Energy consumption of reactive and proactive protocols in mobile ad hoc network in fuzzy inference system

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ABSTRACT

The designing of an efficient routing protocol is a fundamental problem in a Mobile Ad-Hoc Network (MANET). This paper evaluates three ad-hoc network protocols (AODV, DSR & DSDV) in different network scales taking into consideration the mobility factor. It evaluates the performance of various ad hoc routing protocols such as DSR, DSDV and AODV in terms of energy efficiency by varying pause time, node velocity and packet sending rate. It has been verified through extensive simulations using MATLAB, which represent a wide spectrum of network conditions. AODV, DSR delivers the better performance as that of the state-of the art algorithms DSDV. Here, we present a performance comparison of the DSR, AODV and DSDV routing protocols with respect to energy consumption, evaluating how the different approaches. This paper identifies the security issues; challenges to security design and review the state-of-the-art security proposals that protect the MANET link and network-layer operations of delivering packets over the multihop wireless channel.

I. INTRODUCTION

Recently there has been a lot of interest in building and deploying sensor networks – dense wireless networks of heterogeneous nodes collecting and disseminating environmental data.Routing is one of the key issues in MANETs due to their highly dynamic and distributed nature also because the use of mobile networks is growing very fast. In particular, a very large number of recent studies focused on Mobile Ad-hoc Networks (MANETs) [1,2]. The performance of a mobile ad-hoc network depends on the routing scheme employed, and the traditional routing protocols

do not work efficiently in a MANET. Various protocols have been developed for ad hoc networks such as DSDV (Destination-Sequenced Distance Vector) ,DSR(Dynamic Source Routing) and AODV(Ad-Hoc On Demand Routing). These protocols offer varying degrees of efficiency [3]. In this paper, we'll concentrate on the routing problem. Current research has focused on protocols that are low power [4][5][6], scalable with the number of nodes [7] and fault tolerant (to nodes that go up or down, or move in and out of range) [8]. In Goswami et al. [9], determined a difference between routing protocols performance when operating in large area MANET with high speed mobile nodes. In Goswami et al. [10], evaluates the performance of various ad hoc routing protocols such as DSDV and AODV in terms of energy efficiency by varying pause time, node velocity and packet sending rate. Some of the previous work regarding energy efficient routing in *mobile ad-hoc networks* (MANETs) focused on performance comparison of existing ad hoc routing protocols (such as DSR, AODV and DSDV [11]) with respect to energy consumption (e.g. [12]). Recently, new power aware routing protocols for MANETs have been proposed. In Gomez et al. [13] a new technique has been introduced as a power aware enhancement for MANET routing protocols.

However, we think that a more useful metric for routing protocol performance is *network survivability*. By this we mean that the protocol should ensure that connectivity in a network is maintained for as long as possible, and that the energy health of the entire network should be of the same order. This is in contrast to energy optimizing protocols that find optimal paths and then burn the energy of the nodesalong those paths, leaving the network with a wide disparity in the energy levels of the nodes, and eventually disconnected subnets. Energy Aware Routing, the protocol that we have developed tries to ensure the survivability of low-energy networks. It is also a reactive protocol such as AODV and directed diffusion; however, the protocol does not find a *single* optimal path and use it for communication. Rather it keeps a set of *good* paths and chooses one based on a probabilistic fashion. As we will show later, this means that instead of a single path, a communication would use different paths at different times, thus any single path does not get energy depleted. It is also quick to respond to nodes moving in and out of the network, and has minimal routing overhead.

II. FUZZY SYSTEM:

Fuzzy logic is an approach to computing based on "degrees of truth" rather than the usual "true or false" (1 or 0) logic on which the modern computer is based. Fuzzy logic includes 0 and

1 as extreme cases but also includes the various states of truth in between. There are two types of Fuzzy logic inference system (FIS). One is Mamdani type and the other is Sugeno type FIS. Mamdani type system is very popular and is commonly used. In this paper, Mamdani type FIS has been used because it gives non-linear and variable fuzzy outputs.

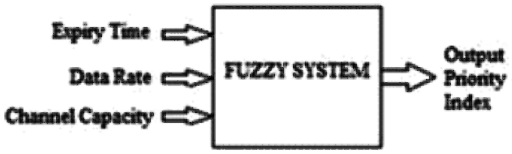

Fig.1. Fuzzy Seheduler

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

- Defining input-output sets which accept nor-malized input-output pairs.
- Generating if-else fuzzy rules based on input-output pairs.
- Creating fuzzy rule base.
- Implementing fuzzy system based on fuzzy rules.

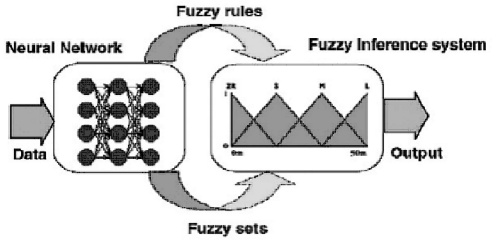

Fig.2. Fuzzy Inference System model

Fuzzy if–then rules

We write if-them rules as follows:

For Energy Consuption

1) If (Node is min) then (AODV-Energy is Normal) (DSDV- Energy is Min) (DSR-Energy is normal).
2) If (Node is normal) then (AODV- Energy is Max) (DSDV- Energy is Normal) (DSR-Energy is Normal).
3) If (Node is max) then (AODV- Energy is normal)) (DSDV- Energy is min) (DSR-Energy is normal).

III. RESULTS

The aim of these simulations is to analyze the DSDV protocol by comparing it with other protocols (AODV & DSR) for its efficiency in terms of power. This has been made by measuring the energy with respect to different network size and taking into consideration the remaining battery power. The simulation tool that has been used in this study is matlab [12]. So matlab is selected for evaluating these protocols. We simulate performance with different node such as 10, 15, 20, 30, 40 .

A Mamdani neuro-fuzzy system uses a supervised learning technique (back propagation learning) to learn the parameters of the membership functions.

In Fuzzy system, 1 factor of the number of nodes has been used in this system for evalu-ation of three AODV, DSDV and DSR routing protocols as input parameter and based on this input factor, effect of the factor on three

AODV, DSDV and DSR rout-ing . In this paper, Fuzzy system tools are used in Matlab software to determine efficiency of the test technique .

This system has 1 input field which relates to factor affecting evaluation of three AODV, DSDV and DSR routing protocols and three classes i.e. min, normal and max verbal words have been as-signed to each factor and 3 output fields which show efficiency of three AODV, DSDV and DSR rout-ing protocols and the output has been classified into three groups and low, normal and high verbal words have been assigned to each factor. In Fig-ure 3, one of the membership functions of input and output parameters are shown.

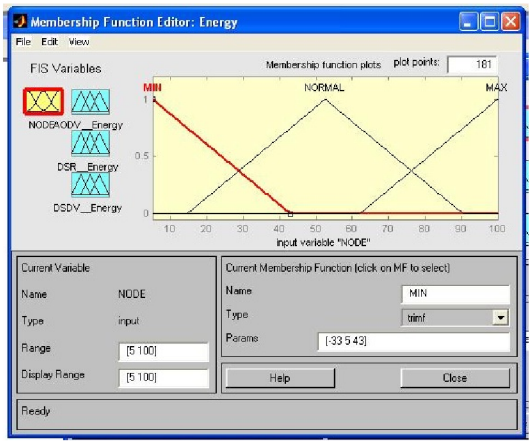

Fig.3. Membership function relating to input of the number of node

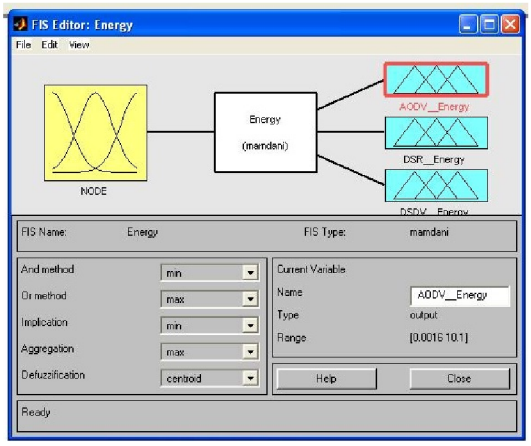

Fig. 4. General model of fuzzy expert System for evaluation of three routing Protocol

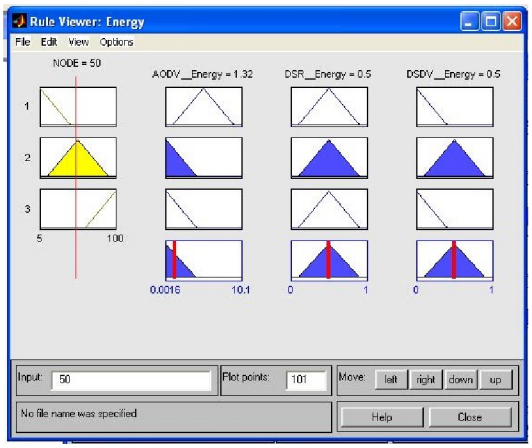

Fig. 5. Result of simulation with 50 nodes

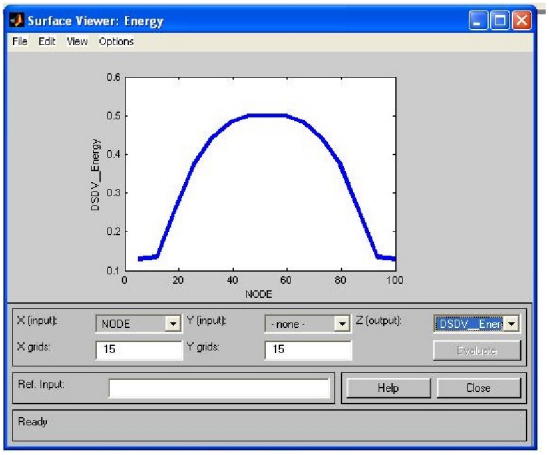

Fig. 6. Effect of number of node on output of energy in DSDV protocol

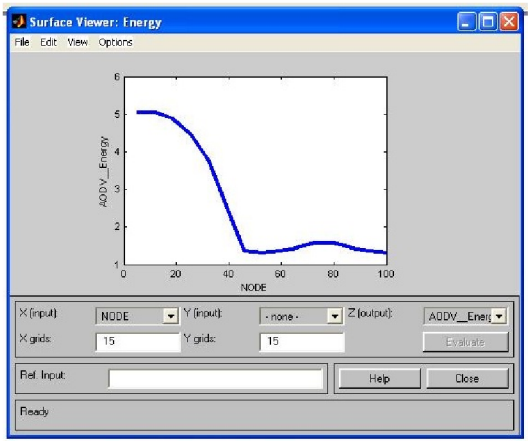

Fig.7. Effect of number of node on output of energy in AODV protocol

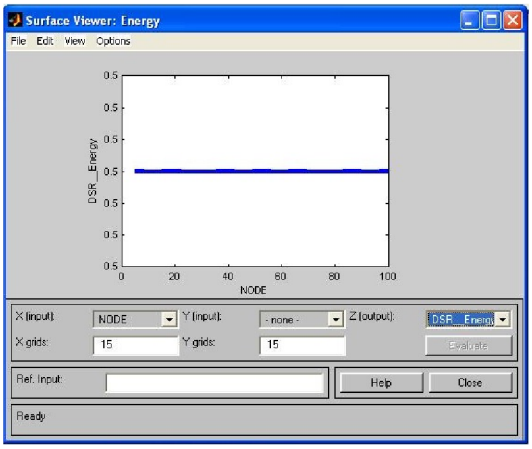

Fig. 8. Effect of number of node on output of energy in DSR protocol

IV. RESULT DISCUSSION

In the following section, the results obtained from our simulations are elaborated. One different performance variable is reported; low capacity radios utilization and the average number of hops required establishing energy consumption.

The utilization of low capacity packet is the ratio of total links established over low capacity channels compared to the total links. Average hop count is an average of end-to-end hops required to reach destination.

As mentioned above, MATLAB software which is a suitable medium for simulation of such systems has been used. Simulation of one case of tests with 50 nodes is given in Fig. 3., Fig. 4. and Fig. 5. The result obtained from effect of the number of node on out-put as 2D

which has been obtained in the simula-tion model. Fig. 5. shows the effect of number of node on output of energy consumption in AODV, DSDV and DSR protocol. Fig. (6,7, 8) shows the effect of number of node on output of energy consumption in AODV, DSDV and DSR protocol. After analysing the above figures we may conclude that AODV and DSR shows the better result in case of energy consumption but DSDV protocol shows the best result in energy consumption parameters if we increase the number of nodes.

In Das et al [14], they tried to extend the lifetime of ad-hoc network with respect to energy efficient multicast routing by calculating route lifetime values for each route. Based on the comprehensive simulation of Fuzzy Based Energy Efficient Multicast Routing using MATLAB and NS2 and comparative study of same with other existing protocols, it is observed that proposed routing protocol contributes to the performance improvements in terms of energy efficiency.

In Razouqi et al. [15] , they concentrated on routing protocols which are widely used in MANET, Destination Sequenced Distance vector (DSDV), Dynamic Source Routing(DSR) and Ad hoc on demand Distance Vector(AODV) routing protocols that are widely simulated in this paper using different scenarios in terms of different traffic types, constant bit rate(CBR), variable bit rate(VBR) then combining both classes in one scenario to scrutinize the impact of this combination. Routing protocols are analyzed against several performance metrics, average energy consumption, average throughput, normalized routing load (NRL), packet delivery fraction(PDF) and total dropped packets(TDP). Combined traffic results shows that DSR and AODV exhibit better behaviours on overall performance metrics examined. For energy consumption, DSDV shows potent response over other protocols when CBR and VBR applied separately, while for shared traffic scenario it shows better performance for lower nodes mobility.

In Goswami et al [10], they evaluated the performance of various ad hoc routing protocols such as DSDV and AODV in terms of energy efficiency by varying pause time, node velocity and packet sending rate. Simulation was done using NS-2. They found that DSDV routing protocol consume 99% energy when node speed is 50 m/s and AODV routing protocol energy consumptions was 100 % when node speed remained same.

In this paper we compare two routing protocol i.e Reactive(AODV & DSR) and Proactive(DSDV) in term of energy consumption behaviour for the three routing algorithms over a wide variety of scenarios and traffic models resulting varying one of the three selected parameters i.e. node velocity, packet

sending rate and pause time. It shows that when the traffic sources numbers increase from 10 sources to 20 sources, routing energy consumption grows 88% in AODV , 78% in DSR & 58 % in DSDV. However, when this factor moves from 20 sources to 30 sources, routing energy consumption grows 70% in AODV , 68 % in DSR & 50 % in DSDV. We observe that DSDV routing protocol consume less energy.

Table 1: Fuzzy value of Input Output Parameter

Groups	*Hop Count*	*Bandwidths (mbps)*	*Battery life (jl)*	*Mobility speed*
AODV	4	55	800	High
DSDV	4	60	300	High
DSR	4	57	300	Medium

The links in the ad hoc network can be broken due to scarce resources like energy, bandwidth, etc. So fuzzy based energy efficient routing protocol uses fuzzy logic and selects multiple routes with very high and high route selection grade. These routes will be in route cache of nodes. During the route maintenance phase, source node checks its route cache for a valid route to destination and transfers the data without any delay. To illustrate the implementation of routing protocol, a hypothetical network is designed to demonstrate the computation of fuzzy systems.

Erengy Consumption in ANOVA Test

Data Energy Energy consumption refers to the amount of energy that is spent by the network nodes within the simulation time. ANOVA statistical computation shows that we do not reject the null hypothesis. That is, there is no significant difference for the different methods in terms of energy performance ($P-value > 0.05$).

Table 2: Summary of Energy

Groups	*Count*	*Sum*	*Average*	*Variance*
AODV	23	7990941	347432.2	8201779957
DSDV	23	8094695	351943.3	20237752574
DSR	23	7267943	315997.5	5554377965

Table for One way ANOVA test in Appendix A In this case, $F_{crit} = 3.135918$ at $\alpha = 0.05$. Since $F = 0.778278814 < 3.135918$, the result are significant at the 5% significance level. So we will accept the null hypothesis, and conclusion can be drawn that there is strong evidence that the expected values in the three groups does not differ. The variation is quite small and can be eliminated at this significance level. The $P-value$ for this test is 0.463364.

V. CONCLUSIONS

This research work proposes the performance of the fuzzy scheduler for ad-hoc network. It is observed from the results that priority scheduling helps in effective routing of packets without minimum loss and with less delay. The performance of the scheduler is analyzed using easuring metrics such as protocol energy

consumption behaviour. The comparison is done for the success rate and the energy consumption for the three routing algorithms over a wide variety of scenarios and traffic models resulting varying one of the three selected parameters i.e. node velocity, packet sending rate and pause time. The results obtained from the simulations allow us to conclude the following as far as energy consumption refers. Generally DSDV performs better than AODV & DSR . Thus DSDV routing protocol performs better than AODV & DSR routing protocol as regards to protocol energy consumptions.

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APPENDIX-A

Erengy Consumption

The one way ANOVA test for Energy is

Table 5: ANOVA of Energy

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.764E+10	2	8.82E+09	0.778278814	0.463364	3.135918
Within Groups	7.479E+11	66	1.13E+10			
Total	7.655E+11	68				