Design and Implementation of Fuzzy Logic Approach for fine tuning of Configuration Parameters in AODV to enhance the performance in MANETs

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Abstract— **the unpredictable movement of the nodes in the mobile ad hoc network creates topological changes which demands adaptable routing. The on-demand routing protocol AODV gained a lot of attention from the researchers in the mobile communication era. The AODV routing protocol operates on some default parameters in a dynamic environment. In this paper, an attempt is made to incorporate Fuzzy logic decision on parameters in AODV to enhance the performance of the mobile ad hoc networks. The performance of the proposed fuzzy logic approach for tuning of parameters in AODV is evaluated using the popular simulator, ns-2.34. The Simulation result reveals that the fuzzy logic decision on parameters provides a better performance than the fixed parameter approach in AODV. The average end-to-end delay was significantly reduced by 64.96 % in medium size networks with the fuzzy approach.**

Keywords- AODV, FUZZY LOGIC, MANETs, PERFORMANCE

I. INTRODUCTION

An Infrastructure less network with mobile nodes offering high adaptability for communication is a mobile ad hoc network [10] [13]. The nodes enter in to the network and move away from the network in their own wish. Route establishment in these networks is really a challenging task [7] [11]. Various routing protocols [5] [6] were developed for establishing the paths among the nodes. One of the routing protocols which gained a lot of attention from all over the world is AODV. The rest of the paper contains AODV routing protocol explanation in section 2, explanation about fuzzy logic approach for the determination of node traversal time in section 3 , various simulation parameters used in the evaluation of proposed approach in section 4, results in section 5 and conclusion in section 6.

II. AD HOC ON-DEMAND DISTANCE VECTOR ROUTING (AODV)

An On-demand routing protocol "Ad Hoc On-Demand Distance Vector (AODV)" [3] [9] constitutes two important mechanisms namely *route discovery* and *route maintenance. In route discovery mechanism,* Whenever a node needs to send data to the destination node, it transmits a *ROUTE REQUEST* (RREQ) message and when it reaches the destination node, the destination node responds with ROUTE REPLY (RREP) message. Once the RREP message reached to the sender, the route has been established and data packets may be delivered on that route. In route maintenance mechanism, any route failures are intimated through Route Error (RERR) messages. The AODV routing protocol utilizes fixed parameters during its operation in a dynamic environment. According to the IETF draft of AODV it was stated that the choice of the parameters affect the protocol performance and the node traversal time value should be chosen with a proper knowledge about the other nodes in the network.

III. METHODOLOGY

Fuzzy logic [4] [12] generalizes the classical two-value logic to a matter of degree. It works for reasoning under uncertainty. Most of the real world problems are represented through fuzzy logic than two-valued logic. Human thinking and experiences can be implemented through membership functions and fuzzy rules in a fuzzy logic. It is an effective mechanism for formulating solutions to problems characterized by vague information.

Changing the node traversal time value in AODV affect the protocol performance and therefore it should be determined with a proper knowledge about the network behavior. The fuzzy logic is incorporated in AODV for the determination of Node Traversal Time is termed as "FUZZY LOGIC BASED NODE TRAVERSAL TIME PERFORMANCE ENHANCED AODV (FLBNTTPEAODV)". In this approach , network size and speed of the mobile nodes are taken as inputs. The Node Traversal Time is considered as an output. The Mamdani Architecture is used in the calculation as shown in figure 1 below.

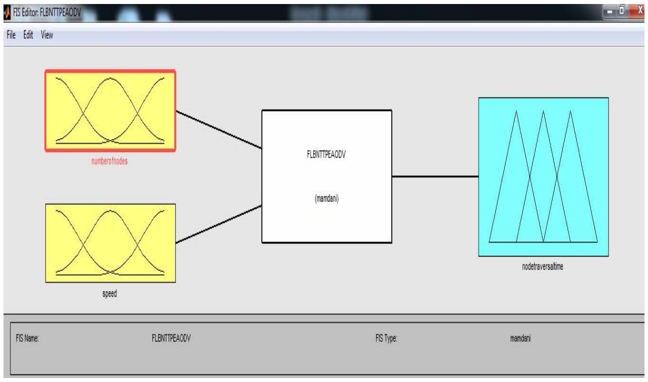

Figure 1 : Mamdani Architecture of FLBNTTPEAODV

The input variable 'number of nodes (nn)' has the linguistic variables Low (L), Medium (M) , High (H), and Very High(V). The input variable 'speed' has the linguistic variables Low(L), Medium(M) High(H), and Very High(V). The output variable 'node traversal time (ntt)' has the linguistic variables Low(L), Medium(M) High(H), and Very High(V). The membership functions for the input variable "number of nodes" is shown in the figure 2,The membership functions for the input variable "speed" are shown in the figure 3 and the output variable nodetraversaltime with its membership functions is shown in the Figure 4.

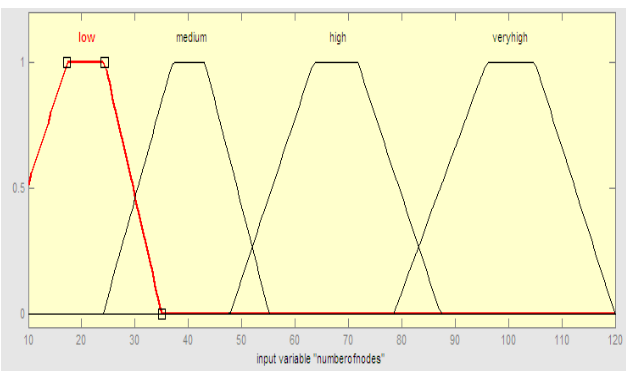

Figure 2: Membership functions of the input variable "numberofnodes"

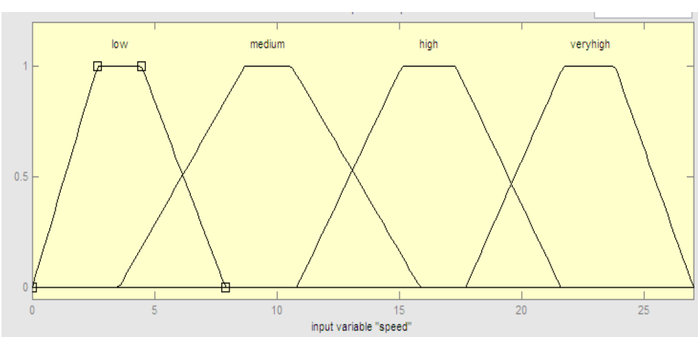

Figure 3 : Membership functions of the input variable "speed"

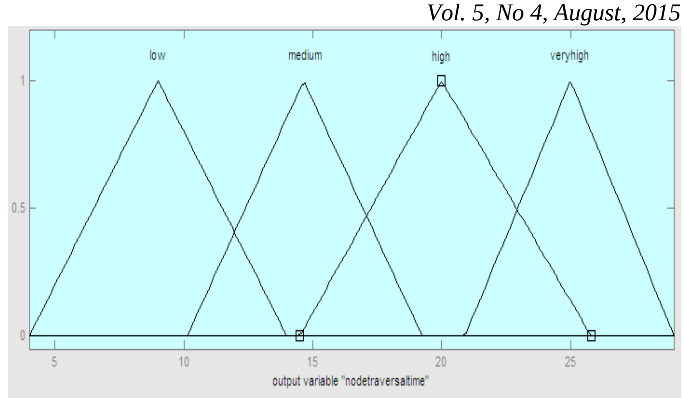

Figure 4 : Membership functions of the output variable "nodetraversaltime"

The fuzzy rule base used in the approach is given in the figure 5 below.

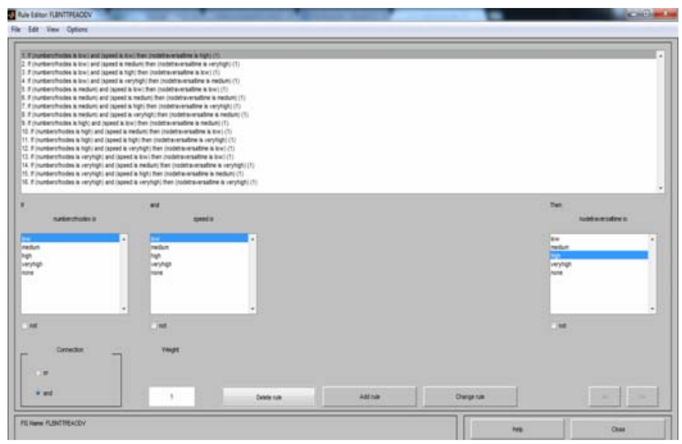

Figure 5 : Rule base of FLBNTTPEAODV

The surface view of the proposed approach is given in the figure 6 below.

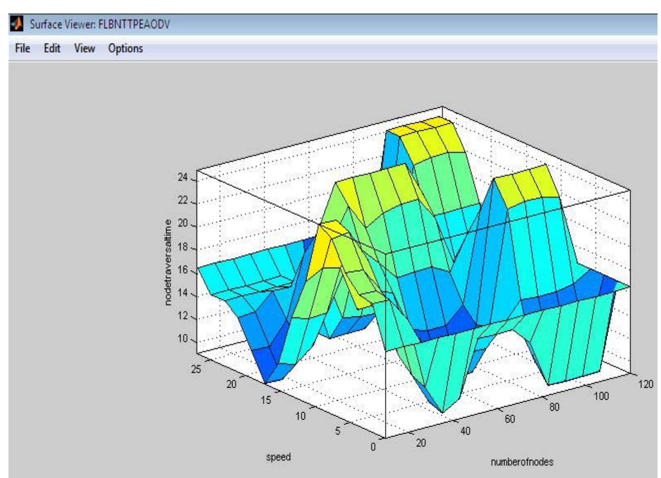

Figure 6: Surface viewer of FLBNTTPEAODV

IV. SIMULATION ENVIRONMENT

Simulation is an economical and an easy approach to carry out experiments in Mobile Ad hoc Networks. The widely used network simulator ns2.34 [8] is used to evaluate the performance [1] [2] of FLBNTTPEAODV and AODV. Simulation Environment used in the evaluation is presented below. Figure 7 presents the running scenario during simulation.

Table 1 : Simulation Parameters used in the Experimental Evaluation

Routing Protocols / Approaches	AODV, FLBNTTPEAODV
Simulation Time	360 s
Area (sq.m)	1000 x 1000
Propagation Model	Two Ray
Traffic	CBR
Packet Size	512 bytes
Number of Packets	100
Nodes	15,47,79,111
Antenna Type	Omni directional
Transmission range	250m
Receiver range	250m
Mobility Model	RandomWayPoint
Pause Time	0 s
Speed	10 m/s
Node Deployment Model	Random

V. RESULTS AND ANALYSIS

The performance metrics namely Packet Delivery ratio , Throughput, End- to-End Delay, Jitter, Routing overhead and Normalized Routing Load are considered to evaluate the proposed approach.

Packet delivery ratio: The Total number of data packets delivered to the destination divided by total number of data packets transmitted by the nodes.

Packet Delivery ratio, pdr = ∑ packets received / ∑ packets sent

Percentage of Packet delivery ratio = pdr x 100.

Figure 8 presents the Percentage of Packet Delivery ratio for AODV and FLBNTTPEAODV w.r.t number of nodes.

End-to-End Delay: It refers to the amount of time taken by the packet to travel from source to destination. End-to-end Delay, ED $= PR_{td} - PS_{ts}$

Where PR_{td} indicates the packets receive time at the destination and PS_{ts} indicates the packet sent time at the source.

Average End-to-end delay refers to the total amount of time taken by all the packets to travel from source to destination to the total number of packets received. Figure 10 presents the Average End-to-end delay for AODV and FLBNTTPEAODV w.r.t number of nodes

Throughput: It is gives the channel capacity i.e. the rate at which a network can send and receive data. Average Throughput refers to the total amount of data received to the time taken from the first sent to the last packet received. Figure 9 presents the Average throughput for AODV and FLBNTTPEAODV w.r.t number of nodes.

Jitter: It is the variation in latency as measured in the variability over time of the packet latency across a network. Jitter is an important QoS factor in assessment of network performance. Average Jitter is the total variation in delay to the number of variations Figure 11 presents Average Jitter for AODV and FLBNTTPEAODV w.r.t number of nodes.

Routing Overhead: Routing Overhead is the number of routing packets required for network communication. Figure 12 presents the Routing Overhead for AODV and FLBNTTPEAODV w.r.t number of nodes.

Normalized Routing Load: Normalized Routing Load is the number of routing packets per data packets delivered at the destination. Figure 13 presents the Normalized Routing Load for AODV and FLBNTTPEAODV w.r.t number of nodes.

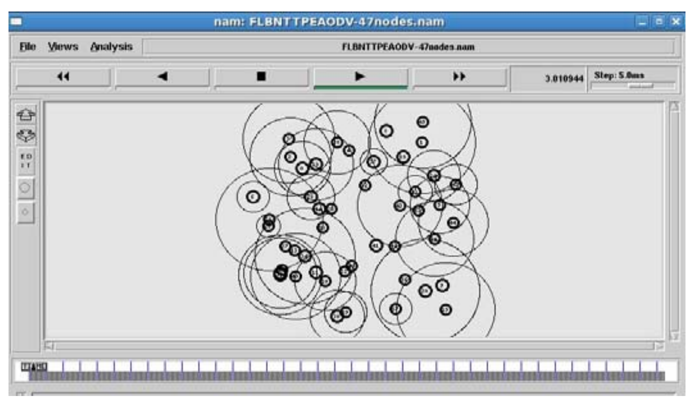

Figure 7 : Running Scenario of FLBNTTPEAODV

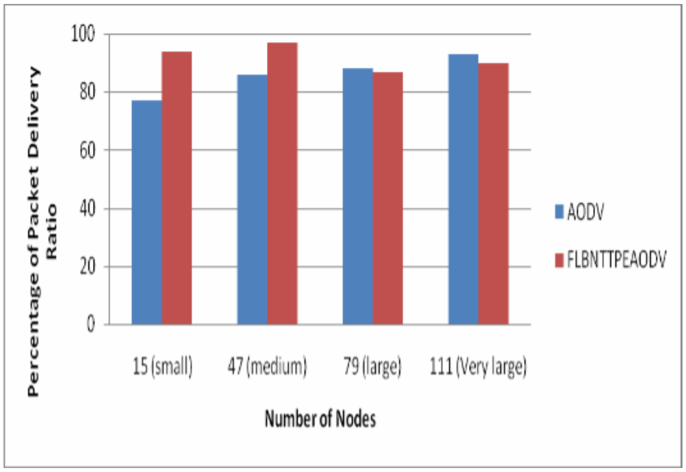

Figure 8: Percentage of Packet Delivery ratio for AODV and FLBNTTPEAODV w.r.t number of nodes

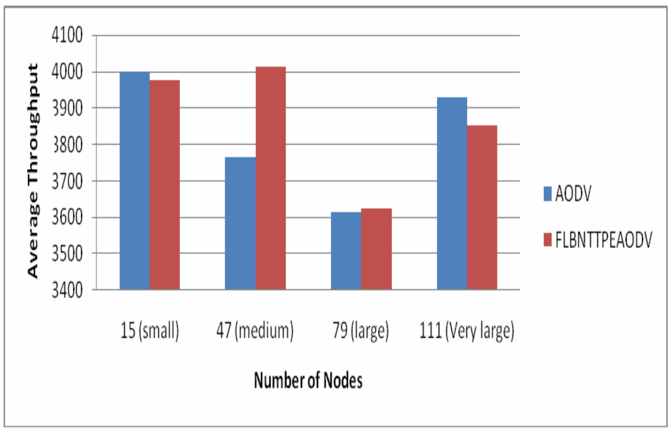

Figure 9 : Average throughput for AODV and FLBNTTPEAODV w.r.t number of nodes

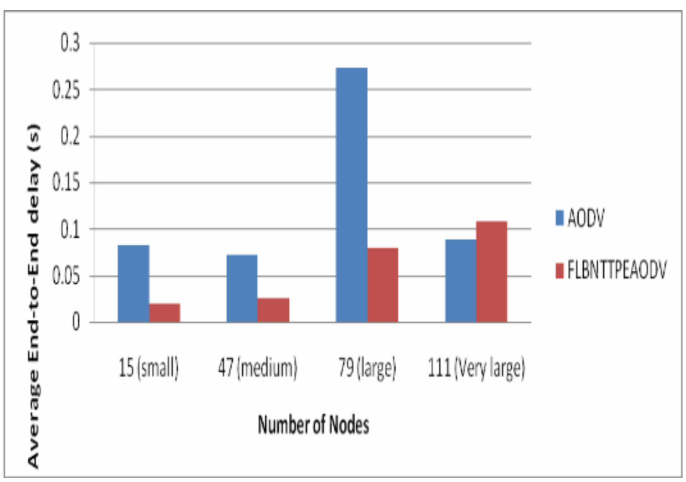

Figure 10 : Average End-to-end delay for AODV and FLBNTTPEAODV w.r.t number of nodes

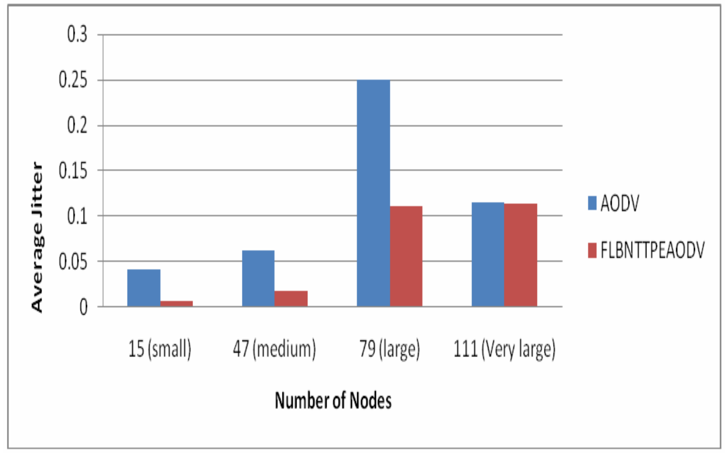

Figure 11: Average Jitter for AODV and FLBNTTPEAODV w.r.t number of nodes

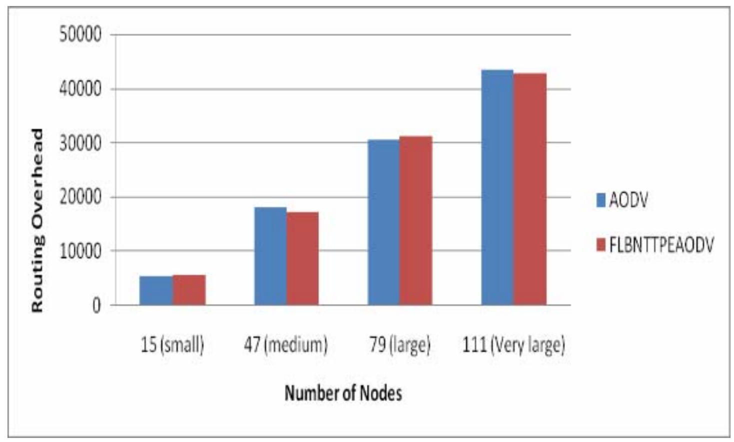

Figure 12: Routing Overhead for AODV and FLBNTTPEAODV w.r.t number of nodes

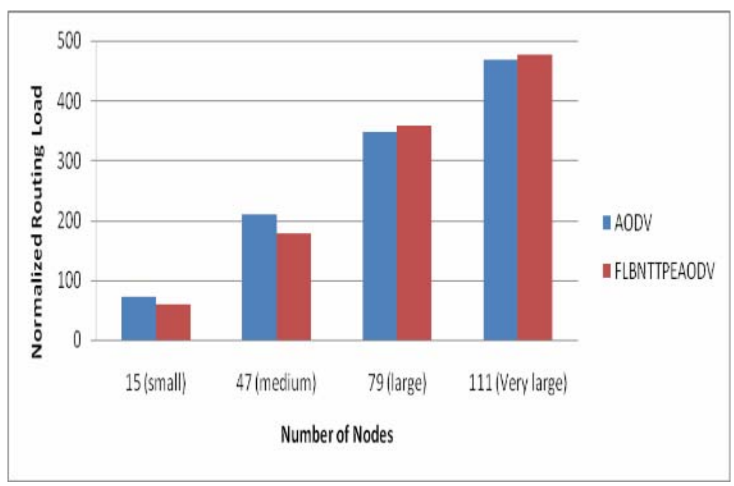

Figure 13: Normalized Routing Load for AODV and FLBNTTPEAODV w.r.t number of nodes

The percentage of packet delivery ratio was enchanced by 22.07 % in small network size and it was enhanced to 12.79 % in medium size networks. The Average throughput was enhanced by 6.58 % in medium size networks. The average end-to-end delay was reduced by 64.96 % in medium size networks. The Average jitter was reduced by 71.38 % in medium sized networks . The Routing overhead was decreased by 4.42% and normalized routing load was reduced by 15.25% in medium network size.

VI. CONCLUSION

The determination of default parameters in AODV with the network behavior plays a vital role in the performance of the network. FLBNTTPEAODV outperforms well in medium sized networks and moderately in small sized networks than the traditional AODV. It is not advisable for large and very large networks. The other techniques may be employed in order to enhance the performance in large and very large networks.

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