Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/3S7VG

SECURE MULTIPATH COMMUNICATION IN ON-DEMAND ROUTING PROTOCOL USING FUZZY CONTROLLER (FC-AODV) FOR MANET

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Abstract

Ad hoc wireless infrastructure less network which access multi-hop because data communication is established by using multi-hop techniques, generally the ad hoc works different nodes like mobile, sensor, vehicle, laptop, router etc. MANET (Mobile Ad hoc Networks) is collection of independent mobile nodes which communicate through wireless link from source to destination either single hop or multi-hop because no need of central control using self-configuring, infrastructure less and dynamic nature of MANET it can lead more flexibility and more economical also robust network due to temporary devices. Multipath is one of un-avoided concept of MANET they lead to easy communication between two nodes using intermediate hops due to problem of obstacle in active path or network this types of topology is very flexible share information through different paths, they build the topology using topology discovery mechanism and Network library. When the new packet in comes, identify all the paths from source to destination based on algorithm and select the path, the effect of multipath model most of the channels we do not have a single path from S to D the samples of various path is different samples due to collision, misbehavior attack that lead to degrade network performance like delivery ratio, throughput, overhead, energy and delay. In this paper we plan to overcome the above drawbacks we proposed the novel design fuzzy controller through on-demand routing protocol and implement and tested using various parameter such as packet delivery ratio, throughput, remaining energy routing overhead and packet loss using one of leading simulator called Network Simulator.

Keywords: MANET, Multipath, Misbehavior Node, Retransmission, Protocol, Fuzzy Controller.

I. INTRODUCTION

Ad hoc is infrastructure less nontraditional wireless network from node A want to communication to node B through intermediate node because it will work limited range of communication beyond range not been work due to no back bone. Ad hoc self-organization, self-configuration and self-healing because no network will operates they will occur any problem in network simple self-reconfigured this is multi-hop wireless network. Application of ad hoc networks as follows: the group of people with laptop and they want to exchange files and data without having an access point, it suitable for military communication at battlefield where there is no network infrastructure, but there are several challenges that ad hoc network faces like limited wireless range (limited up to some range), hidden terminals (face collision will be occur), packet losses (exposed terminal may be chance of packet drop), route changes (route is frequently changing due to no constant communication because dynamic nature, so routes always chaining),

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devices heterogeneity (each devices having different capabilities because they using different devices/nodes like mobile, laptop, desktop, tablet due to ad hoc is heterogenic network) and battery power constraints (ad hoc network will observe will consume lot of power because they use battery power using routing protocol) as shown in fig 1 basic diagram of ad hoc network.

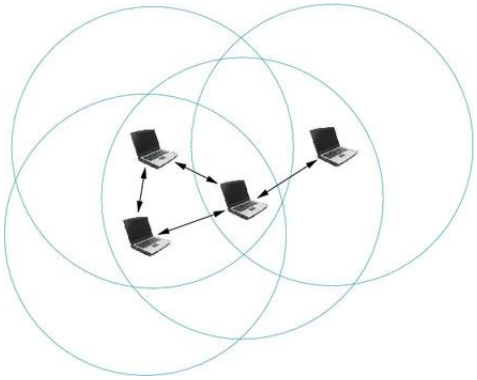

Figure 1 Ad hoc Networks

II. MANET

MANET is type of ad hoc network each device is free to move independently in any direction and will therefore change its links to other device frequently. In MANET each node act as both host and route in autonomous behavior, any time a node can join or leave from the network due to making the network topology dynamic in nature. All nodes have identical (same) features with similar responsibility and capabilities and hence it forms a completely symmetric environment due to mobile nodes are characterized with less memory, power and light weight features. When a source node and destination node for a information is out of radio range, the MANETs are capable of multi-hop routing. Different types of networks are vehicular ad hoc networks (VANETs) in automobile field are used for communication between vehicles and roadside equipment, intelligent vehicular ad hoc networks (InVANETs) are a kind of artificial intelligence algorithm that helps vehicles to behave in intelligent manners during vehicle-to-vehicle collisions & accidents. Smart phone ad hoc networks (SPANs) influence the existing hardware (primarily Bluetooth and Wi-Fi) in commercially available smart phone to create peer-to-peer networks without relying on cellular carrier networks, wireless access points or traditional network infrastructure. SPAN differ from traditional hub and spoke networks, such as Wi-Fi direct in that they support multi-hop relays and there is no notion of a group leader so peers can join and leave at will without destroying the network. Internet-based mobile ad hoc networks (iMANETs) that link mobile nodes and fixed internet-gateway nodes (multiple sub MANET may be connected in a classic hub spoke VPN to create a geographically distributed MANET. It can be lead the following many benefits: 1. scalable (more number of nodes can be formed), 2. The network can be set up at any place and time, 3. Less expensive as compared wired network, 4. They provide access to information and services regardless of geographic position. MANET face various challenges: time varying nature (there are transmission impediments like fading, path

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loss, blockage and interference that adds to the susceptible behavior of wireless channels), limited range of wireless transmission (the data rates are low when compared to the wireless networks), packet losses due to errors in transmission (collision, interference, frequently breakage in paths caused by mobility of nodes, increased collisions due to the presence of hidden terminals problems) frequent network partitions (the random movement of nodes often leads to partition of the network, this mostly affects the intermediate nodes), limitations of mobile nodes (mobile nodes have short battery life) and they have many applications of MANET: business work, military, rescue operation, classroom and conference etc. as shown in fig 2 a simple diagram of mobile ad hoc networks. Router is very essential design to path finding between many devices in the network from source to destination with help of different protocols.

Figure 2 A Simple MANET

III. ROUTING PROTOCOL

How routes communicate with each other, routing protocol use metrics (stranded measurement) to evaluate that path will be the best for a packet travel (information transferring from sore to destination) such as path bandwidth, reliability, delay and current load on that path the following has points has been consider to calculate the metrics. Routing protocols used in wired network cannot be directly applied to ad hoc wireless network due to ad hoc is highly dynamic topology, non-centralized administration, bandwidth constrained and energy constrained because of these reasons they need to design routing protocol for ad of wireless network. Wireless network routing protocol facing the following issues: Security, confidentiality, availability, authentication, integrity, non-repudiation, multipath routing, overhead, delay, collisions, minimum energy consumption, maximize network connectivity and minimum variance in node power levels. Basically mobile ad hoc router model designed three different types (per established connection for proactive, on-demand connection established for reactive and both concept available in hybrid routing protocols) for sharing information between devices in non-fixed network as shown in fig 3 MANET routing protocol.

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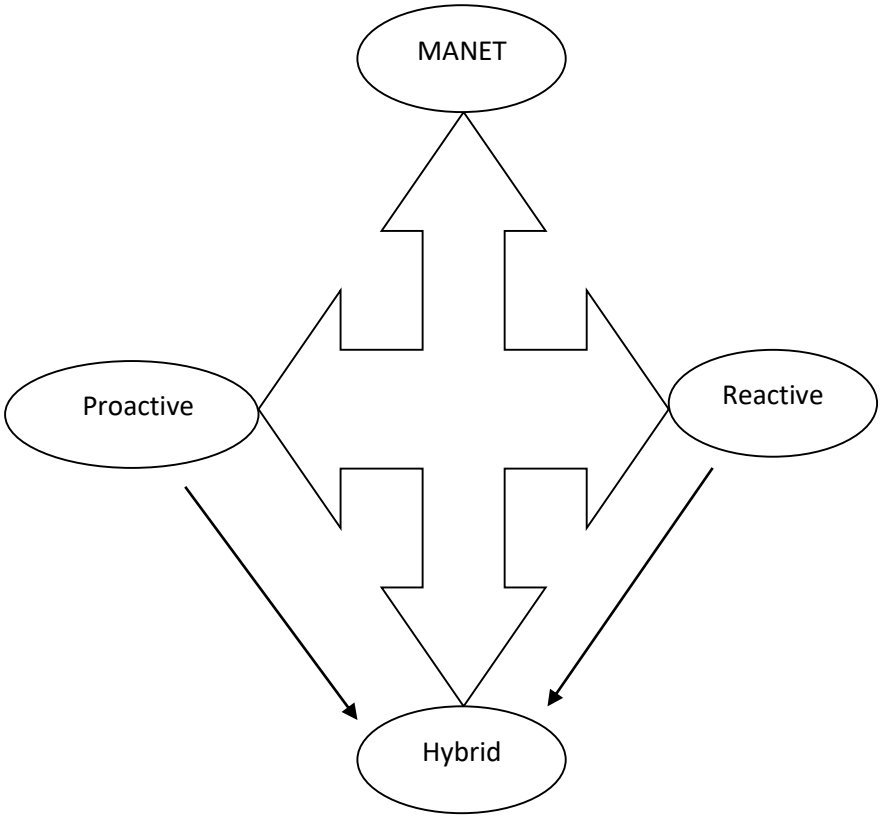

Figure 3 Routing Protocols for MANET

IV. MULTIPATH ROUTING

Multipath importance techniques using alternative multiple path in network which can elide provide such as tolerance increase bandwidth and improving security, the multiple path computing joint and disjoined between nodes in the network, extension of research is going recent years in multipath fading communication based on some criteria like minimum cost, minimum weight, maximum forwarding capability, maximum receiving capability, minimum link breakage path etc. In below figure 4 shows simple diagram of 6 nodes multipath routing, from Node 'S' (source node) want to communicate to Node 'D' (destination node) through intermediate hop source send route request to destination node via B, C, E, F, but between S to D having many paths for the above paths select design, based on above some criteria's select one primary best shortest route, data transmission is started one path selected.

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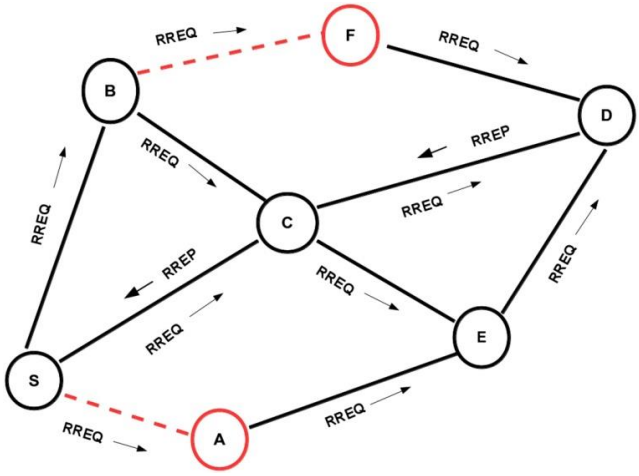

Figure 4 Simple diagram of Multipath Routing

V. BACKGROUND WORK

In section 5 we discussed about technology merits and demerits of existing efficient research work is given below. Developed high throughput based multipath research work done by Douglas S. J. De Couto, et al (2005). Mohammed Tarique et al, (2009) designed and investigated multipath routing protocol provided reliable communication and ensured load balancing as well as improved QoS of MANETs with varies topology level. Multipath routing in MANET which allowed the establishment of multiple paths between a source and destination pair, shortest multipath source routing based on DSR was taken by Zafar et al, (2009). Complete self-configured Secure Energy Efficient (SEC) protocol that was able to create the network and share secure services without any infrastructure. The network allowed sharing resources while offering new services among users in a secure environment analysis by Burmester and de Medeiros (2009). Jiazi Yi, et al. (2010) & Jiazi YI, et al. (2011) proposed multipath dijkstra algorithm using OLSR proactive routing protocol with four different scenarios. May Zin Oo and Mazliza Othman, (2012) they have developed and compared mobility models to measure single path and multipath (proactive and reactive) routing protocols across the mobility models by tuning into TCP and CBR traffic individually. new secure ad hoc on-demand multi-path distance vector protocol is extended called Dolphin Echolocation Algorithm for efficient communication in MANET was designed by Gautam, M. and Mahajan, A.R. (2017). Transition state MAC protocol compared with existing models static power consumption MAC protocol and dynamic power consumption MAC protocol was done by K. Anish Pon Yamini et al. (2019). J. Deepa and J. Sutha (2019) were proposed by A new energy based power aware routing method for MANETs. Fault-tolerant disjoint ad-hoc on-demand multipath distance vector routing algorithm in mobile ad-hoc networks was done by Y. Harold Robinson et al. (2019). Several emerging technology suggested for single & multipath shortest route designed cuckoo search method implemented using Network simulator 2 analyzed by Akram Kout, *et al.* (2018). N.S. Saba Farheen and Anuj Jain, (2020) is discussed predicting the mobile node position and routing based on predicted positions helps to establish routing path with much longevity. Quality of Service based Ad hoc On-

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demand Multipath Distance Vector Routing protocol in mobile ad hoc network was taken by R. Thiagarajan, et al (2021). Most recent energy-efficient load-balancing routing protocol is proposed by Saleh A. Alghamdi (2022) load balanced becomes an urgent necessity and particularly considering the nodes' limited battery resources.

VI. PROBLEM DEFINITION

Network wide multipath routing in MANETs is a vital task of transferring data from a source to the destination. The dynamic nature of MANETs requires the routing protocols to refresh the routing tables frequently while they suffer from transmission congestion which are the results of the broadcasting nature of radio transmission. Since a node in a MANET cannot directly communicate with the nodes outside its communication range, a packet may have to be routed through intermediate nodes to reach the destination. It also becomes essential to monitor the constraints in intermediate nodes (multi-hop routing). Consequently, an efficient routing approach may generate route failures. The simplest scheme of routing in MANET is the one to find a route without malicious nodes. In this research aims provide an unbreakable route to improved remaining energy for the way of secured transmission. Hence, a new routing algorithm named, Ad hoc on-demand Distance Vector with help of Fuzzy Controller (FC-AODV) is proposed.

VII. SIMULATION PARAMETER

In this section, the performance of routing protocol of MANETs in an open environment is evaluated, the simulations are carried out using network simulator (NS 2.34). The mobile ad hoc routing protocols are simulated using this simulator by varying the number of nodes. The IEEE 802.11 Distributed Coordination Function (DCF) is used as the medium access control protocol. The traffic sources are User Datagram Protocol (UDP). Initially nodes are placed at certain specific locations, the simulation parameters are specified below.

Table 1 Simulation parameters

Parameter	Values
Simulation area	700 m * 700 m
Number of nodes	50
Number of packets sender	25
Constant bit rate	4 (packets/second)
Packet size	512 bytes
Initial energy/node	100 joules
Antenna model	Omni directional
Simulation time	500 sec

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VIII. PROPOSED SCHEME

In this section we discussed our proposed reactive routing protocol called ad hoc on demand distance vector with fuzzy controller, the above design focused on increased delivery ratio with help of fuzzy logic (fuzzy logic reduced number of retransmission and reduced used energy). As show in fig 5 is ad hoc on-demand distance vector with fuzzy logic developed reactive routing protocol specially designed for mobile ad hoc networks.

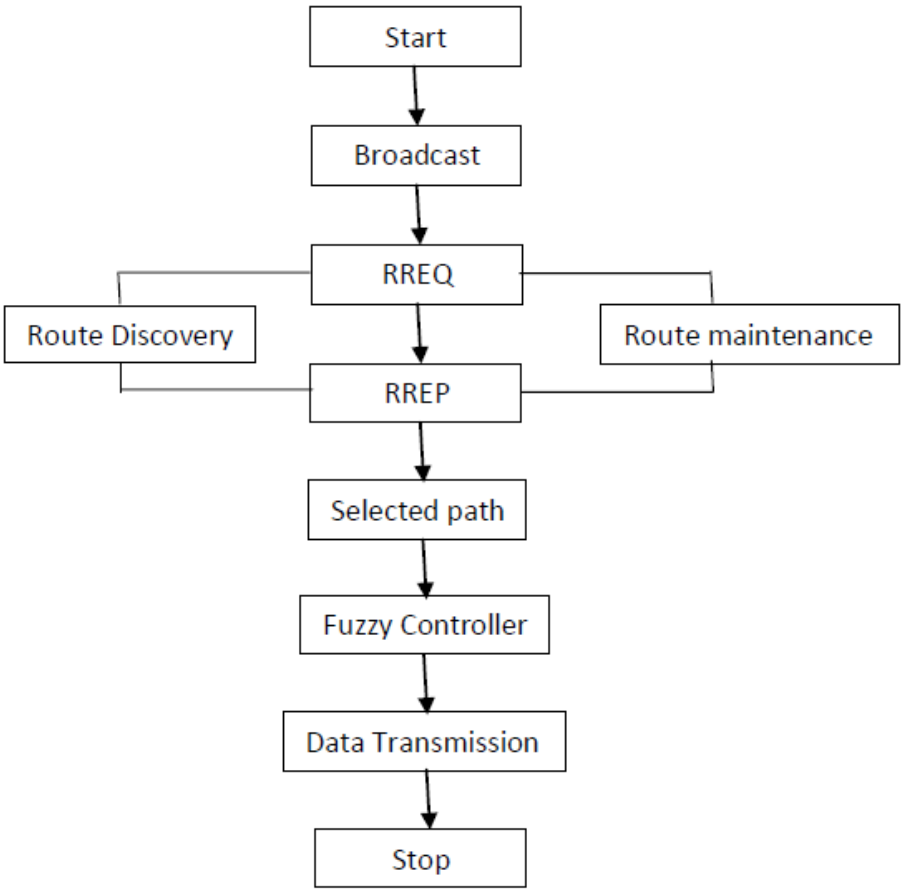

Figure 5 FC-AODV

Above figure clearly show very first from the source node simply broadcast the route request packet (RREQ) to destination through intermediate node, every intermediate node also done same work to other node till they reach destination node. If destination node once receive route request packet from source node, immediately they send route replay packet (RREP) through same intermediate node from destination node to source node this work done every reactive nodes but ADOV having some unique characteristics when start RREQ and RREP at a same time route discovery and route maintenance work symenteneously, the above set of rules designed traditional AODV routing protocol. In this developed work is enhance on-demand routing protocol with help of fuzzy logic, set of rules slightly change also improved network performance due to fixed time period

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cannot able to receive RREP packet simply marked as malicious node because to detect and resolve the misbehaviors node and increased remaining energy due to reduces retransmitting rout request and route replay with help of fuzzy controller table 2 assumed packet type indicators.

Table 2 Packet Type Indicators

Packet type	General packet	RREQ	RREP	FC packet
Packet flag	00	01	10	11

In fig 6 conceptual diagram of fuzzy controller, fuzzy controllers take number of hops, packet queue occupancy and remaining energy along the paths into account while picking routes. The proposed fuzzy routing method is evaluated and compared with conventional AODV routing in terms of packet delivery ratio, throughput, routing overhead, packet loss and remaining energy consumption per node using network simulator 2, proposes a fuzzy path selection based on number of hops and remaining battery power along the path. In our previous papers, the routing decision is shared among the nodes along the path from the source to the destination during the route discovery process using fuzzy controllers which consider number of hops and delay factor. In this paper, we extended the AODV routing protocol to take the remaining battery power and packet queue occupancy in addition to number of intermediate hops as inputs to the fuzzy controller to produce the routes costs to be used in the route selection process. Table 2 identification of different such as 00 general packet, 01 route request, 10 route replay and 11 fuzzy control packet.

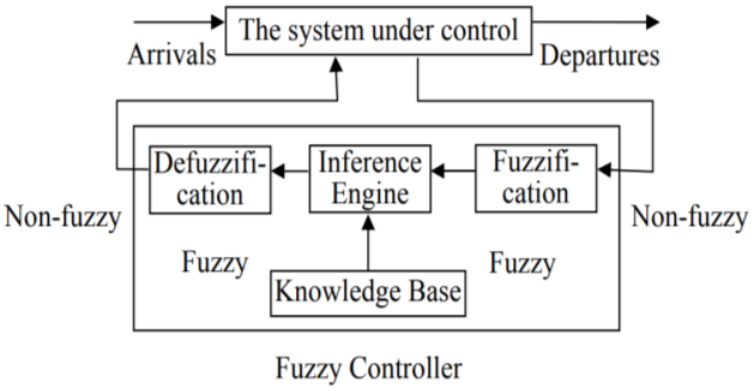

Figure 6 Fuzzy Controller

IX. RESULT AND DISCUSSION

In this section we discussed results and discussion of existing and proposed methods with five different parameters via NS 2.

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Table 3 Results of Parameter Values

Packet Delivery Ratio					
PDR / NN	10	20	30	40	50
AODV	0.75	0.65	0.56	0.44	0.36
FC-AODV	0.85	0.75	0.66	0.54	0.41
Throughput					
Throughput / NN	10	20	30	40	50
AODV	0.65	0.55	0.46	0.34	0.28
FC-AODV	0.75	0.65	0.56	0.44	0.36
Packet Loss					
Packet loss / NN	10	20	30	40	50
AODV	0.03	0.035	0.04	0.05	0.06
FC-AODV	0.02	0.01	0.015	0.02	0.03
Remaining Energy					
Remaining Energy / NN	10	20	30	40	50
AODV	0.92	0.84	0.76	0.72	0.64
FC-AODV	0.95	0.89	0.8	0.76	0.7
Routing Overhead					
Routing Overhead / NN	10	20	30	40	50
AODV	0.23	0.33	0.43	0.53	0.63
FC-AODV	0.18	0.28	0.38	0.48	0.58

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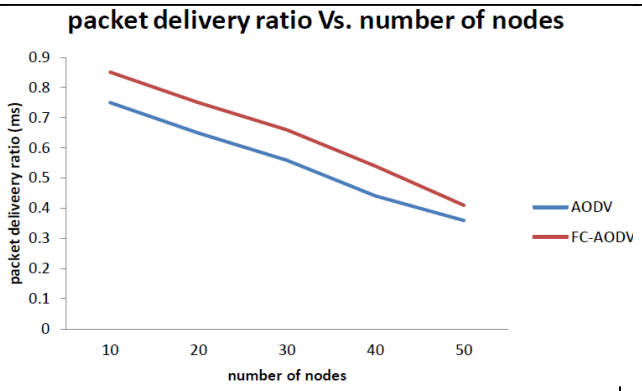

Figure 7 packet delivery ratio Vs. number of nodes

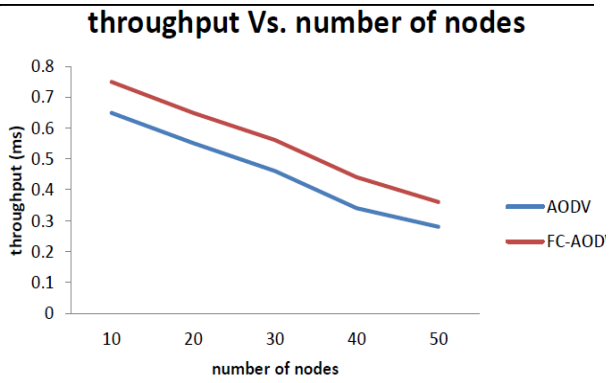

Figure 8 throughput Vs. number of nodes

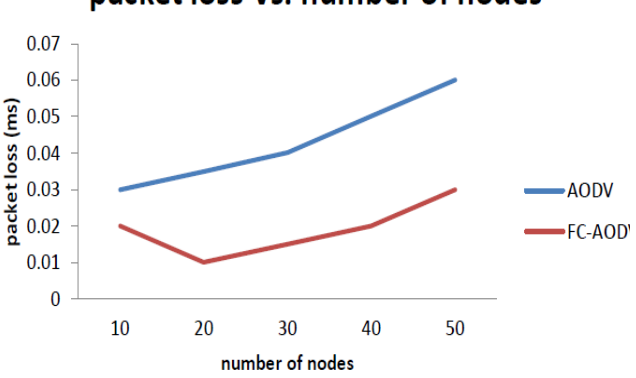

Figure 9 packet loss Vs. number of nodes

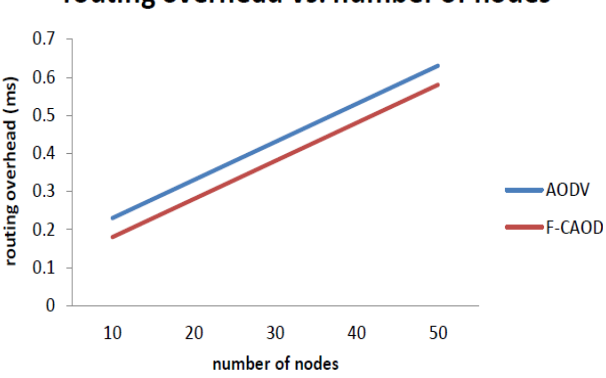

Figure 10 overhead Vs. number of nodes

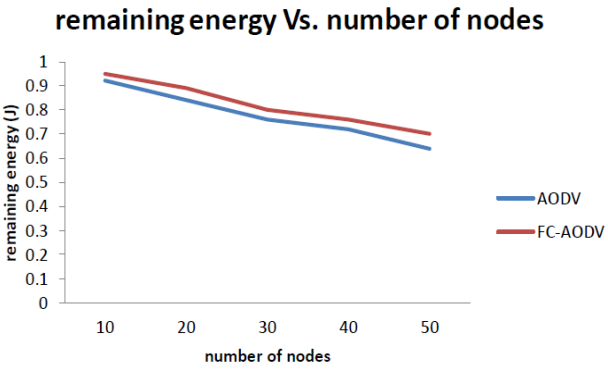

Figure 11 remaining energy Vs. number of nodes

The performance of packet delivery ratio measured from proposed AODV with fuzzy controller and the existing AODV protocol is compared. Fig. 7 and Table 3 show that FC-AODV, it is clear that energy efficient acknowledgements based proposed scheme

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surpass existing scheme performance by 4.21 %, when 3here are 10% and 50% of malicious nodes in the network. Table 3 and Fig 8 proves that the proposed FC-AODV provides better performance of the throughput when there are 10 to 50 of nodes compared to AODV routing protocol. According to table 3 and Fig 9, it is clear that proposed scheme FC-AODV surpassed the performance of AODV in minimizing packet loss by 12% when there are 10 to 50 nodes in the network. As the proposed algorithm finds different short routes frequently, it is possible to minimize the losses. From Table 3, it is clear that secure proposed scheme FC-AODV surpasses AODV performance by above 70% when there are 10 and 50 nodes in the network. Simulation results of routing overhead, Fig 10 It is clear that FC-AODV has the lowest overhead of about 10 to 50 number of nodes. Fig11 and Table 2 compare the remaining energy of the proposed FC-AODV and the existing AODV). Fig. 11 shows that suggested system increased remaining energy when the number of nodes varied compared to the existing system. It is clear that the proposed AODV decreases the average remaining energy by 5.2% with the increasing malicious nodes 20% to 40% than AODV, due to increases duration of time period of three acknowledgments than two acknowledgments it is possible to decrease remaining energy.

From all the figures it's clear that the comparison of the FC-AODV and AODV with misbehavior detection algorithm shows the turnout and packet delivery ratio and throughput increase with the rise within the range of number of nodes and additionally packet loss, routing overhead and used energy decease with the rise within the range of nodes, even though the above methods succeed in reducing average delay and bandwidth of active multipath network.

X. CONCLUSIONS

In this section, it is clear that misbehaver attacking has always been a major threat to the security in MANETs during the transmission drop (or) attack the packet, if wireless communication is done without multipath. So multipath based transmission becomes essential and is very safe with high security. In this research, a proposed routing protocol named AODV proposed with fuzzy controller. The simulation results propose FC-AODV algorithm as compared with the existing AODV algorithm through the network simulation 2. While it is very difficult to guarantee that the connectivity is maintained at all time in a dynamic and mobile environment. This developed model ability to detect misbehaviour nodes with improves average packet delivery ratio by 1.46% and average throughput by 16.9% than the existing routing protocol and reduced packet losses by 1.46%, overhead by 1.46% than the existing routing protocol, result clearly shows propose system still increased average remaining energy by 9.1% than existing method, plan to investigate the following issues in our future research: the same concept can be tried to implement in satellite to reduce more congestion in the route and also to save more energy, the possibilities of adopting with different scenarios to eliminate the requirement of redistributed end-to-end delay can be examined and the performance of FC-AODV can be tested in real time network environment instead of software simulation.

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There is no funding source for my research article

ACKNOWLEDGMENT

We would like to thank above researchers and respected internal expected reviewers who give their valuable review comments with suggestions for updating to improve quality of the paper. We would like to thank authorities of the estimated Annamalai University, Tamilnadu, India and Government College of Engineering, Bargur, Tamilnadu, India.