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Enhancing the Performance of AODV in MANETs using Fuzzy logic

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Abstract----A mobile ad hoc network (MANET) is a self-configuring, infrastructure-less network of mobile devices connected without wires. Most of the routing protocols used for MANETs, such as Ad hoc on demand distance vector (AODV) routing protocol considers minimum hop count as the metric for routing which leads to maximum delay and this in turn leads to congestion. So, in this paper, an attempt has been made to minimize the delay and thus congestion is minimized. Thus, performance of the existing AODV routing protocol is enhanced by incorporating the Fuzzy logic into the original AODV protocol. This is made possible by considering both hop count and network size as the input metrics. Thus, QoS metrics are improved using the proposed system. Our simulation is carried out using OPNET simulator and the results show that the proposed system performs better than the original AODV in terms of average end-to-end delay and packet delivery ratio.

Keywords---MANETs, AODV, QoS (Quality of Service), Fuzzy based inference System.

I. INTRODUCTION

In recent years, a vast research has been seen going on in the field of Mobile Ad Hoc Networks. Due to limited resources in MANETs, to design an efficient and reliable routing strategy is still a challenge. An intelligent routing strategy is required to efficiently use the limited resources. Also the algorithms designed for traditional wired networks such as link-state or distance vector, does not scale well in wireless environment. A Mobile Ad Hoc Network [4] is an infrastructureless, self-organized and multi hop network with rapidly changing topology causing the wireless links to be broken and re-established on-the-fly. A key issue is the necessity that the routing Protocol must be able to respond rapidly to the topological changes in the network. In these networks, each node must be capable of acting as a router. As a result of limited bandwidth of nodes, the source and destination may have to communicate via intermediate nodes. Major problems in routing are Asymmetric links, Routing Overhead, Interference, and Dynamic Topology. The routing protocols in MANETs are divided into two broad classes. They are Reactive and Proactive protocols.

In Reactive or on demand routing protocols the routes are created only when they are needed. The application of this protocol can be seen in the Dynamic Source Routing Protocol (DSR) and the Ad-hoc On-demand Distance Vector Routing Protocol (AODV)[1].Wherein Proactive or Table-driven RPs the nodes keep updating their routing tables by periodical messages. This can be seen in Optimized Link State Routing Protocol (OLSR) and Destination Sequenced Distance Vector Protocol (DSDV). Routing in MANETs is a challenging task and has received a tremendous amount of attention from researchers around the world. To overcome this problem a number of routing protocols have been developed and the number is still increasing day by day. It is quite difficult to determine which protocols may perform well under a number of different network scenarios such as network size and topology etc.

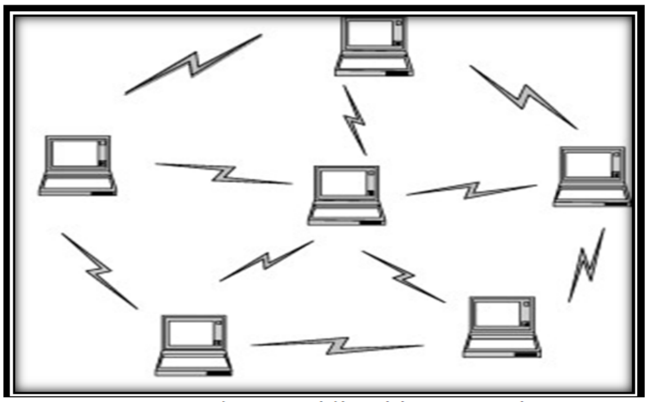

Fig. 1: Mobile ad-hoc network

II. RELATED WORK

Kejun et al proposed method that focuses on routing wait time reduction by making each node along the path from the source to the destination participating in selecting the optimal route, considering not only the minimum hops but also the delay period of each path using fuzzy systems assessment until reaching the destination which does not require any additional waiting time to send the route reply packet on the chosen path.

Yogesh et al focused on comparative analysis of two on demand routing protocols: Ad-hoc On-Demand Distance Vector (AODV) and Dynamic Source Routing (DSR) based on packet delivery ratio, normalized routing overhead and end-to-end delay while varying number of sources and pause time. The simulation experiments are performed using GLOMOSIM. The traffic sources used were CBR and the source-destination pairs are spread randomly. The data packet size is 512 bytes with the performance metrics considered for evaluation were Packet Delivery Ratio (PDR), End-to-end delay, Routing overhead. The analysis shows that routing is very important factor for evaluating the performance of the system.

Traditional routing algorithms cannot fulfill the requirements of an wireless network, because of the dynamic topology and the limited bandwidth that characterize these networks.

Taqwa Odey Fahad presented fuzzy-Based Routing Protocol and it was compared with Ad hoc On-Demand Distance Vector (AODV) and Dynamic Source Routing (DSR). It was compared on the basis of parameters such as packet delivery fraction, normalized routing overhead and average delay with differing pause time and varying number of sources. The simulation experiments are performed using GLOMOSIM by evaluating metrics like Packet Delivery Ratio (PDR), Average end-to-end delay and Normalized routing overhead. The proposed technique achieved a low Routing Overhead than AODV.

III. PROPOSED SYSTEM

In the proposed fuzzy system, Mamdani minimum inference method was used as the fuzzy inference method, where the 'and' operation was set to minimum and defuzzification was carried out using centroid defuzzifer. The triangle membership functions were used to represent inputs and output, with three linguistic variables to the inputs: Low, Medium, and High, and five for the output: Very Low, Low, Medium, High, and Very High. As shown in Fig.2, in the proposed system, the inputs that are given to the fuzzy logic are network size and hop count. The output that has been calculated dynamically is delay. Thus, calculated value is provided as input to the AODV scenario that is run in OPNET environment. It is found that the performance of the AODV routing protocol has been enhanced when compared to the original AODV protocol.

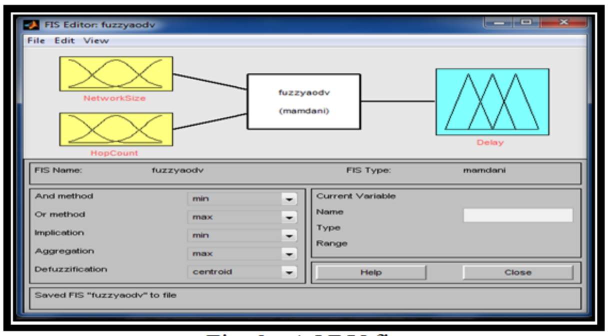

Fig. 2: AODV.fis

IV. SIMULATION MODEL

Our simulation modeled a network of 50 mobile nodes placed randomly in 800 × 800 meter area. Each node had channel capacity of 54 Mbps. The IEEE 802.11g was used as the medium access control protocol. A random waypoint mobility model was used with a speed ranging from 0 m/s to 10 m/s. A traffic generator was developed to simulate CBR (Constant Bit Rate), UDP application. The size of the data payload was 512 bytes. Each source transmitted data packets at a minimum rate of 2 packets/sec, and a maximum rate of 4 packets/sec. Each simulation was executed for 250 seconds of simulation time by OPNET [7] simulator.

In the proposed scenario (Fig.4), the network has been built in OPNET [7] simulator. The end-to-end delay has been calculated using fuzzy logic by giving network size and hop count as inputs. The end-to-end delay which has been calculated dynamically using fuzzy logic is given as input to the above created scenario. Thus, it is found that the performance of the proposed system has been enhanced when compared to the original AODV scenario. The proposed fuzzy logic based AODV protocol has been run and throughput, average jitter, normalized routing load, packet delivery ratio etc, have been calculated and it has been found that the performance of the routing protocol has been enhanced.

Table I: Simulation Parameters

Simulation Parameters	Values
Area Size	800m x 800m
Number of nodes	30,50
Maximum node speed	15 m/s
Simulation time	250 sec
Data rate	4 pkts/sec
Packet size	512 bytes
Communication	50m

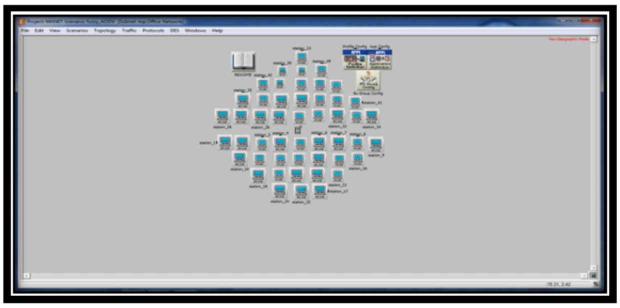

Fig. 3: MANET scenario

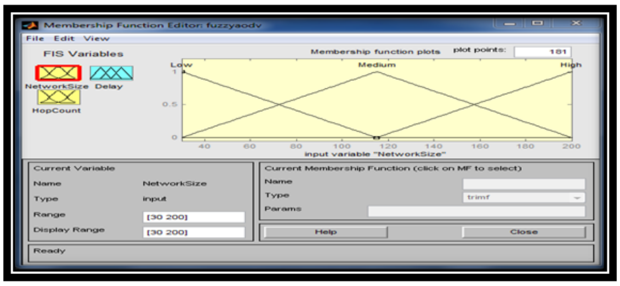

Fig. 4: Network size membership function

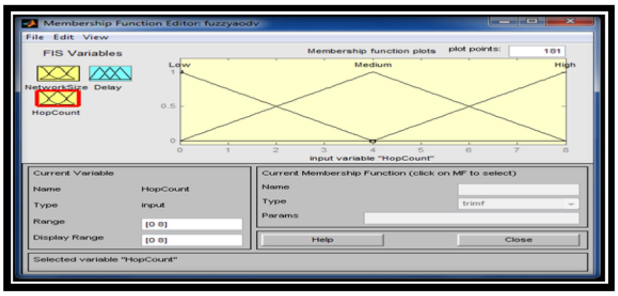

Fig. 5: Hop count membership function

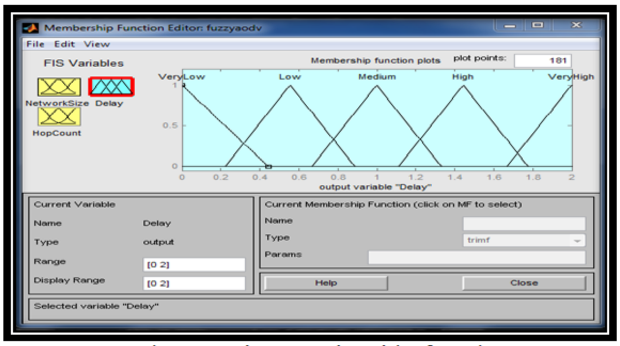

Fig. 6: Delay membership function

V. SIMULATION RESULTS

We evaluated and compared the following metrics:

- **Packet Delivery Ratio:**

Packet delivery ratio is obtained by dividing the number of received data packets by the destinations by the number of data packets originated by the sources.

- **Average End-to-End Delay:**

Average end-to-end delay is the average time taken by data packets when released by sources until reach their destinations.

- **Normalized Routing Load:**

Normalized routing load is the total number of control packets divided by number of transmitted data packets in the network.

From the below Fig.7,Fig.8,Fig.9, graphs we can deduce that the end-to-end delay has been decreased by 34.95%, normalized routing load has been improved by 33.33% and packet delivery ratio has been increased by 3.84%.

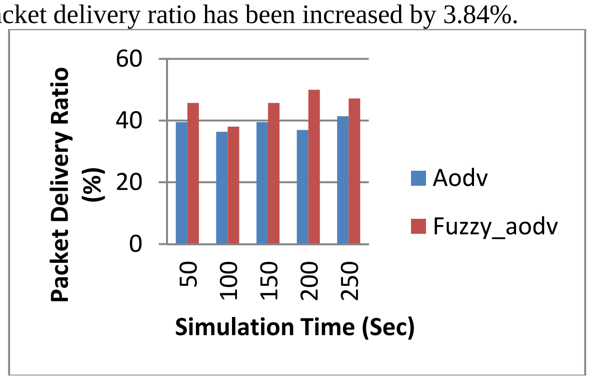

Fig. 7: Graph showing relative packet delivery ratio in AODV and Fuzzy based AODV

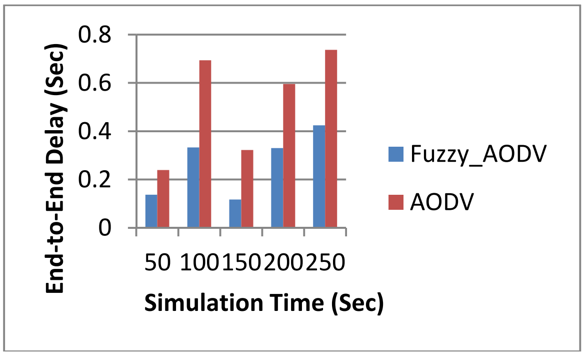

Fig. 8: Graph showing End-to-end delay in Fuzzy based AODV and AODV

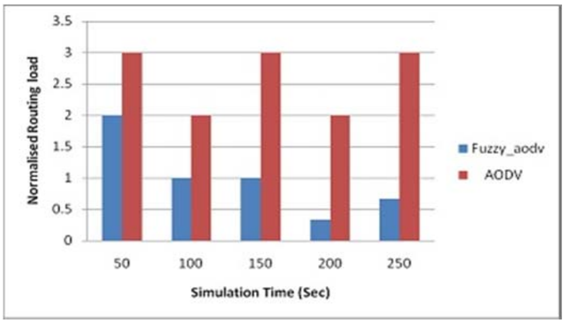

Fig. 9: Graph showing Normalized routing load in AODV and Fuzzy based AODV

VI. CONCLUSION & FUTURE WORK

In this paper, an improvement of AODV routing protocol has been made by calculating the delay dynamically. The inputs taken in the fuzzy logic are network size and hop count and the output that is computed is delay. This output is provided as input to the AODV scenario that is run in OPNET simulator. The performance of the proposed scheme has been compared with the performance of the original AODV. The performance analysis showed that this fuzzy logic based routing has better average end-to-end delay, packet delivery, and normalized routing load than the original AODV routing protocol.

In future research study, other constraints can be taken to produce the fuzzy cost. In addition to this we can integrate security to the above proposed fuzzy based AODV. The performance can be improved by new method in which the route is built on-demand and maintained by locally updating route information. Multiple backup routes are built around the active route and the highest priority backup route will be switched to become the new active route when the current active route breaks or is less preferred. Routes adapt to fast topology variations and reach local optimum quickly. The performance can be further enhanced by applying a newly developed route update procedure with combined metrics of delay, hop count and disjointness, each intermediate node deliberately selects multi-path candidates while contributing to suppression of unnecessary routing packets.

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