

Performance Analysis of AODV with Fuzzy Based Node Traversal Time using Different Scheduling Techniques in MANET

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Abstract— Mobile Ad-hoc network (MANET) is a type of wireless network without any fixed infrastructure. MANET includes different nodes which are connected in random manner and are placed dynamically. In this paper the performance of AODV protocol has been analyzed with optimized NODE_TRAVERSAL_TIME using fuzzy logic controller with the help of scheduling techniques. The optimized value of NODE_TRAVERSAL_TIME has been decided by the proposed fuzzy logic controller to be used in conventional AODV protocol using the power of transmission and speed of the nodes. The performance of the network using AODV protocol with this fuzzy based node traversal time has been compared with conventional AODV protocol using different scheduling techniques like SP, RR and SCF in terms of average throughput, average packet delivery ratio and average routing overhead. It has been found from the simulated and manually calculated results that performance of the network using AODV with fuzzy based node traversal time has been improved. The simulation has been done using qualnet 6.1 simulator.

Key words: MANET, AODV, Fuzzy Logic Controller, Node Traversal Time (NTT), Scheduling techniques, Strict Priority (SP), Round Robin (RR), Self Clocked Fair (SCF), AODVNTT, Qualnet Simulator

I. INTRODUCTION

A mobile ad-hoc network is a type of wireless network without any fixed infrastructure. MANET contains a set of nodes which are able to move dynamically and to communicate with each other without any centralized manner[2].

Ad-hoc on demand distance vector routing protocol is a popularly used reactive routing protocol. In AODV protocol the route is established on demand. Node traversal time (NTT) is one of the significant parameter of AODV protocol that gives a conservative estimate of the average traversal time of one hop for packets and it should include queuing delays, interrupt processing times and transfer times.

NET_DIAMETER is defined as the maximum possible number of hops between two nodes in the network[1][8].

$$\text{NET_TRAVERSAL_TIME} = 2 * \text{NODE_TRAVERSAL_TIME} * \text{NET_DIAMETER}$$

From the above equation it can be said that increase in the value of NODE_TRAVERSAL_TIME will increase the NET_TRAVERSAL_TIME further it will increase the delay of transmitting the packets but reduces the overhead. On the other hand decrease in the value of NODE_TRAVERSAL_TIME will reduce the delay but increases the overhead.

So, selection of node traversal time value is one of the necessary parameter during the design of AODV protocol. This parameter affect many other parameters such as NET_TRAVERSAL_TIME, BLACKLIST_TIMEOUT,

NEXT_HOP_WAIT etc. So, the value of NODE_TRAVERSAL_TIME should be chosen adaptively. The default value of NODE_TRAVERSAL_TIME in AODV protocol is 40 milli-seconds[1].

In this paper an optimized value of node traversal time to be used in AODV has been selected using fuzzy logic controller.

II. CONVENTIONAL AODV PROTOCOL

AODV protocol comes in the category of reactive or on-demand routing protocol. In AODV routing protocol routes are established according to need of sending data. The functioning of AODV protocol may be divided in two phases. One is the process of route discovery and the other one is route maintenance [2]. Route discovery process is started by creating route request (RREQ) packet by the sender node and passed it to the neighboring nodes in the direction of destination. From these intermediate nodes the RREQ message is arrived to the destination node. In the destination node creates a route reply (RREP) packet is created and send it in the direction of source node[3].

In the phase of route maintenance each node related to the route transmits hello messages regularly it indicates that the node is exist in the active route[3]. If any node does not receive hello message from its neighbor nodes in predetermined period of time interval then the node assumes that the link from its neighbor is failed. Further the node generates route error message (RERR) and send it to all the predecessors nodes which are still using the failed link for transmitting data. The intermediate nodes receive RERR message and pass it towards the source. When the source gets this information it re-start the process of route discovery [4].

III. AODV PROTOCOL WITH FUZZY BASED NODE TRAVERSAL TIME (AODVNTT)

The fuzzy logic controller is based on fuzzy set theory, uses some set of rules and the membership function of the linguistic input and output variables. The function of fuzzy logic controller is based on the experiences and thinking of human. This reduces the complexity of mathematical calculation[9].

Fuzzifier, inference system and defuzzifier are the main parts of fuzzy logic controller. The purpose of fuzzifier is to map the crisp input data values to its corresponding fuzzy sets that can be defined using fuzzy rule base. In the inference system the fuzzified values are further processed which consists of a rule base and a number of ways for inferring these rules. These rules can be made through human thinking and may be defined on the basis of their membership functions. All these rules are processed in parallel manner. The defuzzifier converts the output fuzzy sets to a single crisp output[5].

Figure 1 shows the block diagram of proposed fuzzy logic controller.

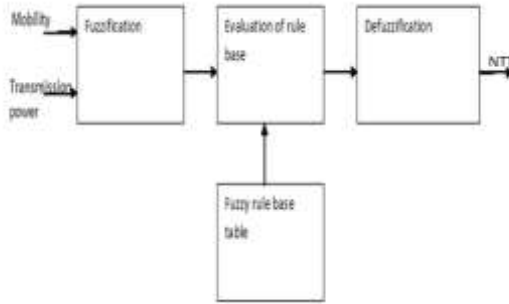


Fig. 1: Proposed fuzzy logic controller

Mobility and transmission power are considered as input and node traversal time (NTT) is considered as the output linguistic variable for the proposed fuzzy controller. The fuzzy membership functions of all input and output parameters are divided into three subsets namely: {low, medium, high}. In the proposed work to define low and high subsets gauss2mf(Gaussian membership function) has been used because it has the advantage of being smooth and non zero at all points and for medium subset trimf(Triangular membership function) has been used because of its simplicity for both input and output variables. Membership functions of all parameters are shown below: Figure 2, 3, 4, shows fuzzy subsets and membership functions for variables; mobility, transmission power and node traversal time respectively.

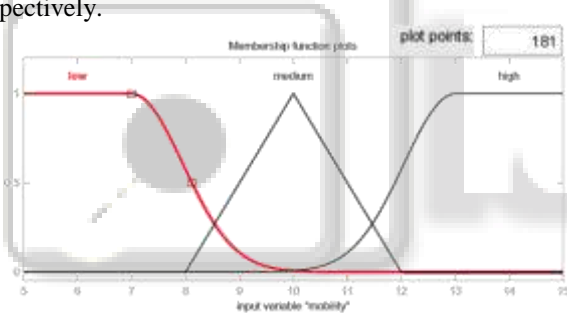


Fig. 2: Membership function plot of mobility.

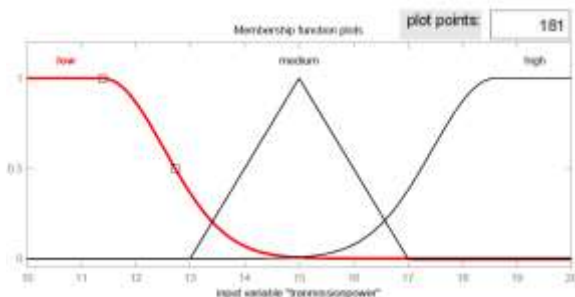


Fig. 3: Membership function plot of transmission power.

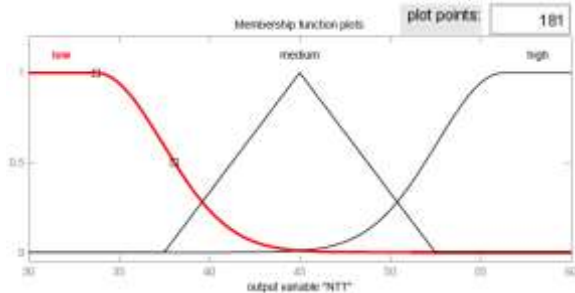


Fig. 4: Membership function plot of node traversal time.

The method for making the rules for proposed fuzzy controller is given below.

A. Effect of Mobility over NTT

In the mobile ad-hoc network because of increasing the node movement, the chance of the failure of the link increase. Due to the failure of link the time of traversal also increases. While decreasing the speed of nodes, increases the reliability of link between the nodes so the traversal time is reduced[6].

Consequently the following rules are proposed-

- (1) If mobility is high then NTT must be high.
- (2) If mobility is medium then NTT must be medium.
- (3) If mobility is low then NTT must be low.

B. Effect of Transmission Power over NTT

In the MANET, as increases the transmission power the reliability of link between nodes and transmission range also increases, this reduces the traversal time. While decreasing transmission power reduces the transmission range and increases the chance of link failure. So the traversal time has been increased [5].

Consequently the following rules are proposed-

- (1) If transmission power is high then NTT will be low.
- (2) If transmission power is medium then NTT will be medium.
- (3) If transmission power is low then NTT will be High.

Consequently the above rules can be written in a two dimensional form as:

Transmission Power	Mobility		
	Low	Medium	High
Low	Medium	High	High
Medium	Low	Medium	High
High	Low	Low	Medium

Table 1: Rule base for proposed fuzzy controller

IV. SCHEDULING TECHNIQUES

Scheduling techniques distributes the resources among all users that are available in the network and also provide them with a higher QoS. The main purpose of any scheduling technique is to maximize the utilization of the network and to achieve the fairness among all users in the network [7].

A. Strict Priority (SP)

In the strict priority technique packets are represented by the scheduler that depends on the QoS of the class and different priority queues have been assigned to these packets, according to the priority of the queue from the highest to the lowest these queues are served [7].

B. Round Robin (RR)

In round robin technique the packet from each priority queue have been serves according to the value of precedence, one-by-one. It means at first the first packet of each queue have been served and then the process is repeated for the next, so in RR technique the packets are served in round [7].

C. Self-Clocked Fair (SCF) Queuing

SCF Scheduler is responsible for generating a virtual time that is used as an index of the work progress, and determines

the sequence of which packets should be served next. The virtual time is calculated internally as the packet comes at the head of the queue [7].

D. Simulation Setup

The simulation work has been done using Qualnet Simulator 6.1 over window platform by varying simulation time. Qualnet simulator is a discrete event simulator that has the ability to simulate both wired and wireless scenarios. Figure 5 shows the simulation scenario setup and table 2 shows parameters used in this scenario. In the simulation model 50 nodes have been placed in a random manner which are connected each other through wireless subnet. The simulation area of 1500m×1500m has been chosen as flat terrain area. There are 5 CBR connections, Random way point type mobility model and data rate of 2 Mbps have been used in this simulation. Omni directional antenna is used to transmit the signals and data. The performance has been evaluated on the basis of performance matrices like total overhead, average end-to-end delay, average throughput.

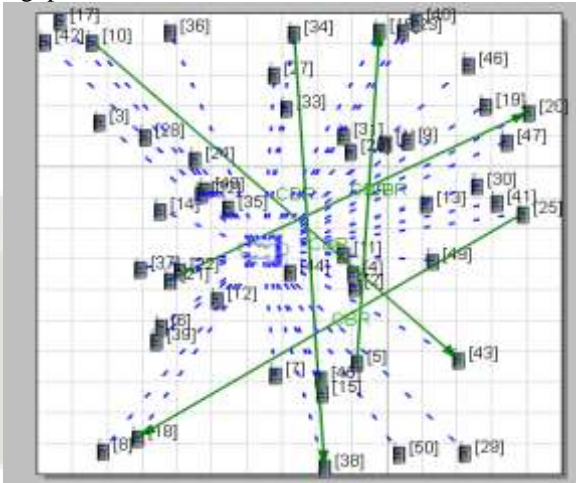


Fig. 5: Simulation scenario

V. SIMULATION PARAMETERS

Common simulation parameters for conventional AODV and AODV with fuzzy based NTT (AODVFNTT) are listed below:

Parameters	Value
Simulator	Qualnet 6.1
No. of nodes	50
Simulation time	30,60,90,120,150sec
Mobility model	Random way point
Pause time	5sec
Data rate	2Mbps
Radio type	802.11b radio
Antenna model	Omni directional
Item size	512 bytes
End time	150sec
Channel frequency	2.4GHz
No. of CBR	5
Number of packets to send	150
Simulation Area	1500m×1500m
Packet rate	1(packet/sec)
Scheduling type	RR, SP, SCF
Queue type	FIFO

Transmission power	15dbm
Mobility	10mps

Table 2: Simulation parameters

VI. PERFORMANCE METRICS

In the proposed work following metrics for the evaluation of performance have been used:

A. Routing Overhead

$$\text{overhead} = \frac{\sum_{i=1}^n \text{number of SentCtrlPkt by the source}}{\sum_{i=1}^n \text{number of received data by destination}}$$

Where n is number of nodes in the network. This metric can be used to evaluate how many control packets are sent for successful delivery of data packets that determines the efficiency and scalability of the protocol.

B. Packet Delivery Ratio (PDR)

PDR is the ratio of the number of successfully received data packets received to the number of data packets transmitted.

C. Average Throughput

It is defined as the average number of successfully received data packet at destination per second and measured in (bit/sec). Throughput should be as high as possible.

VII. SIMULATION RESULTS

To analyze the performance of AODV and AODVFNTT, the values of mobility and transmission power have been considered 10mps and 15dbm respectively for both AODV and AODVFNTT. The value of Node_Traversal_Time is taken 40ms for conventional AODV and 45ms for AODVFNTT. The performance of AODVFNTT has been compared with conventional AODV for this purpose different types scheduling algorithm have been taken into account.

The results are given below:

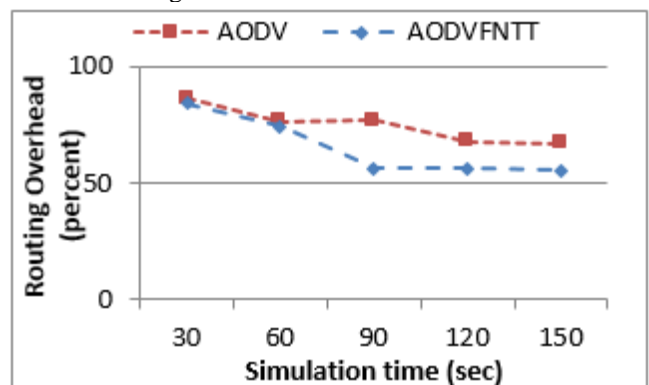


Fig. 6: Routing Overhead using Round Robin type Scheduler

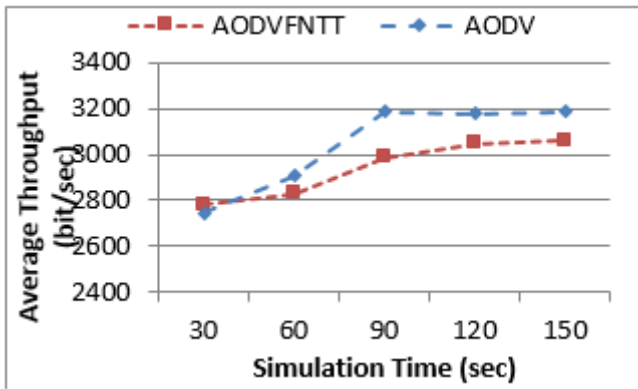


Fig. 7: Average Throughput using Round Robin type Scheduler

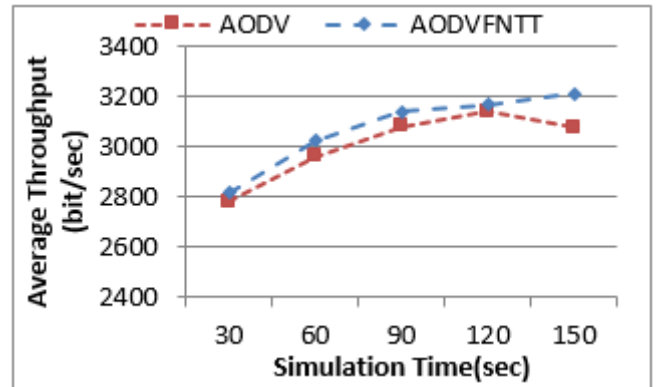


Fig. 10: Average Throughput using Self-Clocked Fair type Scheduler

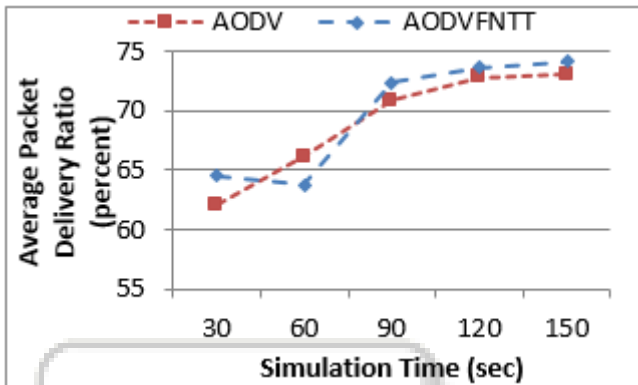


Fig. 8: Average Packet Delivery Ratio using Round Robin type Scheduler

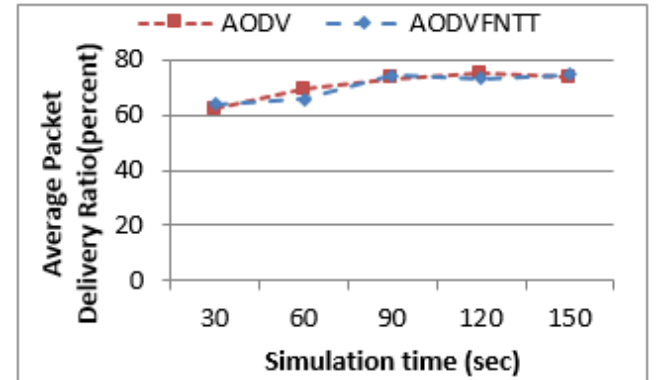


Fig. 11: Average Packet Delivery Ratio using Self-Clocked Fair type Scheduler

Figure 6, 7, 8 shows the routing overhead, average throughput and average packet delivery ratio respectively using round robin type scheduler. Since increase in the value node traversal time also increases the value of net traversal time this will reduce the overhead and increase the throughput as well as packet delivery ratio.

Figure 9, 10, 11 shows the routing overhead, average throughput and average packet delivery ratio respectively using self-clocked fair type scheduler. Since increase in the value node traversal time also increases the value of net traversal time this will reduce the overhead and increase the throughput as well as packet delivery ratio.

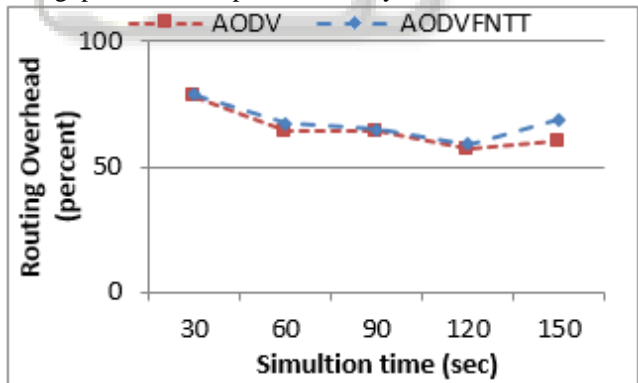


Fig. 9: Routing Overhead using Self-Clocked Fair type Scheduler

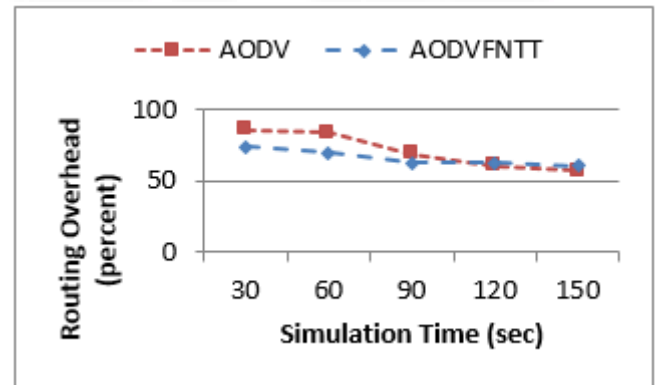


Fig. 12: Routing Overhead using Strict Priority type Scheduler

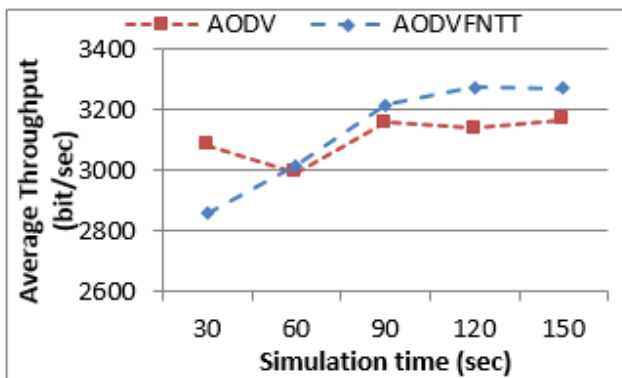


Fig. 13: Average Throughput using Strict Priority type Scheduler

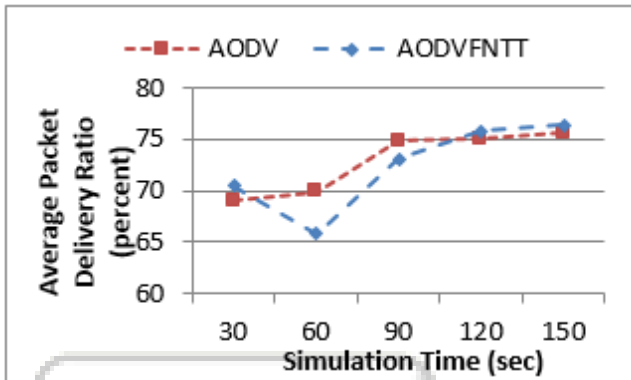


Fig. 14: Average Packet Delivery Ratio using Strict Priority type Scheduler

Figure 12, 13, 14 shows the routing overhead, average throughput and average packet delivery ratio respectively using self-clocked fair type scheduler. Since increase in the value node traversal time also increases the value of net traversal time this will reduce the overhead and increases the throughput as well as packet delivery ratio.

From all the results it has been observed that for all types of scheduler, AODV protocol with fuzzy based node traversal time gives better results than conventional AODV protocol.

VIII. CONCLUSION

In the proposed work, an efficient method to optimize node traversal time of AODV protocol using fuzzy logic controller has been proposed. The performance of the whole work in terms of routing overhead, average throughput and average packet delivery ratio using conventional AODV and AODV with fuzzy based NTT for different types of scheduling techniques have been compared. From the simulation results it can be deduced that AODV protocol with fuzzy based node traversal time performs better in terms of routing overhead, average throughput and average packet delivery ratio. On the basis of this work it can be concluded that instead of default value of NTT, the value can be determined accurately and dynamically through fuzzy logic controller and this gives better results than default.

REFERENCES

[1] C.E. Perkins, E.M. Royer and S. Das, "Ad-hoc on demand distance vector (AODV) routing", *IETF*

internet draft, draft-ietf-manet-aodv-08.txt, march 2001.

[2] Subramanya Bhat.M, Shwetha.D, Devaraju.J.T, "A performance study of proactive, reactive and hybrid routing protocols using qualnet simulator", *international journal of computer applications* (0975 – 8887) volume 28– No.5, august 2011.

[3] Mukesh Kumar Garg, Dharam Vir, Dr. S.K. Agarwal, "Simulation analysis of AODV, DSR and ZRP routing protocols in manet using qualnet 5.0 simulator", *International journal of scientific and research publications*, ISSN 2250-3153, volume 3, issue 3, March 2013.

[4] Rekha Chakravarthi, "A fuzzy approach to detect and control congestion in wireless sensor networks", *indian journal of computer science and engineering (IJCSSE)*, ISSN 0976-5166, volume 3, no 3, jun-jul 2012.

[5] E. Natsheh, S. Khatun and A. Jantan, "A model of route lifetime optimization with linguistic knowledge in wireless ad-hoc networks", *mathware & soft computing* 16 (2006), 23-36 .

[6] Xiao SHU, Xining LI, "Relations among mobility metrics in wireless networks", *I. J. communications, network and system sciences*, 3, 207-283, august-2008.

[7] Swaroop R.Puranik, Vijayalakshmi M, Lingangouda Kulkarni, "A Survey and Analysis on Scheduling Algorithms in IEEE 802.16e (WiMAX) Standard", *International Journal of Computer Applications* (0975 – 8887) Volume 79 – No 12, October 2013.

[8] K. Narasimha Raju, Dr. S.P. Setty, "Implementation of fuzzy logic based node traversal time performance enhanced AODV in mobile ad-hoc networks", *International Journal of Advances in Computer Science and Technology*, vol.3, no.3, march2014.