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A Survey on Fuzzy-Based Routing protocols in MANETs

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Abstract--- MANET is defined as a self configuring network which consists of wireless nodes that are interconnected. MANETs use wireless connections to connect various networks. There are numeral of issues and challenges in a mobile adhoc network. Routing is one of challenging issue in MANETs. The execution of mobile AdHoc network can be profoundly enhanced if the directing convention can be made versatile to the present system conditions. Thinks about demonstrate that the restriction of conventional routing protocols is the absence of capacity to react instantly to the adjustments in movement and portability conditions. Mobile nodes capable of switching immediately between proactive routing mode and reactive routing mode based on current status of the node can overcome the above constraint. A fuzzy based route mode selection come close to with information from multiple layers can inform direct switching capability to the mobile nodes. This choice system uses the data with respect to the quantity of connection breaks, the interface line length and the application sort (Delay tolerant or Delay touchy) of every hub. Hence a fuzzy based protocol could improve the performance of MANETs. This paper places of interest a relative study of conventional, modified and fuzzy based routing protocol and proposes the profit of using fuzzy logic in routing protocol.

Keywords: Mobile AdHoc Network (MANET), Routing in MANET, Fuzzy Logic.

I. INTRODUCTION

Mobile Adhoc Networks(MANET)

A MANET is a type of Adhoc network. MANETs are infra structure less networks that are self created and self controlled by a collection of mobile nodes that are interconnected and are able to dynamically form an autonomous multi-hop network. Because of self-forming environment and the ability to handle with quick topology changes MANETs are having a variety of applications.

Figure 1: Mobile Adhoc Network

In MANET every node acts as a router, which helps in forwarding packets from source to destination. MANET nodes can be personal devices such as laptop, mobile phones and PDA. MANET can alter locations and organize itself on the wing. Its application area includes military applications, local level(conference), emergency operations, business applications, personal area network, blue tooth and used in VANET (Vehicular Adhoc Network).

II. ROUTING PROTOCOLS IN MANETS

Routing is process of finding an optimum route among available, in order to transfer packets from source to destination. Routing is considered as a two distinct process. Route discovery and Packet forwarding. Routing protocols are of two types, namely, Static routing and Dynamic Routing. In Static Routing, to transfer packets in the network, the administrators manually allot routes between source and destination. These routes are fixed over whole session. In Dynamic Routing, the router takes the responsibility of building and exchanging information regarding routing table according to changes in network topology. Dynamic Routing Protocols are further classified into three types. They are Reactive, Proactive, and Hybrid protocols.

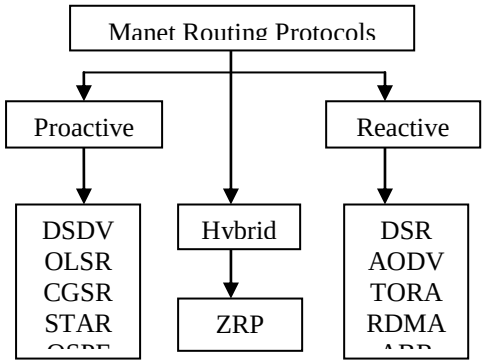

Figure 2: MANET routing protocols

DSDV [1] (Destination Sequenced Distance Vector Routing) is a routing table-driven protocol for adhoc network, the nodes keep up routing information all over the network, and it can be transmitted without delay when data packets are essential to sent, which makes it proper for high real-time necessities in the networking environment. However, there are various troubles of DSDV such as this protocol is mainly used for network that the size is not large, as well as the changes in the network topology is not very frequent. DSR [2] (Dynamic Source Routing) routing protocol is source-based routing and on-demand routing, the route will store records when it communicates with two nodes. Therefore, it reduces the cost of routing maintenance. In addition, it reduces the routing requesting information on channel possession by using the routing cache technology. on the other hand, the packet header length increases linearly and it adds overhead with the increase of hops path, additionally, RREQ (routing request) packet uses the flooding to extend to the whole network, which will fallout in a bulky network load. AODV [3] (Adhoc On-demand Distance Vector) routing protocol is on-demand routing protocol based on DSDV and DSR routing protocols. On the other hand, AODV can keep away from routing loops by engrossing hop counting and destination serial number mechanism in DSDV routing protocol, on the other hand, AODV absorbs routing detection and route preservation mechanism in DSR routing protocol. Although AODV routing protocol is relatively grown-up, it still flaws such as large routing overhead and network latency.

III. FUZZY LOGICS IN MANETs

Fuzzy logic is applied in various areas such as quality of service-based routing, energy-aware routing, security, and Medium Access Control(MAC) protocols. Because of the basic features of ad hoc networks like uncertainty due to dynamic topology and mobility of nodes, limited resources and unstable links; a precise and accurate model is not possible to implement. In MANETs, fuzzy logic has been used to get better decision-making, condense resource consumption and increase performance. Fuzzy logic is also used to adaptively optimize protocol parameters more accurately and dynamically. The fuzzy routing protocols discover a maximal set of disjoint paths from source to destination, and then use a Fuzzy Logic Controller(FLC) to find out how to use those paths to hold the traffic. By implementing fuzzy logic techniques in MANET routing protocols then the network performance metrics such as network throughput increases, packet delivery ratio increases, routing overhead load decreases, and end-to-end delay decreases. Examples of fuzzy routing approaches are FLWMR[1] [4], which uses the number of hops in a path as its metric, and FLWLAMR[2] [5], which uses aggregate packet backlog along the path as its metric.

IV. QUALITY OF SERVICE

During transmission of packets from source to destination, the set of necessities that needs to be met by the network which is referred as a Quality of Service(QOS). QOS is considered as an important feature to make use of the network resources such as bandwidth, jitter, node energy level, queue length, delay, cost and reliability in an enhanced and well-organized manner. These QOS parameters can be given as inputs to fuzzy controller for determining the most preferred path.

V. FUZZY BASED ROUTING PROTOCOLS IN MANETS

Many algorithms have been proposed for routing in MANETs. Among them some are either reactive or proactive. The most vital issue of all the current calculations is that they don't fulfill all Quality of Service(QOS) parameters while finding the "best" way. It is critical to concentrate on all or most extreme QOS parameters at time of discovering "best" way in MANETs. Therefore, this section provides the outline of the existing Fuzzy Logic Based routing algorithms of MANETs.
Starting with the case study survey of different published algorithms like

[A] FBEEMR[3] technique [6],
[B] EERP[4] for MANET using VSMT[5][7],
[C] FA[6] to enhance route stability of AODV routing protocol [8],
[D] HS-AODV routing protocol based on FCT[7][9],
[E] EESR[8] using QOSMA[9] in MANET [10],
[F] FLDB[10] for GPSR[11] mobile PB[12] routing protocol[11].

Using [A], with parameters as Hop Count(HC), Packet(P) and Energy(E), it concludes that Energy is inversely proportional to HC and P will be the best probability for optimal route. That means, in this protocol the FLC[11] takes HC, P, E as input parameters and Route Lifetime(RL) as output parameter. Each input and output variable are divided into seven linguistic values such as very low, low, less low, medium, less high, high and very high. Multiple fuzzy rules are inferred on these input parameters and for each and every route RL is calculated. Optimal path is selected whenever RL is very high. If HC is very low, P is very low and E is very high then RL is very high.
Therefore, the relation between input and output parameter are as in eq (1), eq (2) and eq (3)

$RL \propto 1/HC$ eq (1)

RL ∝ 1/P eq (2)
RL ∝ E eq (3)
so the final relation is as
RL ∝ E ∝ 1/P & 1/HC eq (4)

Using [B], with parameters as Energy(E) and Distance(D), it concludes that Energy is inversely proportional to Distance will be the best probability for optimal route. That means, in this protocol the FLC takes E and D as input parameters and Rating of Route(R) as output parameter. Each input and output variable are divided into three and nine linguistic values. Multiple fuzzy rules are inferred on these input parameters and R is calculated for each route. The route which is having higher energy and shorter distance is selected as optimal route. Therefore, the relation between input and output parameter are as in eq (5) and eq (6)

R ∝ E eq (5)
R ∝ 1/D eq (6)
So the final relation is as
R ∝ E ∝ 1/D eq (7)

Using [C], with parameters as Residue Energy(RE), Node Speed(NS), Hop Count(HC), it concludes that RE is inversely proportional to NS will be the best probability for optimal route. That means, in this protocol the FLC takes RE, NS, HC as input parameters and Trust Node(T) as output parameter. Each input and output variable are divided into three and five linguistic values. Multiple fuzzy rules are inferred on these input parameters and the node which is having high RE, low NS, short HC (or) high RE, low NS, medium HC (or) high RE, low NS, long HC is considered as trusted node (more qualified) to be part of a stable route. Therefore, the relation between input and output parameter are as in eq (8) and eq (9)

T ∝ 1/ NS eq (8)
T ∝ RE eq (9)
So the final relation is as
T ∝ RE ∝ 1/NS eq (10)

Using [D], with parameters as Hop Count(HC), Sent Control Packet(P), it concludes that P is directly proportional to HC will be the best probability for optimal route. That means, in this protocol, FLC takes HC, P as input parameters and Active Route Timeout(ART) as output parameter. Each input and output variable are divided into three linguistic values. Multiple fuzzy rules are inferred on these input parameters and the route which is having ART as high is the considered as best route. ART will be high if HC and P is low. Therefore, the relation between input and output parameter are as in eq (10) and eq (11)

ART ∝ 1/ P eq (10)
ART ∝ 1/HC eq (11)
So the final relation is as
ART ∝ 1/P & 1/HC eq (12)

Using [E], with parameters as Link Expiration Time(LET), Probabilistic Link Reliable Time(PLRT), Link Packet Error Rate(LPER),Residual Battery Power(RBP) and Link Received Signal Strength(LRSS), it concludes that LET, LRSS, RBP are inversely proportional to PLRT, LPER.That means, in this protocol, FLC takes LET, PLRT, LPER, RBP, LRSS as input parameters and Route Selection Probability(RSP) as output parameter. Each input and output variable are divided into three linguistic values. Multiple fuzzy rules are inferred on these input parameters and for each route RSP is calculated in terms of percentage. Therefore , the route which is having high percentage will be selected as optimal route,which is constant and energy capable. Therefore the relation between input and output parameter are as in eq (13), eq (14), eq (15),eq (16),eq(17)

RSP ∝ LET eq (13)
RSP ∝ 1/ PLRT eq (14)
RSP ∝ 1/LPER eq (15)
RSP ∝ LRSS eq (16)
RSP ∝ RBP eq (17)
So the final relation is as
RSP∝LET&LRSS&RBP∝1/LPRT &1/LPER eq (18)

Using [F], with parameter as Node Moving Speed(NMS) , Number of Neighboring Nodes(NoNNs), it concludes that NoNNs is inversely proportional to NMS will be the best probability for optimal route. That means, in this protocol, FLC takes NMS, NoNNs as input parameters and Beacon Packet Interval Time(BPIT) as output parameter. Each input and output variable are divided into five linguistic values. Multiple fuzzy rules are inferred on these input parameters and this protocol selects the most excellent BPIT based on NMS mobility and NoNNs. Therefore the route which is having very short BPIT is considered as optimal route. The BPIT will be very short if NMS is high, NoNNs is very small (or) if NMS is very high, NoNNs is very small. Therefore the relation between input and output parameter are as in eq (19) and eq (20)

BPIT ∝ 1/ NMS eq (19)
BPIT ∝ NoNNseq (20)
So the final relation is as
BPIT ∝ NoNNs ∝ 1/NMS eq (21)

Table 1: Comparision of Fuzzy Logic based routing protocols

Routing Protocol	QOS parameters
FBEEMR[3] technique	Hop Count, Energy Level
EERP[4] for MANET using VSMT[5]	Energy Level, Maximum Distance between intermediate nodes
FA[6] to enhance route stability of AODV routing protocol	Hop count, Energy Level, speed, Trust Value,
HS-AODV routing protocol based on FCT[7]	Hop Count, bandwidth, delay
EESR[8] using QOSMA[9] in MANET	Link Expiration Time, speed, delay, energy level,
FLDB[10] for GPSR[11] mobile PB[12] routing protocol	Number of Intermediate nodes, speed

VI.CONCLUSION

This paper discusses how Fuzzy Logic theory can be used for implementing routing in AdHoc networks. It is important to consider maximum QOS parameters or all QOS parameters to select best possible path in adhoc networks. But as per best of my knowledge ,no existing protocols are considering all or maximum QOS parameters. Most of the authors are using 2 or 3 parameters as routing metrics. The future scope of this work can be enhanced to develop a new Fuzzy Logic based routing protocol for MANETs which will take all the important QOS parameters.

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VIII.ABBREVIATIONS

1. FLWMR[1]-Fuzzy Logic Wireless Multipath Routing
2. FLWLAMR[2] - Fuzzy Logic Wireless Load Aware Multipath Routing
3. FBEEMR[3] - Fuzzy Based Energy Efficient Multicast outing
4. EERP[4] - Energy Efficient Routing Protocol
5. VSMT[5] - Vague Set Measurement Technique
6. FA[6] - Fuzzy Approach
7. FCT[7]- Fuzzy Control Theory
8. EESR[8] - Energy Efficient Stable Routing,
9. QOSMA[9] - Quality Of Service Monitoring Agents
10. FLDB[10]- Fuzzy Logic Dynamic Beaconing
11. GPSR[11] - Greedy Perimeter Stateless Routing
12. PB[12] - Periodic Beaconing