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Research Article

COMPARISON AODV AND DSDV ROUTING PROTOCOLS WITH USING FUZZY LOGIC IN THE MANET

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ABSTRACT
Mobile ad hoc networks have consisted of the nodes which are freely displaced. In other words, this network has dynamic topology. Routing protocols find route of forwarding data packets from the source node to the destination node. A routing protocol plays important role in finding the shortest time and the route path. In this paper, considering significance of the subject, attempt has been made to present a model using fuzzy logic approach to evaluate and compare two routing protocols i.e. AODV DSDV using effective factor of the number of nodes based on 2 outputs of delay and throughput rate (totally fuzzy system with four outputs) in order to select one of these two routing protocols properly under different conditions and based on need and goal. To show efficiency and truth of fuzzy system, two protocols have been evaluated completely equally using NS-2 simulator and attempt has been made to prove efficiency of the designed fuzzy system by comparing results of simulation of fuzzy system and NS-2 software.

Keywords: AODV routing protocol, DSDV routing protocol, fuzzy expert system, MANET.

INTRODUCTION

Mobile ad hoc network is a type of ad hoc wireless networks which has become highly important in wireless communication. This network has composed of a set of wireless nodes and mobile phones and computer can play role of these nodes. Routing in these networks is complex and difficult because there is no fixed topology and nodes are freely displaced. In these networks, each node plays role of a router. Military networks, crime management networks etc. can be among the examples of mobile ad hoc network. One of the most important issues in ad hoc networks is routing. There are different types of routing protocols such as AODV and DSDV routing protocols. This paper analyzes and evaluates these two protocols with fuzzy logic and NS-2 simulator. This paper is organized as follows: previous works, relates to concepts mentioned in this paper, the designed fuzzy system, results of simulation are mentioned with NS-2 software and at the end, result of the research is mentioned.

PREVIOUS WORKS

Good studies have been conducted so far to evaluate and analyze routing protocols in ad hoc networks some of which we describe here. Morshed et al. in their paper compared AODV and DSDV protocols with different parameters. In their test, they showed that AODV protocol was better than DSDV routing protocol for real time applications [1]. Mohapatra et al. in their paper analyzed function of several routing protocols on ad hoc network and studied delay, throughput and packet delivery [2]. Odeh et al. analyzed and compared function of two protocols i.e. DSR and

AODV. Criterion for their comparison was data packet size. They found that DSR protocol had better function for packet of below 7 bytes [3]. Boukerche et al. studied and compared AODV, PAODV, CBRP, DSR, DSDV protocols and found that DSR and CBRP routers had higher power compared with other protocols [4].

STATEMENT OF CONCEPTS

In this Section, we introduce two AODN and DSDV routing protocols in this paper.

A. Routing in mobile ad hoc network

Ad hoc networks are classified into two groups including mobile ad hoc network and intelligent sensor network. Mobile ad hoc network has composed of wireless nodes. Nodes are freely displaced. In other words, this network has dynamic topology. Figure 1 shows an mobile ad hoc network. Routing is difficult in this network. In order to send data soundly and with low delay to destination, routing protocols should be used. DSDV and AODV protocols are of the popular protocols which are evaluated and compared with different nodes size.

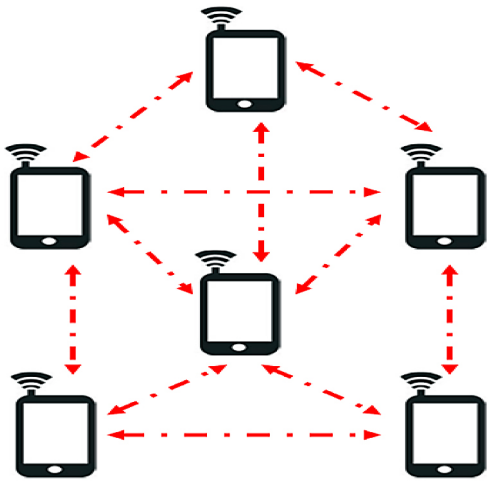

Fig. 1. Ad hoc network

The above figure shows an ad- hoc network and each one of these nodes can be regarded as a router or can have a middle node for routing to send data from the source to the destination.

B. DSDV routing protocol

This protocol performs routing with Bellman–Ford algorithm. Each node has a routing table which is updated continually and periodically. The inputs which are located in routing table include the number of nodes for reaching destination, sequence numbers for reaching destination which is generated by the destination node and is the destination address [2, 5]. Data packets are transferred to nodes with routing table. Preventing creation of loop is one of the features of this protocol.

C. AODV routing protocol

This protocol discovers route with request approach. In other words, this protocol finds routes with RREQ, RREP and RERR messages. When the source node wants to send data to destination, source node first broadcasts messages called RREQ to its neighbor nodes. When the RREQ message reaches destination node, the destination node will send its response to the source node from the same previous path with RREP message and it means that the route has been found from source to destination and the source node can send its data. One of the features of this protocol is that it performs routing action only if necessary. ADOV protocol uses a routing method and acts similarly to DSR [6, 7, 8].

As mentioned above, the source node first broadcasts its route request among neighbors and the node forwards its response message into the source node. Figure 2 shows message broadcasting procedure. This figure has 8 nodes in which node A has role of source and H has role of destination. Node A broadcasts route request among the neighboring nodes and also neighboring nodes route request source node to another node.

When request message reaches node H or destination node is found, the destination node forwards the response message to node A and the source can send its data. Figure 3 shows response of destination node to the source node.

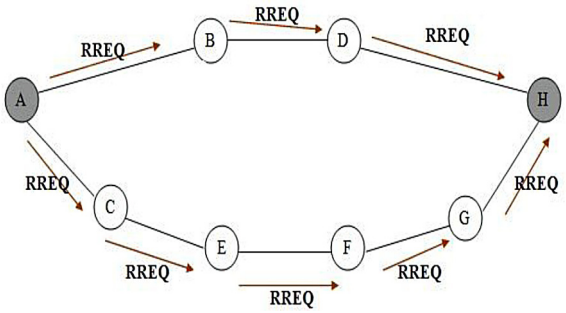

Fig. 2. Sending route request from node A (source)

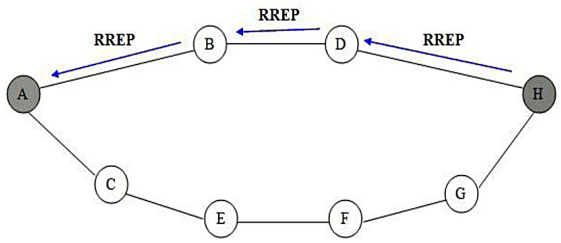

Fig. 3. Sending node H response (destination) to sphere A (source)

FUZZY SYSTEM CONSTRUCTION

In this Section, we introduce the proposed fuzzy system for evaluation of two AODV and DSDV and stages of fuzzy system construction are described as follows:

A. Fuzzy system

Fuzzy systems are able to make decision and control a system with expert systems so that the most applicable case for using them is to model relations in complex medium or anywhere which there is no clear model in the system such that it makes conclusion and decision for the system by relying on some inputs and their results. It is very complex to recognize reasons for efficiency of a test technique. The following Figure shows general diagram of MANET model with fuzzy system. The most important idea in use of fuzzy system which has been shown in Figure 4 is that verbal words are transferred to fuzzy system and the fuzzy system expresses efficiency of the protocols under different conditions considering the signs which have been shown with verbal words.

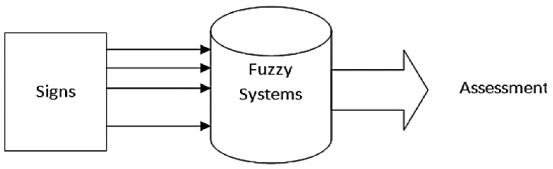

Fig. 4. Function of Fuzzy system

In the fuzzy system, we have used rules as Relation 1 to model the concepts [9].

$$if x_1 is A_1^1, \ldots, x_m is A_m^1 then y = B^1 \qquad (1)$$

Utilized membership functions are triangular, yet they have different number of variables. This difference roots in natural quiddity of parameters such as degree of anemia.

The most paramount reasons justifying use of fuzzy systems are Annabelle Mercier [2005], Kim-Hui Yap [2005]:

- The sophistication of natural world which leads to an approximate description or a fuzzy system for modeling.
- Necessity of providing a pattern to formulate mankindknowledge and applying it to actual systems.

Thus, the following procedure is considered to define expert fuzzy system:

- Defining input-output sets which accept normalized input-output pairs.
- Generating if-else fuzzy rules based on input-output pairs.
- Creating fuzzy rule base.
- Implementing fuzzy system based on fuzzy rules.

In this artical we utilize product inference engine, singleton fuzzifier and center average defuzzifier in order to build fuzzy system. In our inference engine we also used Mamdani product implication and individual-rule based inference combined with algebraic summation and mulitplication for t-norms and max for s-norms. Thus, product inference engine can be written as denoted by equation (2) [9]:

$$\mu_{B'}(y) = \max_{l=1}^{n}[\sup(\mu_{A'}(x)\bigcup_{i=1}^{k}\mu_{A_i^l}(x_i)\mu_{B'}(y))] \qquad (2)$$

In this fuzzy system, singleton fuzzifier and average defuzzifier are utilized. Singleton fuzzifier is widely applied as it simplifies calculation of inference engine. Moreover, center averages defuzzifier is the most popular defuzzifier used in fuzzy systems and fuzzy control systems owing to its simplicity, justifiability and continuity. Center average defuzzifier is calculated as shown in equation (3) [10]:

$$s(A_j \Rightarrow Classh) = \frac{1}{m}\sum_{x_p \in Classh}\mu_{A_j}(x_p) \qquad (3)$$

B. Input–output parameters of the fuzzy systems

As mentioned before, 1 factor of the number of nodes has been used in this system for evaluation of two AODV, DSDV routing protocols as input parameter and based on this input factor, effect of the factor on two AODV, DSDV routing protocols is studied but as mentioned above, other factors such as nodes searching speed, number of packets etc. are also effective on evaluation of two AODV and DSDV routing protocols. As a

result, it is not possible to determine efficiency of two AODV and DSDV routing protocols under different conditions but attempt has been made to calculate efficiency of two AODV and DSDV routing protocols with a fuzzy system using this single factor for taking suitable measures. Therefore, the above fuzzy system has four outputs which show efficiency of two AODV and DSDV routing protocols based on different input states.

In this research, FIS tools were used in Matlab software to determine efficiency of test technique and its general diagram is shown in Figure 5.

This system has 1 input field which relates to factor affecting evaluation of two AODV and DSDV routing protocols and three classes i.e. low, normal and high verbal words have been assigned to each factor and 4 output fields which show efficiency of two AODV and DSDV routing protocols and the output has been classified into three groups and low, normal and high verbal words have been assigned to each factor. In Figures 6 and 7, one of the membership functions of input and output parameters is shown.

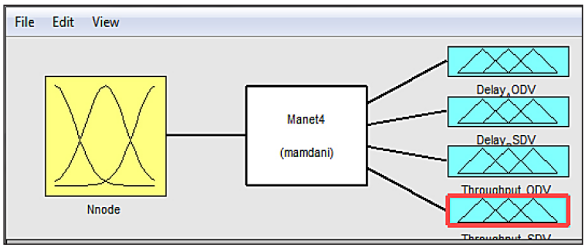

Fig. 5. General model of fuzzy expert system for evaluation of two AODV and DSDV routing protocols

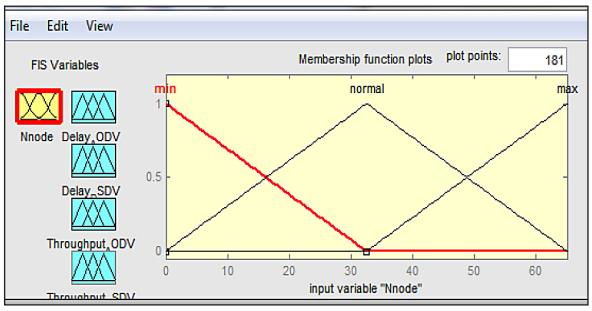

Fig .6. Membership function relating to input of the number of node

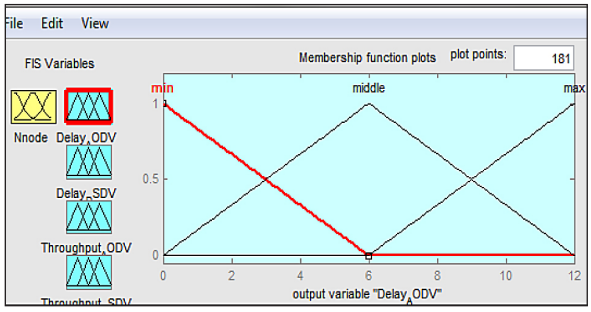

Fig .7. Membership function relating to delay of AODV routing protocol

C. Construction of rules database

A simple method for generation of fuzzy rules is clustering of input features with specified number of fuzzy membership functions (for example, triangular membership function and assignment of verbal words to each cluster). With the classified space for each model, one way for generation of fuzzy rules is to consider all possible combinations of antecedents (input features) and this method has been also used in this research.

D. Fuzzy if–then rules

With the mentioned facts, we write if-them rules as follows:

1. If (Nnode is normal) then (Delay_AODV is middle) (Delay_DSDV is max) (Throughput_AODV is max) (Throughput_DSDV is max).
2. If (Nnode is max) then (Delay_ AODV is min) (Delay_DSDV is max) (Throughput_AODV is max) (Throughput_DSDV is min).
3. If (Nnode is min) then (Delay_AODV is max) (Delay_DSDV is min) (Throughput_AODV is min) (Throughput_DSDV is min).

E. Simulations and statement of results of fuzzy system

As mentioned above, MATLAB software which is a suitable medium for simulation of such systems has been used. Simulation of two cases of tests with 15 and 35 nodes is given in Figures 8A and 8B we then showed results ob-

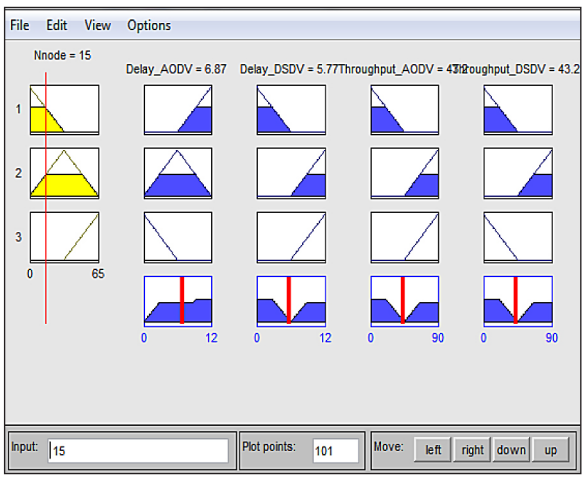

Fig. 8A. Results of simulation with 15 nodes

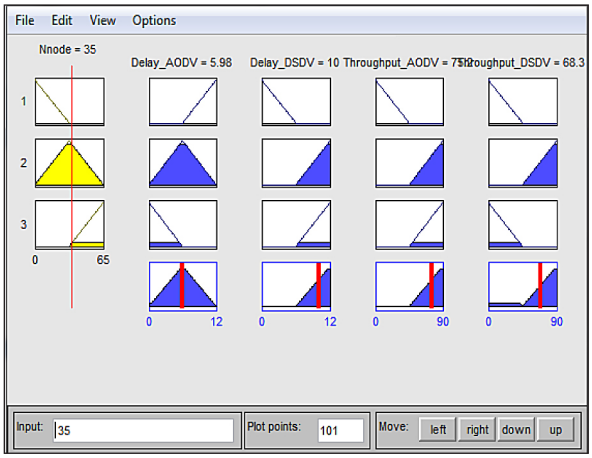

Fig. 8B. Results of simulation with 35 nodes

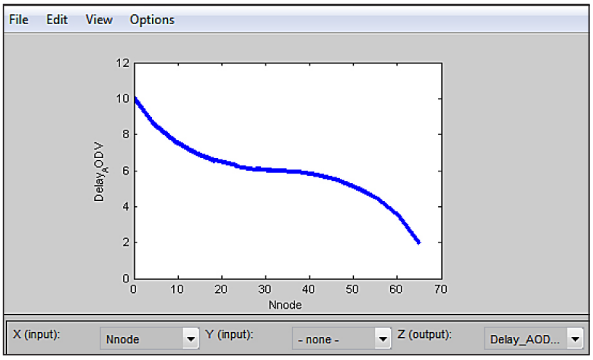

Fig. 9A. Effect of number of node on output of delay in AODV protocol

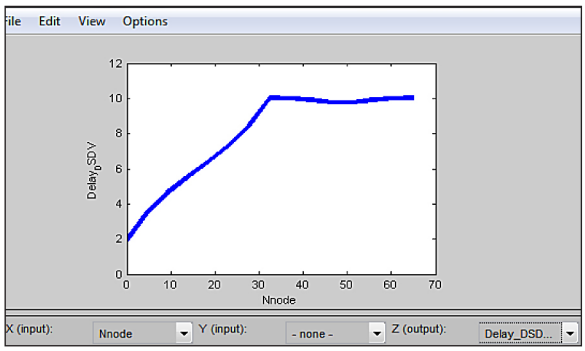

Fig. 9B. Effect of number of node on output of delay in DSDV protocol

tained from effect of the number of node on output as 2D which has been obtained in the simulation model.

F. Results

Results of fuzzy expert system for two outputs of delay and throughput are given in Table 1. The results for two protocols which have been tested with nodes 10, 15, 25, 35, 45, 55 and 65 are shown in Figure 10A and 10B. The obtained results show that AODV protocol has lower delay

Table I. Results of the experiment

Number of nodes	Delay (sec)		Throughput rates (kb)	
	AODV	DSDV	AODV	DSDV
10	7.5	4.79	35.9	35.9
15	6.87	5.77	43.2	43.2
25	6.17	7.75	5S.1	58.1
35	5.98	10	75.2	68.3
45	5.56	9.S2	73.3	50.3
55	4.5	9.S9	74.2	35.9
65	1.96	10	75.3	14.7

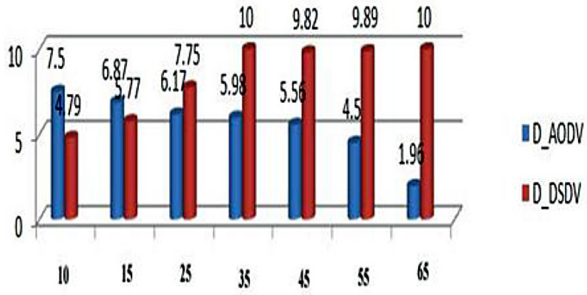

Fig. 10A. Bar chart of delay

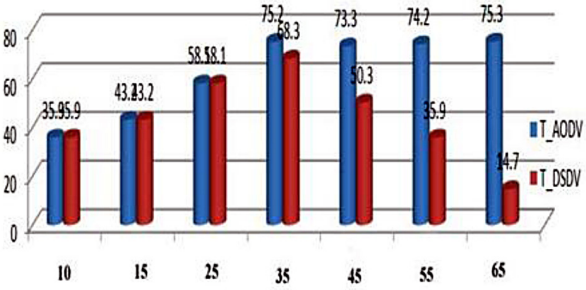

Fig. 10B. Bar chart of Throughput

rate and higher throughput than DSDV protocol with increasing the number of nodes.

Results obtained from execution of the designed fuzzy system for the number of different nodes are exactly mentioned in Table 1. Now, we have evaluated and simulated two AODV and DSDV routing protocols for the number of similar nodes with NS-2 software in order to show performance and reliability of the proposed fuzzy system by comparing results of executing fuzzy system and NS-2 software with each other.

SIMULATION AND STATEMENT OF RESULTS WITH NS-2 SOFTWARE

In this Section, we compare two AODV and DSDV routing protocols by performing test and NS-2 software has been used to simulate the pro-

tocols and NS2 Visual Trace Analyzer software has been used to analyze the results. Our evaluation criterion is condition of the sent packets, the maximum delay and maximum forwarded data per second. Each one of them is discussed here. The settings which have been done for analysis of this test are shown in Table 2. Figure 11 shows simulation medium and Figure 12 shows layout of nodes in which number zero is source node and node number 1 is destination node.

Table 2. Parameters used for simulation

Parameter	Values
Channel type	Channel/Wireless channel
Number of nodes	10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65
Simulation time	150 sec
Area of simulation	500x500
Routing Protocol	AODV, DSDV
Mac Type	802.11
Data Type	TCP/FTP
Interface queue type	QueuelDrop Tail

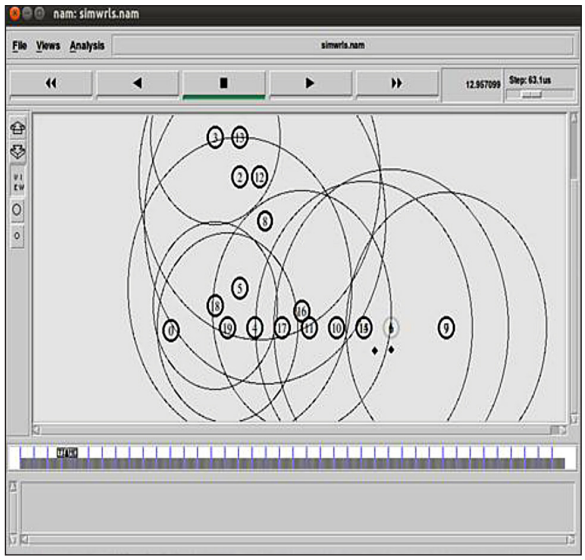

Fig. 11. Simulation medium with NS2 software

A. The forwarded packets

In this Section, condition of the packets which have been generated, dropped and transferred are shown with different nodes with both protocols.

Figure 13 shows the generated packets, dropped packets and transferred packets for AODV protocol with different nodes. For example, a test has been done on 10 nodes in this Figure. There are 4038 TCP packets and 13 packets have been

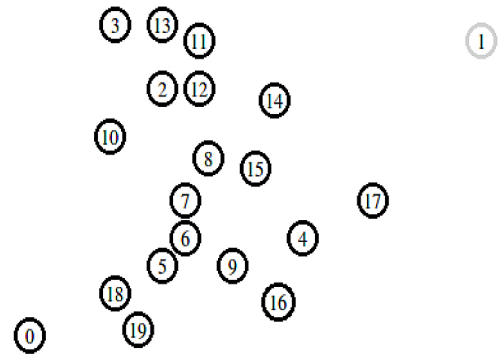

Fig. 12. Layout of nodes with 20 nodes in which node number zero is source and node number 1 is destination

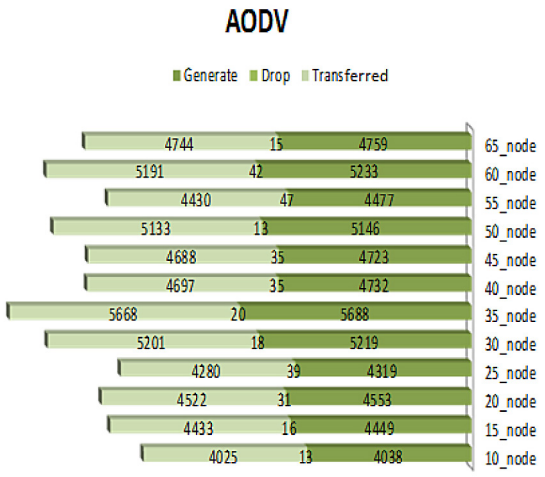

Fig. 13. The forwarded packets with AODV protocol

dropped. The number of packet which has been transferred from source to destination is 4025. Considering this Figure, it can be said that with increasing the number of nodes, the number of packets forwarded from source to destination increases.

Figure 14 shows the generated packets, the dropped packets and transferred packets for DSDV protocol with different nodes. For example, there are 4726 TCP packets in the test which has been performed on 10 nodes and the number of the dropped packet is 41 and also the number of transferred packet from source to destination is 4685.

B. Maximum delay of both protocols

In Figure 15, maximum delay of protocols is shown as line chart for both protocols. Considering the following Figure, it can be mentioned that although we see high delay rate in AODV protocol by analyzing 10 nodes, we see lower delay rate with increasing the number of nodes. Therefore, it can be said that AODV has lower delay rate.

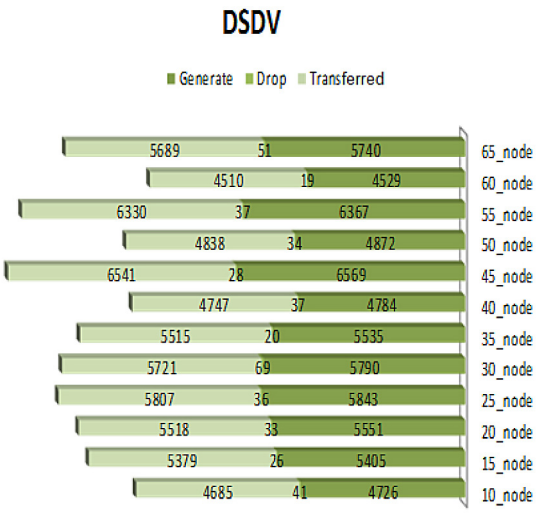

Fig. 14. Number of the forwarded packets with number of different nodes for DSDV protocol

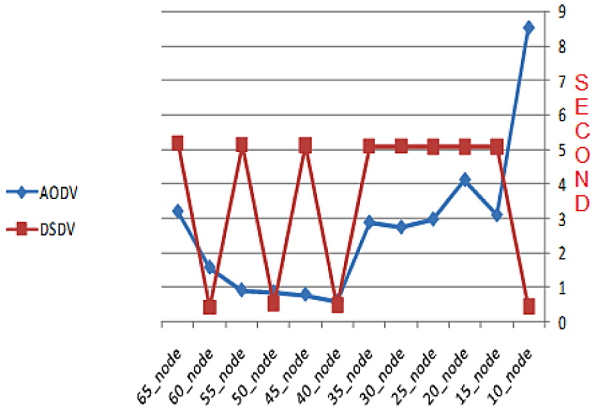

Fig. 15. Maximum delay of protocols as line chart

CONCLUSION

In this paper, fuzzy system has been designed to evaluate two DSDV and AODV protocols in mobile ad hoc network and to prove truth of the fuzzy system, we compare results of comparing two protocols with NS-2 software and the results show that the designed fuzzy system has suitable efficiency for proposing and selecting one of these two routing protocols principally and logically under different conditions and based on different applications. It can be generally said that AODV protocol has better performance than the DSDV protocol in terms of the data transfer rate per second and delay rate with increasing the number of node in the network. Generally, we can say that goal of designing the fuzzy system in this paper is to help ordinary user select type of the routing protocol only based on information of ordinary user (even if the user has no accurate information about routing protocols of Manet networks) and only based on personal discernment of the user regarding the number of nodes based on application of network as verbal words (high-low-medium).

REFERENCES

1. Morshed Md Monzur, Franz Is Ko, Dongwook Lim, Md Habibur Rahman, Md Rezaur Rahman Mazumder, and Jyotirmoy Ghosh. Performance evaluation of DSDV and AODV routing protocols in mobile ad-hoc networks. In: New Trends in Information Science and Service Science (NISS), 4th IEEE International Conference on, 2010, 399-403.
2. Mohapatra S. and Kanungo. Performance analysis of AODV, DSR, OLSR and DSDV Routing Protocols using NS2 Simulator. Procedia Engineering, 30, 2012, 69-76.
3. Odeh A., Eman A.F. and Muneer A. Performance Evaluation of AODV and DSR Routing Protocols in MANET Networks. International Journal of Distributed and Parallel Systems (IJDPS) Vol. 3, 2012.
4. Boukerche A. Performance evaluation of routing protocols for ad hoc wireless networks. Mobile Networks and Applications 9(4), 2004, 333-342.
5. Ramesh V., Subbaiah P., Koteswar Rao N. and Janardhana Raju M. Performance Comparison and Analysis of DSDV and AODV for MANET. International Journal on Computer Science and Engineering 2(2), 2010, 183-188.
6. Gupta S.K. and Saket R.K. Performance metric comparison of AODV and DSDV routing protocols in manets using ns-2. IJRRAS, Vol. 7(3), 2011, 339-350.
7. Bhosle A.A. and Tushar P.T. International Journal of Computer Science, Engineering and Applications (IJCSEA). Black-Hole and Wormhole Attack in Routing Protocol AODV in MANET, 2(1), 2012, 45-54.
8. Rahman Abdul Hadi Abd, and Zuriati Ahmad Zukarnain. Performance comparison of AODV, DSDV and I-DSDV routing protocols in mobile ad hoc networks. European Journal of Scientific Research.
9. Zadeh LA., Fuzzy Logic, Neural Networks and Soft Computing, Com. of the ACM, vol. 37, 1994, 77-84.
10. Ishibuchi H., Nozaki K., Yamamoto N., Tanaka H., Construction of fuzzy classification systems with rectangular fuzzy rules using genetic algorithm, Fuzzy Sets and Systems, Vol. 65, 1994, 237-253.