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STOCHASTIC MULTICRITERIA ACCEPTABILITY BASED ROUTING TECHNIQUE FOR AD HOC NETWORK

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Abstract: Device to device Communication is a very impressive method of communication as it does not need any pre exiting expensive communication infrastructure. Devices (nodes) themselves perform all the network operations such as routing. Such types of networks are very useful in areas where communication infrastructure is not available or it was destroyed by some kind of mistake. A mobile Ad-hoc network is a network of this class. In a MANET routing is done by nodes themselves and there are several methods available in the literature of routing. Reactive routing is a technique in which routes are recorded only if they are needed. AODV is most popular reactive routing protocol of mobile ad hoc network. In this paper we are presenting a novel concept of route selection "SMART" in which stochastic multi-criteria acceptability analysis method is used to find the best route for transmission of packet from source to destination. This acceptability method is a branch of multi-criteria decision method (MCDM), and it has flexibility to assign importance to different criteria and the same can be change according to the situation in which the network is being used. The proposed scheme is implemented on NS-2 Platform and compared with other noteworthy research papers for verification of improvement in performance.

Keywords: Ad Hoc Network, Multi-criteria,SMART,MCDM, Mobile ad hoc network

I. INTRODUCTION

In real world there may exist situation in which communication facility is needed in the areas where communication infrastructure is not installed or it was destroyed. Device to Device communication bridge the gap. In ad hoc network devices(nodes) communicate with each other either directly or with the help of forwarding chain system(FCS). In FCS intermediate nodes cooperate with neighbors by forwarding their packets intended for others. Cooperation of nodes is a key issue in designing routing methods for ad hoc networks. Routing protocol is a binding agent in the network which ensures the delivery of packets from source to destination. Reactive routing method reduces the overhead since route are not searched when there is nothing to transmit. AODV searches all the routes from source to Destination and in the case of multiple routes, the route with minimum Hop Count(HC) is selected for transmission of packets. Minimum Hop Count ensure that the route is shortest but there are some other factor which must be considered at the time of route selection.

As stated earlier cooperation of nodes is a key issue in device to device communication. Everything is okay if all nodes behave benevolently, but sometimes some nodes of the network may show selfishness and drop packets intended for others. This type of behaviors may the because of a desire to save its own energy[1]. We are dealing with a heterogeneous network in which devices may have different hardware capabilities. Another significant reason for packet drop is congestion at the forwarding nodes. Congestion & packet drop may occur due to buffer overflow at the forwarding nodes. Ad hoc nodes are very prone to early power drain-out due to limited battery capacity. Energy consumed in all the network operation such as transmission[2] and reception of packets, overhear the acknowledgment and even to keep the node alive. This paper proposed a method for route selection based on multi-criteria decision analysis (MCDA) method.

The proposed method calculates the trust value for each node of a route. This value depends on the selfishness and buffer capacity of the node. A factor for robustness is calculated for which includes trust, energy level and hop count for each node. Moreover this is on adoptive method in which we can change the preference given to different criteria's[3].

II. LITERATURE SURVEY

A number of researchers proposed methods for on demand routing. We are presenting a review of some papers which related to AODV routing.

Rahila Khanam*, Anshika Goyal [1]: in this paper authors proposed the methods and new algorithm to select the shortest path. This algorithm are based on the maximum energy node. Source are selected the node whose energy are maximum and send the packet. When this node are failure and faulty than the source node leave that path and select the neighbour nodes to

send the packet whose energy are maximum that path are selected to send the packet.

Kapil Kumar, Shiva Prakash, Sumit Kumar Singh [2]: In this paper authors also work on the node energy and the congestion factor. The authors create a algorithm called ETR-AODV. In this algorithm source select the node to transfer the packet whose energy are maximum. Generally in AODV the source broadcast the RREQ message to the nodes. The neighboring nodes receive the RREQ packet and forward its to neighbors. But the idea behind the ETR-AODV is that before forward the packet, each intermediate node find the congestion factor(CF) and available energy (AE) and these values to the field reserved in the AODV.

Krupa A Talwar, Benakappa S M [3]: In that paper authors proposed the I-AODV algorithm to find the route selection to send the packet. I-AODV has two steps. First step is based on signal strength of the nodes and second step uses normal AODV. The signal strength AODV works with measuring the signal strength between nodes and compare this values with RSSI (Receive Signal Strength Indication) threshold value. If this value are greater than the threshold value, than select these path otherwise discarded. If a route is not found in first step than system will switch normal AODV that select tha path with minimum hop count.

P. Shrinivasan, Dr. P. Kamalakkannan [4]: In this paper the authors proposed the RSEA-AODV (Route Stability an Energy Aware) model to select the stable path to send the data packet. The route stability are find based on the signal strength and energy aware factor are find using node residual energy. The path stability are find based on route stability and energy aware routing scheme.

Mostafa Rajabzadeh, Arash Mazidi, Mehdi Rajabzadeh [5] : In this paper authers are proposed a new intelligent algorithm called SG-AODV(Smart and Goal based AODV). In this technique a combine factor are used based on energy of nodes, congestion in routing queue of nodes and status of link that called "Score". The algorithm are used score for selecting the best route and choose highest scores as main route and remaining routes are stored in temporal memory of nodes. That routes are used when the main route are damage or interrupt.

May Cho Aye and Aye Moe Aung[6]: In this paper authors proposed a energy efficient multi-path routing AODV. Authors considered two energy factors, first is transmission power of nodes and second is residual energy as a energy metrics. These two metrics are used to find the optimal path for data transmission. In this paper the algorithms works in three steps: control transmission power, calculate residual energy and system operation.

Hnin Yu Swe and Soe Soe Khaing[7]: In this paper authors propose modified AODV with energy metrics, EC-AODV. In this paper authors consider on the energy level of node. Each node do not participate in route discovery and data forwarding process if residual energy is less then threshold value. This method are worked in two phases to select the best path. First is route discovery and second is route maintenance. In first phase each node checks its residual energy. If the residual energy of node is less then threshold value, then does not select this path for data transmission.

Hsin-Mu Tsai, Nawaporn Wisitpongphan and Ozan k. Tonguz[8]: Here the authors are used link quality to select the best path to transfer the packet. The authors also used "hand-off" technique. The route selection mechanism are based on 32-bit Route Quality(RTQ) field in the packet header. When the source node broadcast the RREQ packet route request packet also include the RTQ field in the packet header. This RTQ packet indicate the quality of route. When the node receiving RREQ, a node updates the RTQ in the packet in the packet header with current SSNR value. For route maintenance the "hand-off" mechanism are used.

III. PROPSED METHODOLOGY

In ad hoc network, when a node needs to communicate with some other node which is out of its direct transmission range, the node must relay on its neighbors to deliver the packets. The intermediate nodes form a forwarding chain with its extremities connected to the source and to the sink of the communication. The packet are forwarded hop by hop through the chain. Our goal is to developed effective technique that can select the routes not only considering the hop count but takes a number of criteria for decision making[4][7]. The criteria taken are trust value, energy level and hop count of the forwarding chain. Reactive routing methods such as AODV find all the possible routes to the destination. Consider the scenario given in the figure1 in which routing method searched three routes to reach the destination.

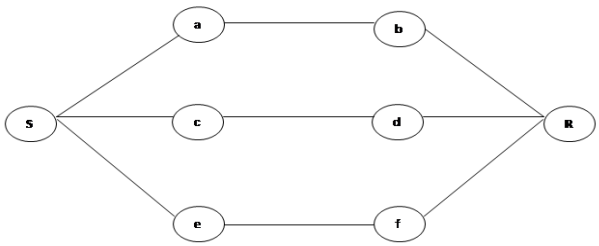

Fig 1 : Network Scenerio

In the present scenario three routes are R1,R2 and R3. Each of the route may have a number of nodes to form a forwarding chain. The trust value of nodes in the chain can be estimate by selfishness of nodes and congestion at the nodes. Energy level is the node can be calculated as the difference of initial energy and consumed energy[10].

Table 1 gives a multiple criteria metrics for all the possible alternative routes R1, R2 ,and R3.

Alternate	**Weight**	**w1**	**w2**	**w3**
	Criteria	**Tn**	**En**	**HCn**

R1		F11	F12	F13
R2		F21	F22	F23
R3		F31	F32	F33

w1,w2 and w3 are the weights assigned to different criterion. This given us flexibility to change the importance assigned to parameters.

In this scenario to find out the optimal path for the packet transmission. We first calculate the Robustness Factor for each possible routes. The value of robustness factor are depend on the three major criteria : Trust value of nodes, Energy of nodes and number of Hop-count is used to reach the destination.

Robustness Factor: We discuss above Robustness Factor depend on three criteria namely: Trust value of nodes, Energy of nodes and Hop-count.

1. Trust on nodes: The Trust value of nodes measured by congestion and selfishness of nodes.

Congestion: Congestion is a condition in communication network where too many packet are present in a communication link. Congestion may occurred when the load on network is greater than the capacity of the network.

Selfishness: Selfish nodes are node that not participating in the process of routing, not sending HELLO message and reply, dropping data , packet and deleting RREQ packet. Used these two parameter, we find out the trust value on the nodes.

2. Energy of nodes: In this criteria we find the remaining energy of all nodes in the possible nodes. For packet transmission maximum remaining energy nodes are selected. Remaining energy compute the formula:-

Remaining Energy = Initial Energy – consumed Energy

Initial Energy: Energy that provide to the nodes for simulation.

Consumed Energy: Energy used by nodes for forward the packets.

3 Hop-count: Hop count is the number of intermediate nodes between source to destination through the packets are routed.

Robustness Factor(RF) for R1:-

Trust of Route R1 is F11 = fn(Ta & Tb)
Energy of Route R1 is F12 = fn(Ea & Eb)
Hop-count of Route R1 is F13 which is equal to the no of hops from source to destination.

Robustness Factor(RF) for R2:-

Trust of Route R2 is F21 = fn(Tc & Td)
Trust of Route R2 is F22 = fn(Ec & Ed)
Trust of Route R2 is F23 which is equal to the no of hops from source to destination.

Robustness Factor(RF) for R3:-

Trust of Route R3 is F31 = fn(Te & Tf)
Energy of Route R3 is F32 = fn(Ee & Ef)
Hop-count of Route R3 is F33 which is equal to the number of hops from source to destination.

Trust value of R1:- Trust is to believe that someone is good and honest and will not harm you, or that something is safe and reliable. In this dissertation work trust of a node calculated by the combination of selfishness and congestion.

Fi1 is for trust value of route i.
F11 is trust value of route 1
F11 = Ta+Tb
Ta is trust of node "a"

Tb is trust of node "b"
Ta = fn(Sa, Ca)

Where Sa is the selfishness of a node a

For example RF1 = F11 W1+F12 W2+F13 W3
where i = Route number (i=1,2,3.....n)

j = Criteria

Total Criteria = m (m=3 for example figure shown in figure 1)

Total alternative = n **(n**=3 for example figure shown in figure 1**)**

IV. SIMULATION ENVIRONMENT AND PERFORMANCE METRICS

A. Simulation Environment

We are used NS-2.34 network simulator for simulation. NS-2 is used Tcl(Tool Command Language) script as a input. Network simulator is very important and efficient analyzing tool used for routing in network and different protocols used for wired and wireless. NS-2 initially scenario and traffic files are produced. After execution of TCL script two files are created NAM file and Trace file. Trace file is used to analyze the behavior of network. Trace files are analyzed by using AWK script.

Following steps are performed to run the simulation:-

- select performance parameters.
- Generate scenario and topology files using cbrgen and setdest commands.
- Write Tcl script(.tcl extension).
- Execute Tcl script(Use ns command).
- Generate Trace and NAM file.
- Execute Awk script to measure performance.

B. Performance Metrics:

To determine the behavior and performance of AODV routing protocol various performance metrics are to be used.

1 Throughput:

Throughput is refer to the amount of data transfer from source to destination in a specific amount of time. Throughput is expressed as bytes or bits/sec.

Throughput = (number of data packet received * packet size * 8)/simulation time

2 Packet Delivery Ratio(PDR):

Packet delivery ratio is the number of data packet success full delivered to the destination nodes over number of data packets produced by source node.

Packet Delivery Ratio = (received packet / generated packet) * 100

3 End-to-End Delay:

The term end-to-end delay refers the time taken by a packet to be transmitted across a network from source to destination.

4 Packet Dropped:

It is difference between number of packets sent and receive. It can be calculated as

Packet loss = Data packet sent – Data packet Receive

5 Normalized Routing Load:

It is calculated by delivery the total number of routing packets sent over the total number of routing packets received.

NRL = SENT ROUTING PACKET/RECEIVED ROUTING PACKET

V. SIMULATION AND RESULT ANALYSIS

A. Simulation Tool and Parameters

We are developing an application which is provided routing simulation. For developing this application, we are using NS2 which is performed in Linux Ubuntu 14.04 Platform.

NS2 is network simulation environment which support .tcl script for the logic writing, having xgraph feature for the graph and other GUI for the result performance. It is also having Animation support using its NAM extension where the node simulation can be perform and result also can observe in the console. Network simulation code can be done in tcl script by using network simulation set up and library provided by the system.

Table 2: Set up Environment

No. of Nodes	30
No. of Source	10
Area	1000X1000
Mobility model	Random waypoint
Bandwidth	2mbps
Speed	0,1,5,10,15,20m/s
Pause time	10 sec
Buffer Size	100
Transmission range	2100m
Sensing range	2100m
Packet size	1012bytes
Traffic source	CBR
MAC protocol	IEEE 802.11

B. Result Analysis

Table 3 : Throughput

Speed(m/s)	Pro_AODV	Smart_AODV
10	41.81	26
20	44.78	50
30	45.65	49

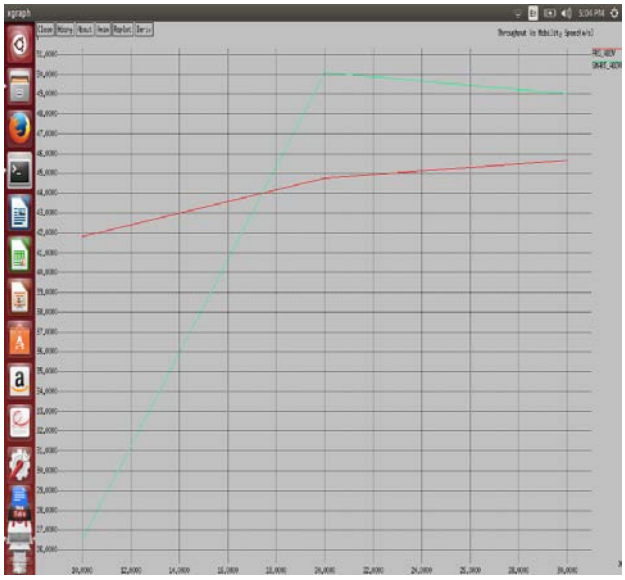

Fig 2: Throughput

Table 4: Packet Loss

Speed(m/s)	Pro_AODV	Smart_AODV
10	54	2
20	43	1

30	40	39

Fig 3: Packet Loss

Table 5: End to End Delay

Speed(m/s)	Pro_AODV	Smart_AODV
10	1.33	0.22
20	2.00	0.10
30	2.22	0.18

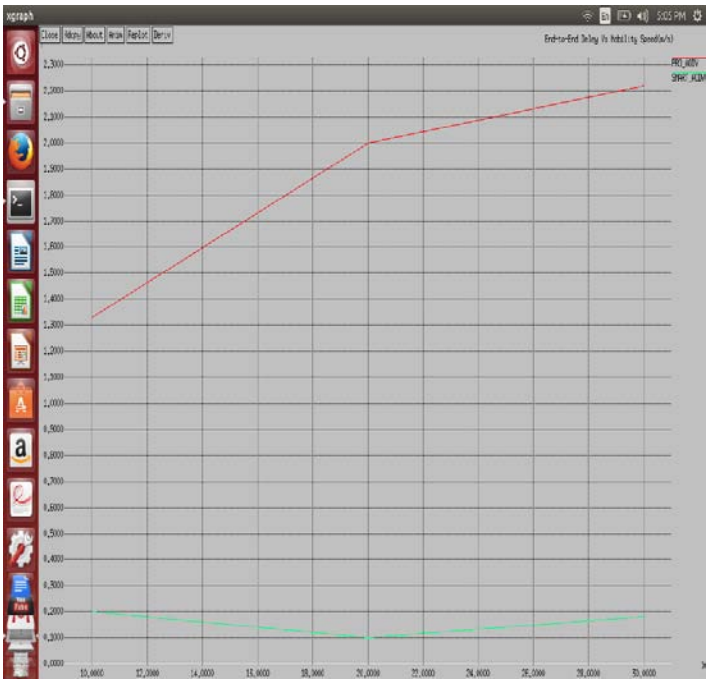

Fig 4: End to End Delay

C. GRAPHICAL REPRESENTATION OF DELAY, THROUGHPUT AND PACKET LOSS WITH MALICIOUS NODE:

Table: 6 : Comparison Table of malicious Node for Packet Loss

Time m/s	Std_AODV			Smart_Aodv		
	3node	6node	9node	3node	6node	9node
10	8	6	5	30	30	19
20	60	2	55	15	15	50
30	4	20	3	7	10	10

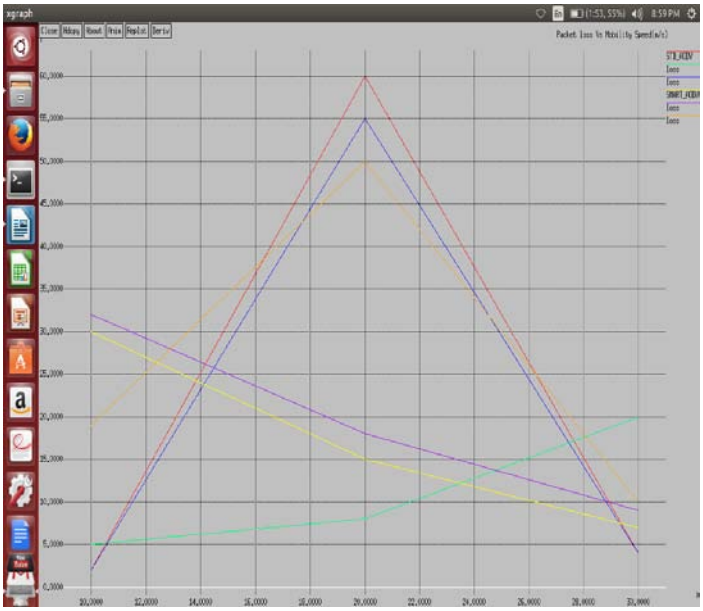

Fig 5: malicious Node for Packet Loss

Table 7 :Comparison Table of malicious Node for Throughput

Time m/s	Std_AODV			Smart_Aodv		
	3node	6node	9node	3node	6node	9node
10	23	25	25	35	35	34
20	3	2	2	37	37	3
30	24	29	25	46	46	17

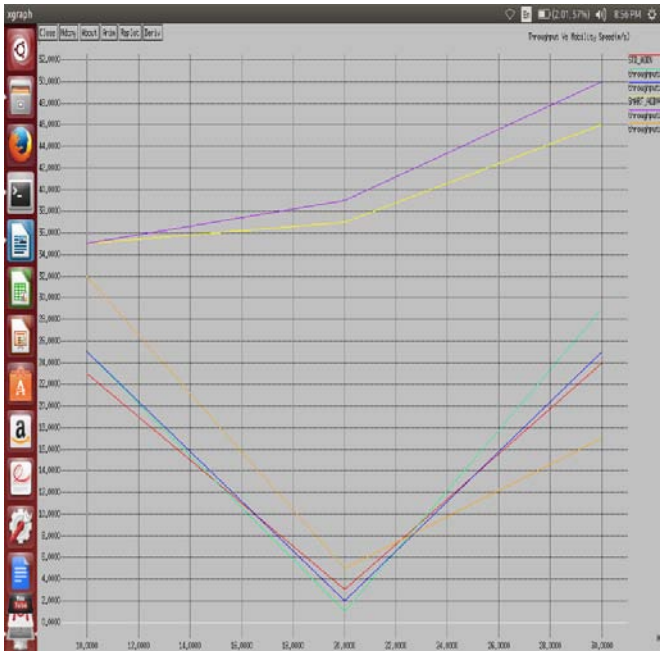

Fig 6: malicious Node for Throughput

Table8: Comparison Table of malicious Node for End to End delay

Time m/s	Std_AODV			Smart_Aodv		
	3node	6node	9node	3node	6node	9node
10	0.10	0.13	0.13	0.02	0.12	0.10
20	0.42	0	0.6	0.10	0.12	0.6
30	1	0.2	0.2	0.09	0.09	0.5

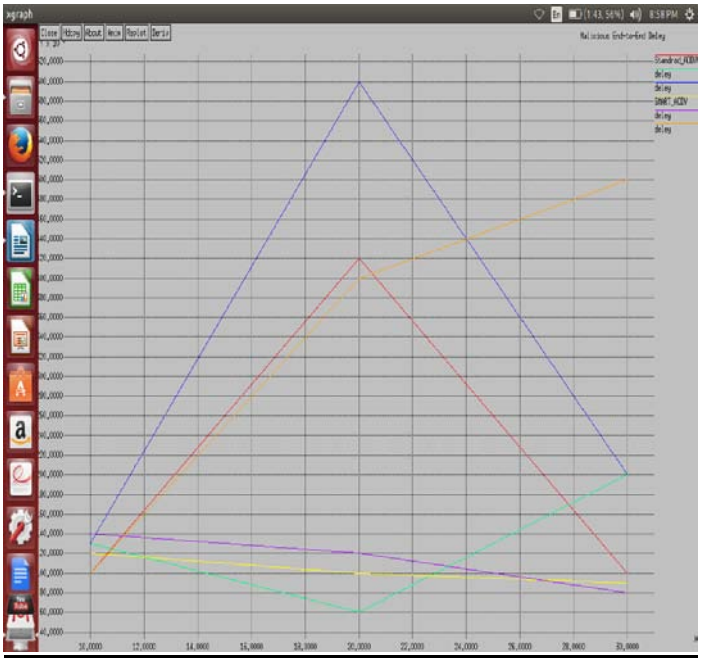

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Fig 7: malicious Node for End-to-end Delay

VI. CONCLUSION

Mobile ad hoc network is group of mobile nodes that free to move anywhere on the network. Because of its infrastructure less nature ad hoc network easy to developed at any place and any time. In this dissertation we developed a mechanism for find the optimal root for sending the data packet. Many challenges are exists like noise, traffic, congestion and various type of energy consumption face to network failure. In previous, many researchers are work for trust based path but we describe the concept of Robustness Factor(RF). This Robustness Factor(RF) based on the metrics like – energy , selfishness, congestion and hop-count. With the use of these metrics we create a trust based equation and find the Robustness Factor(RF) of every route. After calculating the Robustness Factor(RF) which route is high Robustness Factor(RF) that route is selected to send the data packet. Our proposed algorithm provides the better result of all parameters like end-to-end delay, Packet delivery ratio, energy consumption and throughout. Proposed method is better than AODV protocol.

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