changing topology and infrastructure less, decentralized characteristics, security and power awareness is hard to achieve in mobile ad hoc networks. Hence, security and power awareness mechanisms should be built-in features for all sorts of applications based on ad hoc network. The focus of the study is on these issues in our future research work and effort will be made to propose a solution for routing in Ad Hoc networks by tackling these core issues of secure and power aware/energy efficient routing.

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