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TEELR: Trust enhanced Energy Efficient Load balanced Routing for Ad hoc Networks

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I. Abstract:

Ad hoc network is an indivisible part of wireless networks. Mobile ad hoc network is a kind of ad hoc network where mobile nodes are communicated randomly. In existing research works, it is difficult to find the reliable path and find balancing of load in the network. In this research work, Trust enhanced Efficient Load balanced Routing is developed to improve energy efficiency. In first phase of the proposed protocol, multipath routes are discovered by obtaining the route construction and route maintenance. In second phase, reliability of routes is found with maximum packet delivery ratio. In third phase, the energy is improved by selecting reliable nodes and paths. The proposed protocol is simulated using network simulator tool. It outperforms better than existing schemes in terms of performance metrics like packet delivery ratio, load balancing ratio, overhead, network lifetime and route reliability ratio.

Keywords: *Trust, multipath, energy efficiency, route reliability and performance metrics*

I.INTRODUCTION

Reliability of ad hoc network is the biggest task to achieve in the network scenarios. Paths are frequently changing according to network environment and node mobility. Due to that, paths are often broken which may lead to decreased network performance. In this research work, a reliability based multipath routes are discovered based on node trust score and performance metrics.

II.PREVIOUS WORK

In this work, Mobile agent integrated Energy Efficient Reliable routing protocol [1] was proposed to attain the reliability and to reduce the energy consumption of nodes. The following metrics were used for analysis of reliability i.e. degree of bandwidth usage, link cost factor, degree of node originality, availability of routes and drain ratio of node. In this network environment, agents of nodes are communicated and reached in hop based routes towards destination. Here the integrity of data packets was based on degree of links.

The fuzzy based energy model [2] was proposed to attain the Quality of Service based on link parameters. The layers used for this approach was robust. For this energy model, three layers from protocol architecture were adopted i.e. routing layer, physical layer and link layer. The inference and noise ratio were determined using the bottom layer of protocol stack. The behavior of the intermediate nodes and clock period were calculated using link layer. The update of the packet transmission was decided by the packet rate and number of packets travelling towards the destination node.

In [3], the analysis of various classification routing methods was done in the intrusion detection in ad hoc networks. The performance was characterized using classifiers. Two classifications i.e. basic and cost based., were implemented to know the impact of intruders on energy based routes. The network datasets were used which includes the types of attackers, mobility of nodes and activity of selfish as well as malicious nodes in the region.

The adaptive and reliability based congestion aware routing protocol [4] was proposed by vadivel and

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murali. During routing discovery phase of this protocol, the transmission errors and congestion in the particular routes were dramatically reduced. Based on the channel conditions, capability of routes, the congestion was effectively detected and it was immediately reported to the source node through intermediate node.

The reliable ant based trustworthy routes [5] were established to know the status of participation of active and genuine nodes. The participation report was generated based on the trust score of individual node. The fake nodes were identified based on threshold value of nodes. The performance metrics were simulated between proposed and existing routing methods.

In general communication between the sender and receiver, messages are divided into frames and it will be transferred with session key. A trust based routing scheme [6] was proposed to provide optimal energy model by reducing the impact of misbehaving nodes in the network. The network lifetime was improved using the trust based routing. Trust values are estimated and add it in the routing table of neighbor node in order to protect the nodes from the attackers. In each route maintenance phase, vulnerability of attackers was store in the routing table of source node.

A reliable fault-tolerant routing algorithm [7] was introduced for ad hoc network. Both fault tolerability and data redundancy were increased in each route maintenance phase. The reputation metrics were used for choosing the backup routes if any failure occurs in the network environment. This routing was initiated if backup node expires. The first path i.e. active primary path was chosen for data forwarding between source and destination node.

A novel scheme [8] based on dynamic topology was introduced to obtain the location of intermediate nodes. Here the availability of nodes in the present zone was located to improve the accuracy of routing. The routes were performed using request control packets. The energy consumption was minimized based on sink node location through efficient routing mechanism.

A transparent topology based network routing mechanism [9] was introduced for improving the network performance. The gain was improved by adopting different network scenarios. Here nodes may be mobile or immobile according to QoS requirements. Based on energy value of nodes, the routing procedure was alternated. The minimum path counts were used to improve the network lifetime here.

In this work, two energy aware routing algorithms [10] were used based on reliable and cost effective routing approaches. The performance metrics i.e, route stability, cost value, energy efficiency was improved using the algorithm. The power efficient and remaining energy routes were discovered to improve network operational time. Through the reliable and energy efficient route, the total power spent on end to end routes was reduced dramatically here.

III.PERFORMANCE OF

In this phase, a reliable multipath energy efficient approach is developed to improve the network lifetime. There are three phase involved i.e. establishment of route reliability, route discovery and maintenance phase and packet forwarding phase for energy efficiency.

Route Reliability phase:

In this first phase, node reliability is estimated to provide improved network performance. The following steps are used to ensure reliability of routes.

Step 1: Source node communicates the node within the network transmission range.

Step 2: Discover the broadcast paths between source and sink node through stable intermediate nodes.

Step 3: Calculate the packet loss rate between intermediate nodes to determine the stability of links.

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Step 4: If any routes found with less packet loss rate, source node will prefer that route for packet forwarding.
Step 5: Probability of link existence is used for determining network performance..

Multipath routing through minimum hop distance

In this phase, there are three steps which are actively participated to provide network balancing. The first step is construction of routes. Remaining are path discovery and route maintenance phase. In the first step, the following procedure has to be maintained to support the route discovery process.
Step 1 : Compute the residual energy for each path.
Step 2: Estimate the reliability factor for each node based on activity and stability of nodes.
Step 3: If any node consumes more than 75 Joules for packet transmission, that node will be immediately isolated from the network by the source node.
Step 4: Discover the multiple paths from source to sink node.
Step 5: Stable routes are found based on node reliability factor and residual energy of routes.
Step 6: Source node broadcasts the reliable route information to all participating nodes in the network.
Step 7: Form the cluster based on huge number of nodes based on node to node connectivity.

Multipath route discovery process

In this phase, routes are discovered by the cluster head to all cluster members by sending C_Join Request packets. If any intermediate clusters inside the cluster region receive the request, it will send an acknowledgement packet i.e. C_Join Reply packets for packet forwarding to CH. The stale routes by misbehaving node are removed by the cluster members. The forward and reverse route information was stored by all cluster members.
If any route failure occurs, the CH initiates the fresh route discovery process in the revere route phase. Once the packets are forwarded to sink node, the clock is generated for obtaining the process delay in the primary route. The visiting route table is maintained based on packet reachability ratio through multiple paths. The route information is updated in routing table based on packet interval. The temporary data communication is removed by all cluster members after route discovery phase. Figure 1 shows the illustration of multipath route discovery process.

Multipath route maintenance process:

Once all routes are discovered from CH to all cluster members, the responsibility of CH is to find the reliable routes. The reason behind this is to withstand node failures, frequent path breaks, and degradation of reliability factor. There are two CH maintained in this phase. The source CH maintains the communication of cluster members and destination CH monitors the possibility of alternative routes. If any link breaks or node failures occur, the C_Join Req packets will be immediately sent to find the reliable paths and stable nodes. The CH stores and broadcast all back up path information to cluster member nodes if any failure occurs unconditionally.
Due to unavoidable power failures, network may be overloaded to withstand misbehaving nodes. The reappearance of the node is done by removing existing failures. Immediately the beacon messages will be sent to source node to become a part of route cost function.
A fresh path can be setup if needed. It can be discovered if any loss found in reliability factor, high mobility nodes, low energy level and the presence of misbehaving nodes. The attackers inside the network are difficult to predict if multiple routes are participated in the network. The reliable data communication is installed in each node and packets to provide improved energy level.

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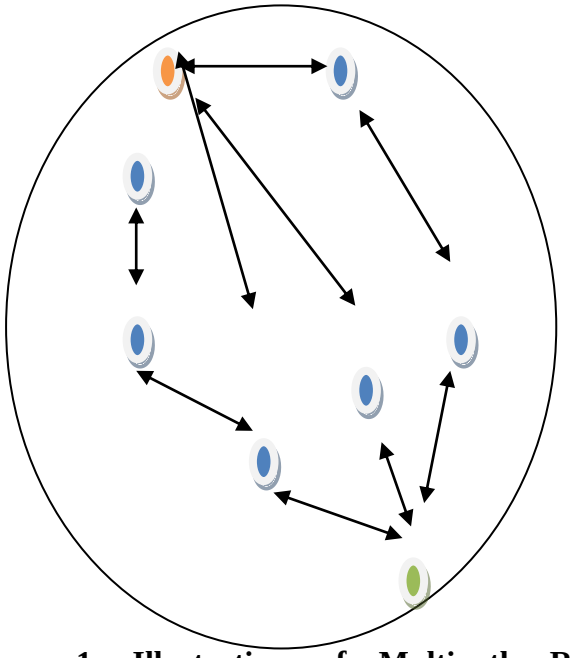

Figure 1. Illustration of Multipath Route Establishment

The reliable routes are discovered by the following steps.

Step 1 : The header of packets is included by the route reliability by CH. The route_reliability metric is determined as,

$$R\_REL = \frac{PLR(\tau)}{TP} + E_l(\tau)$$

The metric is based on the ratio of packet loss and energy spent on during packet loss to the total number of packets deployed.

Step 2: Once the metric is calculated, it will be estimated for all paths by CH. It will be broadcasted to all intermediate nodes.

Step 3: Each packet contains sequence number. If it is matched, it will be immediately reported to CH about false packets.

Step 4: The path reliability count is broadcasted to all cluster members or intermediate nodes if sequence number is matched.

Step 5: The fault tolerability rate of path is estimated based on packet loss rate.

Step 6: The fault tolerable routes are found with least energy.

Step 7: The energy level of node is 85 Joules. If any node falls below the threshold value, Route error packets will be generated by CH.

Step 8: Low energy nodes are isolated from the network. Alternative nodes can be replaced.

IV. SIMULATION RESULTS

Trust enhanced Energy Efficient Load balanced Routing (TEELR) is simulated using the network simulator (NS2.35). The protocol analysis is done for 200 nodes. The Variable bit rate traffic used for the traffic scenarios.

Table 1. Simulation and Setting Parameters of TEELR

No. of Nodes	200
Area Size	1200 x 1200 sq.m
Mac	802.15.4
Radio Range	250 meter
Simulation Time	100 sec
Traffic Source	Variable Bit Rate
Packet Size	128 bytes
Mobility Model	Random Way Point
Protocol	AOMDV

The following performance metrics is used for valuation.

Route reliability ratio: It is the ratio of reliable routes to the total available routes.

Load balancing ratio: It is the ratio of number of packets travelled through multiple paths to the packet travelling through single path.

Network lifetime: It is defined as the energy level of entire network.

Control overhead: It is the excessive control packets travelling in the route.

Packet delivery ratio: It is the ratio of number of packets delivered to the number of packets sent.

Figure 2 shows the performance of TEELR over existing schemes in terms of route reliability ratio. The proposed scheme achieves high ratio than existing schemes.

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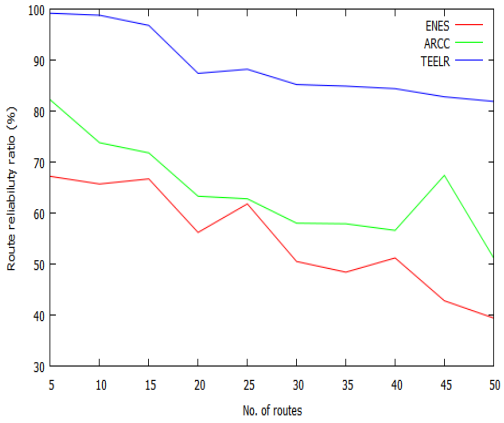

Figure 2. Route reliability ratio Vs No. of routes

Figure 3 shows the analysis of load balancing ratio while varying number of routes in x axis. The ratio of TEELR is high compared to existing schemes.

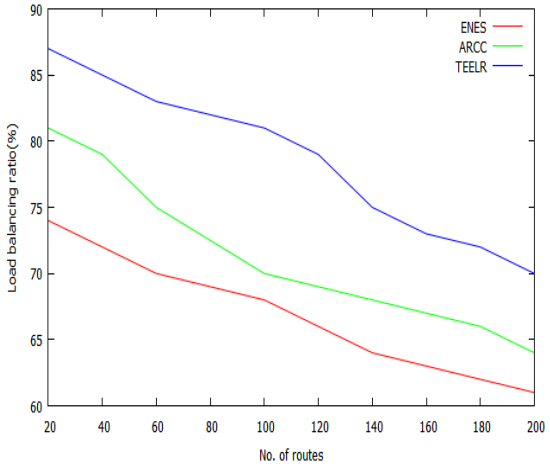

Figure 3. Load balancing ratio Vs No. of routes

Figure 4 illustrates the performance of network lifetime while varying simulation time in x axis. From the results, it is seen that TEELR achieves more network lifetime than existing schemes.

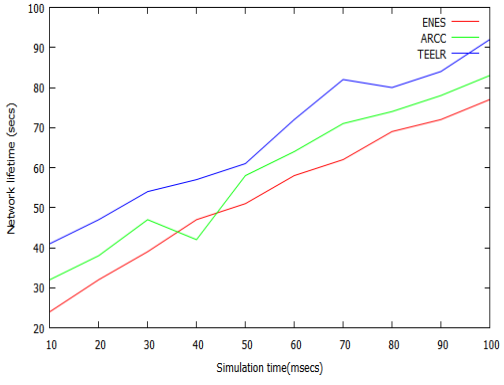

Figure 4. Network lifetime Vs Simulation time

Figure 5 illustrates the performance of Packet delivery ratio of TEELR while varying the number of nodes in x axis. The proposed scheme achieves high ratio than existing schemes..

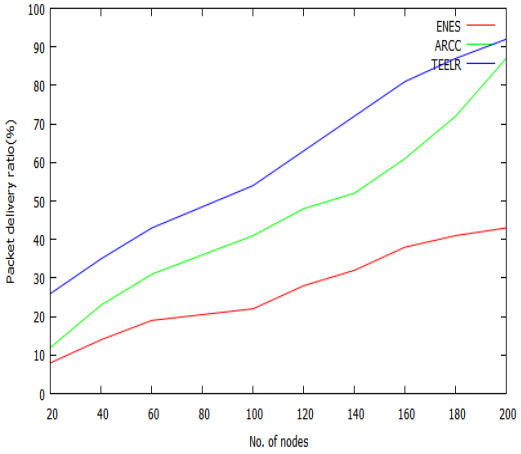

Figure 5. Packet delivery ratio Vs No. of nodes

Figure 6 shows the results of control overhead while varying pause time in x axis. It is seen that overhead of TEELR is less compared to existing schemes.

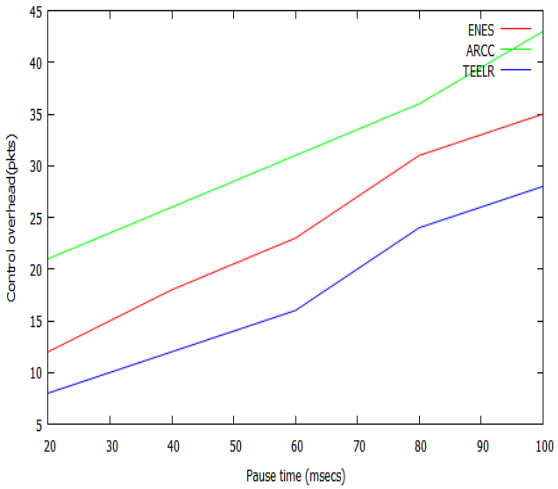

Figure 6. Control Overhead Vs Time

V.CONCLUSION

MANET is the predominant network used for real time applications. Mobile nodes are randomly moving inside the network environment. Due to dynamic links, the performance of network may be degraded. It is because of more packet loss rate. In

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this research work, trust based energy efficient routing is proposed to attain the balancing between network lifetime and load balancing ratio. Here multipath routes are discovered and reliable routes are found based on reliability metric. The packet loss is dramatically reduced using the protocol. Based on the simulation results, the TEELR achieves high packet delivery ratio, load balancing ratio, less overhead and more network lifetime.

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