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A Two Hop Relay Battery Aware Mote Scheme for Energy Redeemable and Network Lifespan Improvement in WSN

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Abstract**:** ***The nodes available in the market are now of miniaturized nature, also have the characteristics of low cost and power values. Wireless Sensor Network (WSN) will be a sparse network with independent points acting as energy sources. The application in WSN includes temperature sensing, sound sensing, and pressure session. The data is sent from one point to other using multi intermediate nodes. The selection of intermediate nodes will be done based on computation of trust. As the number of hops increases energy consumption will become high and this can be improved with the help of relay node which can store the data and deliver the data once destination is in its range. The selection of relay node can be done in multiple ways like random, based on meeting probability and in the proposed two hop relay battery energy aware algorithm makes use of multiple factors namely residual energy, virtual currency based data, meeting probability, security computation so that the communication can be optimized. The proposed method is also compared with several existing methods with respect to delay, energy consumption, alive nodes, dead nodes, lifetime ratio and residual energy.***

Keywords WSN, Energy Redeemable, Network Lifespan.

I. INTRODUCTION

The nodes used in the WSN network are very popular; amount of traffic data exchanged among the nodes is drastic in nature and can result in congestion at various points. The methods used in the literature are not effective in handling such use cases of traffic data .The traffic congestion can be handled by making use of routing mechanism based on opportunity ratio measure within the less congested area. The heterogeneous networks are a combination of both homogenous and non-homogenous set. When the nodes move in an environment there are multiple occurrences of network connections. The various applications in which Delay Tolerant Network (DTN) is used are mobile based terrestrial capacity networks, space based planned networks. The entire packet which has to be send between nodes is divided into multiple independent data chunks; each chunk will contain semantic kind of fata values. The cache and direct forward approach are used to transfer data across multiple independent groups. Endpoint Identifiers (EIDs) are used for communication between two different sets of nodes.

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The nodes in the cover set are found out, for the cover set the packet reply value is computed, reply value which corresponds to lowest value is chosen to move the data to the next node. The chance factor used in the method will defer nodes used in previous transmission. The security is an important concern for grid based WSN network, the second concern is supply of energy to the end systems. The combination of power based networks and information system form a grid system which is smart in nature. For the case of traditional system fossil based fuel and will also have an effect on the environment. Wireless Senor Network (WSN) has been used for wide variety of applications. The workers who are helping for the building zones [1], the physical activity are detected using low cost, compact, washable and ergonomic sensor nodes. The two major factors which impact the workers' health namely dust allergy and ultra violet rays are detected by using a node which is embedded in the garment of workers.

The Node Strategy is the algorithm which is used to place the nodes in the area of x*y meters. The input to the algorithm are Number of Nodes, Minimum x position, Maximum x position, Minimum y position & Maximum y position, Generate the Node Id Starting with Node Id as '1', Generate of X position of Nodes randomly, Generate of Y position of Nodes randomly, Store the information in the format of a set (NodeId, Xpos, Ypos),Increment the Node ID and Repeat the process until all nodes are placed in the network. The node strategy can be shown in the Fig1

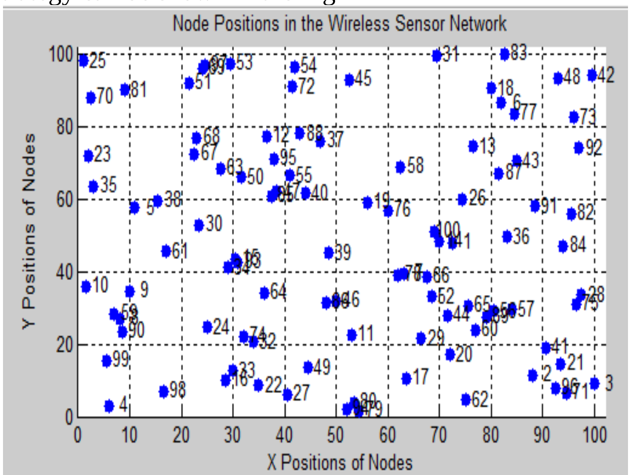


Fig1: Node Strategy Placement

Fig1 shows the node strategy placement in the network for an area of 100*100 area. As shown in the fig1 the Node 4 is placed at the location (7,2), Node 45 is placed in the location (55,95) and Node 62 is placed in the location (78,4). In a similar fashion each of the nodes are at unique positions. The rest of the paper is organized as follows.

Section II deals with literature survey with respect to delay tolerant networks, Section III deals with the proposed method. Section IV provides short information of existing methods used for comparison and finally Section V will be used to obtain results.

II. LITERATURE SURVEY

The real time information is very important for civilian and military applications, divide the network into two tiers to address the network lifetime issue. The nodes known as Aggregate and Forwarding Nodes splits the flows into different paths during transmission [2]. The advantages of the system include Improvement on the bit rates by making use of multi session flows and Maximizing the network lifetime with the help of forwarding nodes in the network and the corresponding disadvantages for the system are Multisession flow requires multiple paths to be active at the same time. Hence more number of nodes gets involved in routing which decreases the battery level of nodes in the network, Special Nodes known as aggregator and forwarder nodes are chosen randomly instead of any criteria specific information where it increases the possibility of dead node becoming the AFN node.

Hole is a location in which a dead node occurs and then the neighbors near the hole consume more energy [3]. Generally Hole is avoided by not visiting the perimeter of the hole. The algorithm is proposed which balances the energy by changing the size of the holes. The forwarding strategy of existing geographic routing protocols need not be changed; Routing Load can be balanced by controlling the size of the holes and the disadvantage of the system is that forwarding node strategy is not changed but it can mean that the node is repeatedly picked and it can have lesser energy. Mission-critical monitoring and surveillance systems with delay and reliability QOS constraints is used in Efficient QoS-aware Geographic Opportunistic Routing (EQGOR).

The algorithm will find the candidate set which are good with respect to energy efficiency, latency, and time complexity because of this End to End Delay is reduced and Packet Delivery Ratio is improved [4]. The upper bound value for network lifetime depends on protocol used, monitoring of region, number of nodes, path loss and energy for node, Lifetime of Network analysis is performed based on region end points. The division of network into small partitions and assigning of individual node from that region based on characteristics of Packet Delivery Ratio is a critical process [5]. The routing process in order to select the forward node geographical selection [6] of relay node is used by using contention among receivers. The forward selection depends on number of hops, distance and average count of neighbors. It also performs periodic wake up and sleep for the nodes at regular intervals which increase the lifetime of the network. The algorithm make use of sleep and wake up period which helps in the nodes losing less energy and indirectly increasing the lifetime of the network but the disadvantage of this approach is that Lot of latency is created due to duty cycle periods.

III. TWO HOP RELAY BATTERY AWARE

The proposed system is built on top of two hop relay based networks. The source node first signs the data to be sent with a private key. Obtains the relay node in the network and chooses the best relay node based on the cost and security. Finally forwards the packet to the relay node. The relay node when it meets the destination node then forwards the packet to destination. The destination node sends the ACK and the ACK is given to source node once it meets with relay node. Relay node is selected by using parameters like meeting probability and virtual currency [7]. In the proposed approach important factors will be considered apart from regular two hop relay network namely virtual currency , meeting probability , residual energy and trust level are used to select the relay node during the two hop relay networking process. This will increase the network lifetime and overall security of the packets. The advantages of proposed method are the following;

- Whenever a forward node is picked we consider residual energy as well as the trust level based on the signature because of which the security of the network will increase and also the network lifetime will increase
- No need of performing Multiple Route discoveries. On Demand Single route will be discovered.
- If the nodes have become dead an alternative route will be discovered which can send the remaining packets.

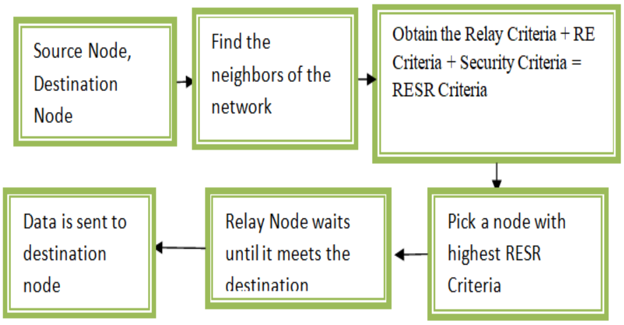


Fig 2: Proposed System Flow

Fig 2 shows the flow for the proposed work. As shown in the fig 1 source node, destination node is the input for the algorithm, find the neighbors of the source node, for each of the nodes in the neighbors relay criteria, residual energy, security criteria are computed. Among the neighbors nodes the node which has the highest RESR criteria will be picked as the forward node. The initiator node will communicate to the relay node, from the relay node to the destination node.

The Residual Energy is computed by using the following formula

$$RE = CE - Ec \quad (1)$$

Where, CE is the current energy, Ec is the energy consumed and RE is the residual energy.

The generation of historic profile can be computed by taking the input parameters Number of Iterations, Source Node and Destination Node. For each of iterations i.e neighbors of initiator node is found out, after that the cover set nodes are found out, store the traversed list, after that the non-traverse list and then finally virtual currency is computed.

The virtual currency is found out by using the following steps

- Source Node will send packets to neighbors
- Obtain the ACK Count
- Find the value of Virtual Currency = NACK/Nsent
- If in a given iteration this process has happened then the same node cannot be tested for the next iteration
- After all iterations are completed compute the meeting probability and also we get the cutoff threshold R

Each of the neighbor nodes counts the number of times it meets each of the other node in the network for M rounds at the time instants $t_1, t_2, t_3, \ldots t_m$.

Each of the neighbors computes the probability

$$\text{probability} = \frac{\text{Number of times a node i meets}}{m} \quad (2)$$

The finalprobability is computed using the following equation

$$P = k \times \sum_{i=r+k}^{i-n} \left(\frac{1}{n} \times \frac{C_{i-r-1}^{K-1}}{C_{n-1}^{k-1}} \times \frac{r}{i-k} \right) \quad (3)$$

Where,

k= Number of iterations

n=number of nodes

C= combination formula

r= threshold number (Obtained in History Profile)

IV. SHORT INFORMATION OF ALGORITHMS

The algorithms which are used for comparison are Epedimic Algorithm and Incentive Compactible Routing Protocol.

A. Epedimic Algorithm

The Epedimic algorithm based Route Discovery Algorithm (RDA) based on Purely Random Propagation, but it improves the propagation efficiency by recording the nodes traversed so far. Specifically, RDA adds a "node-in-route" (NIR) field to the header of each share. Initially, this field is empty. Starting from the source node, whenever a node propagates the share to the next hop, the id of the upstream node is appended to the NIR field. Nodes included in NIR are excluded from the random pick at the next hop. This non repetitive propagation guarantees that the share will be relayed to a different node in each step of random propagation, leading to better propagation efficiency. The flow used for each neighbor node is shown in the fig3

The epedimic trust is defined as

$$\text{epedemic trust} = \frac{\text{Average delay}}{\text{end to end delay}} * N_{\text{packets}} \quad (4)$$

For all the neighbors, the individual route discovery is found out. For each of the route end to end delay, number of packets which have been delivered by the route and average delay is found out in order to compute the epedimic trust. After computing the epedimic trust for all the routes, find the maximum epedimic trust and then route which has the maximum epedimic trust will be selected route.

Fig 3 shows the individual route discovery for epedimic algorithm. The input for the epedimic algorithm source node, destination node, coverage area and Time To Live (TTL) period will act as an input. Find the distance with respect to other nodes, among those nodes pick the node which are within the transmission range. Find whether the node is present in the cover set. If present then communicate with destination and stop the discovery process. The neighbor node is selected based on store and forward approach, next TTL is decreased and then repeats the process until the destination is reached. If the TTL has become zero then NACK is send to source and the packet is dropped.

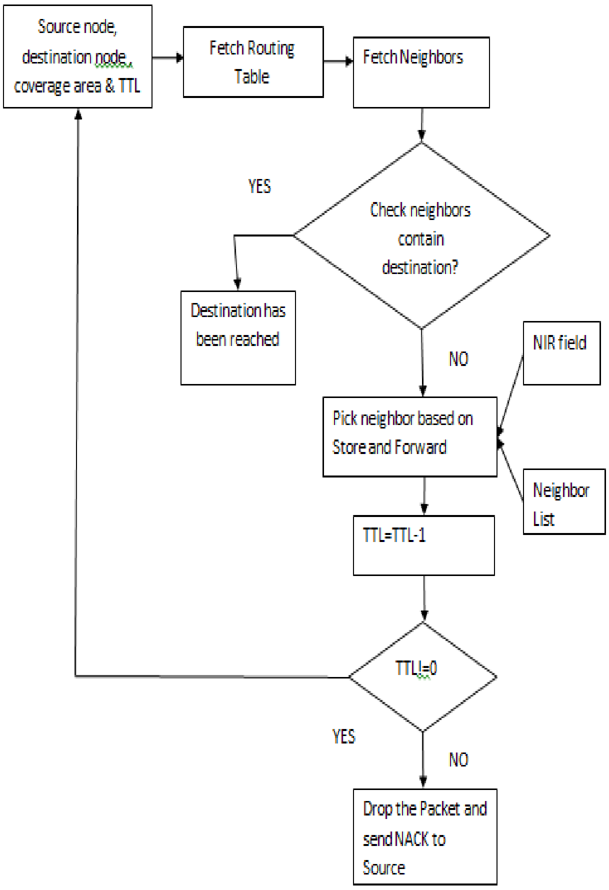


Fig 3: Epedimic Route Discovery Algorithm

B. Incentive Compatible Routing Protocol

The Incentive Compatible Routing Protocol (ICRP) will be a two hop algorithm which will generate the historic profile for each of routes on how many times a node will meet the other node. The initiator node will find the cover set nodes, from the cover set nodes a relay node is chosen as the node which has the highest meeting probability. The routing path will be SN→ RN→ DN, where SN is the source node, RN is the relay node and DN is the destination node.

V. RESULTS AND DISCUSSION

The simulation set up for all the three algorithms namely proposed system and existing methods namely Epedimic algorithm and ICRP algorithm.

Parameter Name	Parameter Value
Number of Nodes	100
Initial Battery Energy	1000
Energy Required for Transmission	20 J
Energy Required for Generation	10 J
Attenuation Factor	0.7
Time To Live	4
Number of Iterations	25
Source Node	30
Destination Node	76

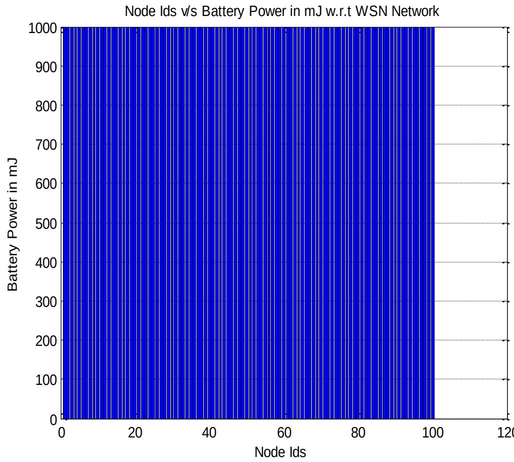


Fig 4: Initial Battery Energy for Nodes

Fig 4 shows the initial battery energy for nodes. As shown in the fig all the 100 nodes have been initialized with the same amount of energy.

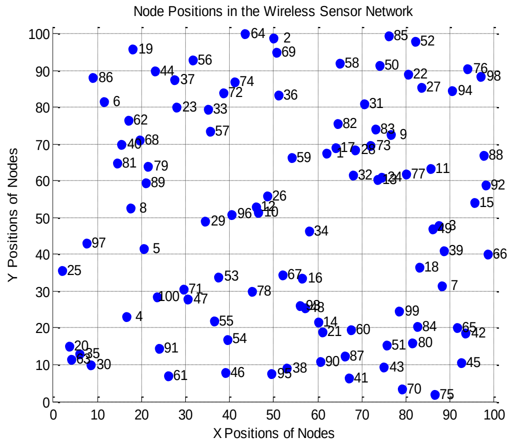


Fig 5: Node Strategy Algorithm

Fig 5 shows the node strategy algorithm. As shown in the fig nodes are distributed in an area of 100*100. As shown in the fig Node 5 is present at the location (20, 40), Node 8 is present at the location of (19, 52). In a similar fashion remaining 98 nodes have their own unique positions.

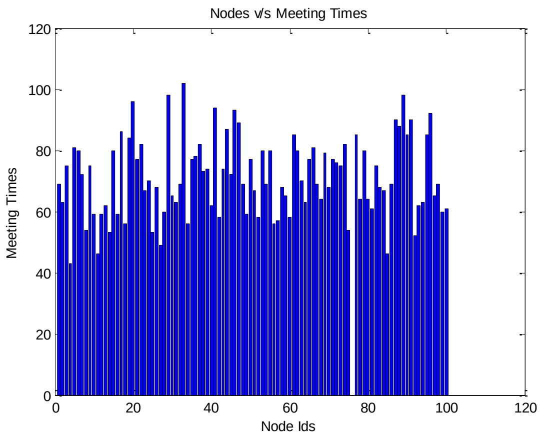


Fig 6: Node Meeting Times

Fig 6 shows the number of times the destination node meets other node in the network. As shown in the fig 6. Destination node will meet Node 29 around 98 times. Node 20 will meet the destination node around 96 times. In a similar fashion the fig shows the meeting times with respect to all other nodes in the network.

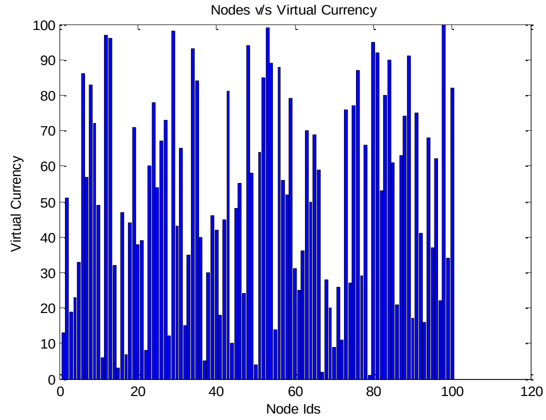


Fig 7: Virtual Currency Analysis for Nodes

Fig 7 shows the virtual currency for various nodes in the network. As shown in the fig 7 Node 29 has the virtual currency of 98. Each of the nodes will have their own values of virtual currency.

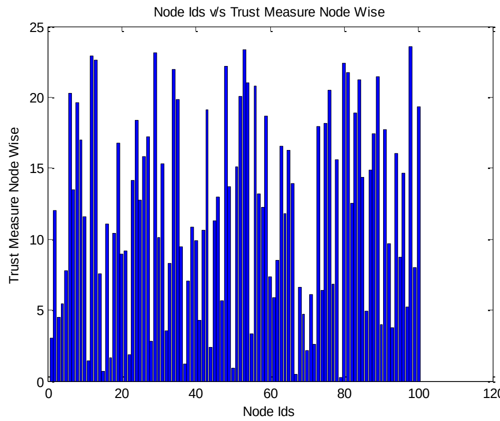


Fig 8: Trust Computation for Nodes

Fig 8 shows the trust computation for nodes in the network. As shown in the fig8 Node 53 has a trust weight of 23. Node 16 has a trust value weight of 11.

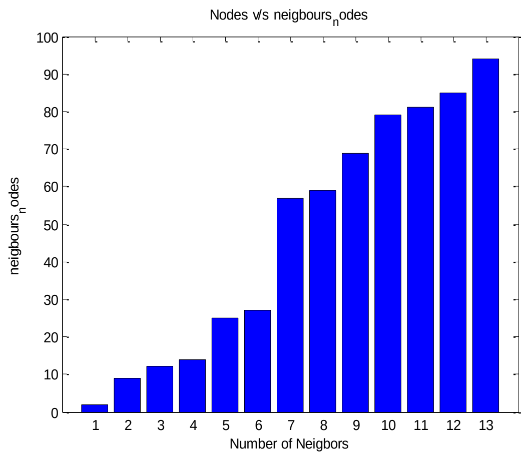


Fig 9: Neighbor Nodes in the Cover Set

Fig 9 shows the neighbor nodes. As shown in the fig there are 13 nodes which are within transmission range of initiator. The first node is Node 2, the second node is Node9. The 13 nodes in the cover set are {Node 2, Node 9, Node 12, Node 14, Node 25, Node 27, Node 57, Node 59, Node 69, Node 81, Node 85, Node 94}

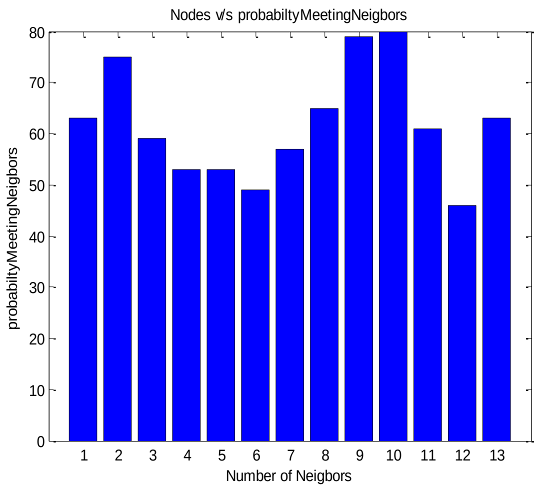


Fig 10: Meeting Count for Neighbors

Fig 10 shows the meeting count for neighbors. As shown in the fig10 the Node 2 will meet the destination node 61 times, Node 9 will meet the destination node 74 times. In a similar fashion the other nodes meeting count is determined.

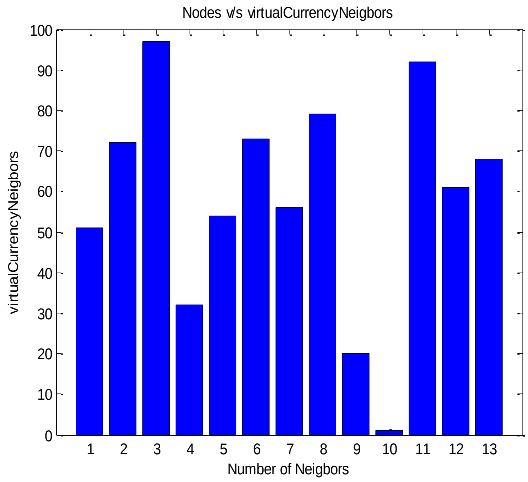


Fig 11: Virtual Currency for Cover Set Nodes

Fig 11 shows the virtual currency for the cover set nodes in the network. As shown in the fig 11 Node 2 is having virtual currency of 50, Node 9 has the virtual currency of 70 and for the remaining nodes of the cover set the virtual currency will be different.

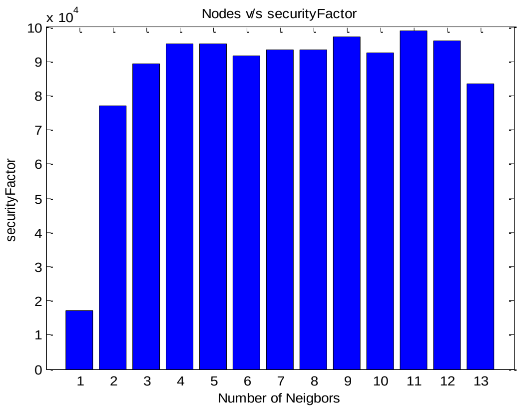


Fig 12: Security Factor for Nodes

Fig 12 shows the security factor for nodes. As shown in the fig 12 Node 2 is having security factor of 180k, 962k is the security factor of Node14 which is the second node in the security factor analysis. Node 81 has the highest security factor.

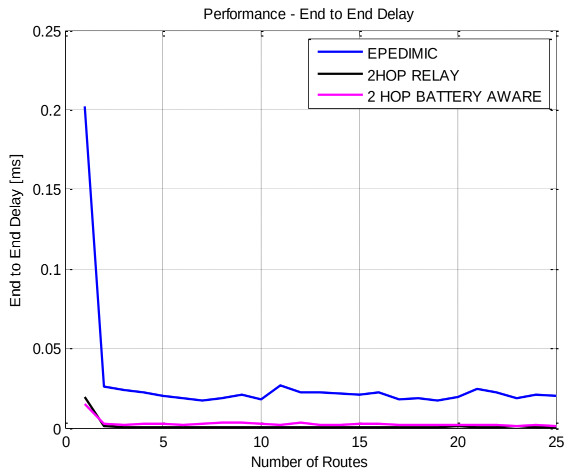


Fig 13: End to End Delay

Fig 13 shows the end to end delay. As shown in the fig 13 proposed two hop relay battery aware algorithm has the lowest end to end delay as compared to two hop relay and epedimic algorithm.

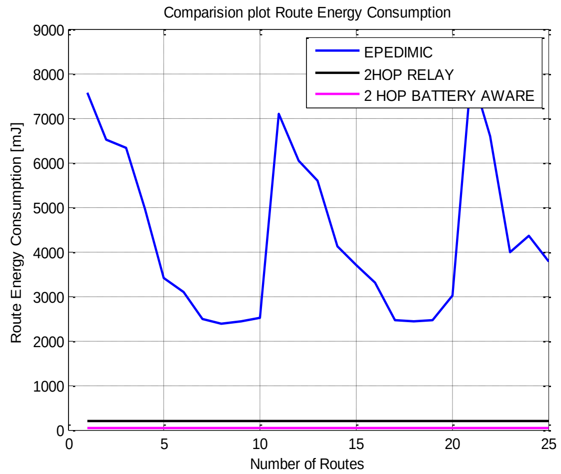
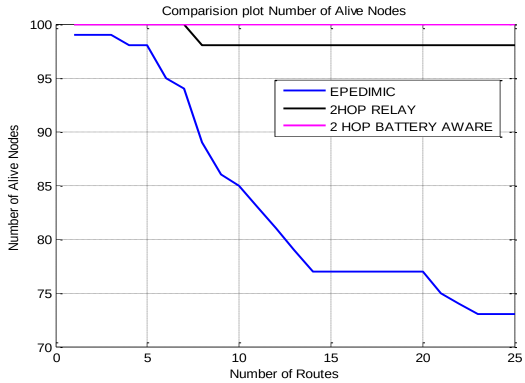


Fig 14: Energy Consumption

Fig 14 shows the energy consumption. As shown in the fig two hop battery aware will have lowest energy consumption followed by two hop relay and epedimic algorithm has the highest energy consumption.



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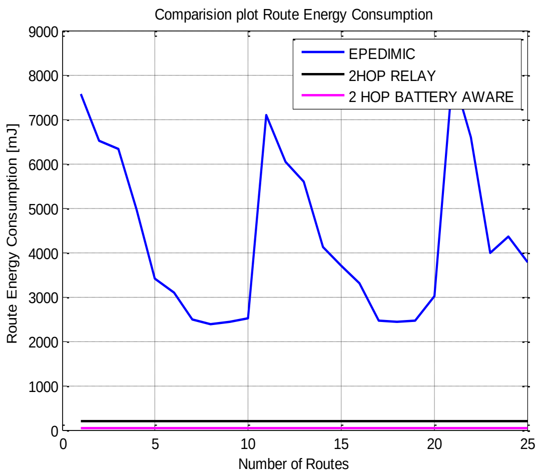

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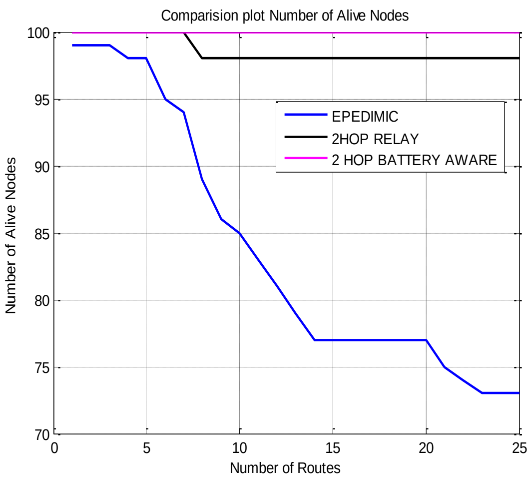

Fig 15: Number of Alive Nodes

Fig 15 shows the Number of Alive Nodes. As shown in the fig 15 two hop relay battery aware has all the 100 nodes alive even after 25 iterations, two hop relay has the number of alive nodes with a value of 98 iterations and epedimic has least number of alive nodes with a value of 73 alive nodes.

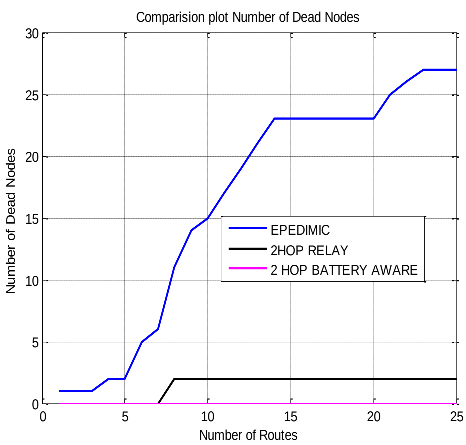

Fig 16: Number of Dead Nodes

Fig 16 shows the Number of Dead Nodes. As shown in the fig16 two hop relay battery aware has 0 dead nodes followed by 2 dead nodes for two hop relay and epedimic has highest number of dead nodes with a value of 27.

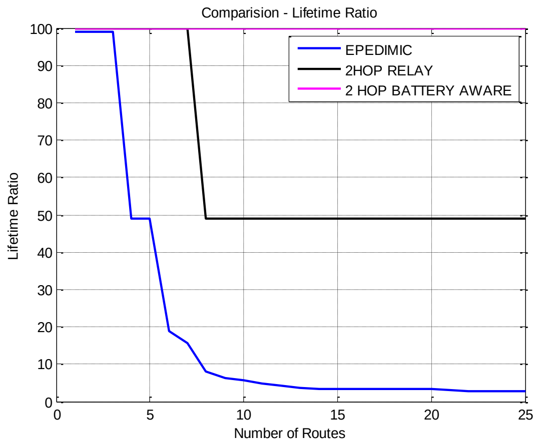

Fig 17: Lifetime Ratio

Fig 17 shows the lifetime ratio. As shown in the fig 17 the lifetime ratio of two hop relay battery aware is 100% event at the end of 25 iterations. Two hop relay has the lifetime ratio of 50% and finally epedimic algorithm has the value of 8% lifetime ratio.

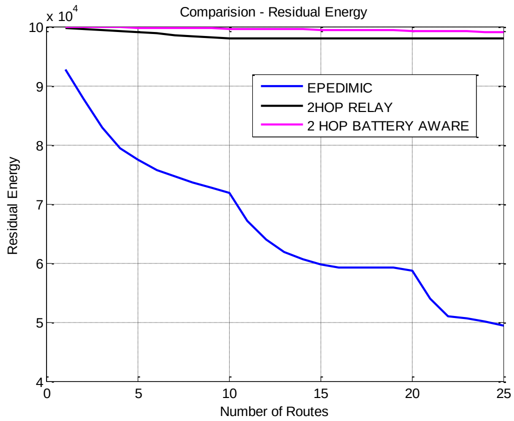

Fig 18: Residual Energy of Network

Fig 18 shows the graph of residual energy for network. As shown in the fig 18 two hop relay battery aware has the highest residual energy followed by two hop relay and epedimic has the lowest amount of residual energy.

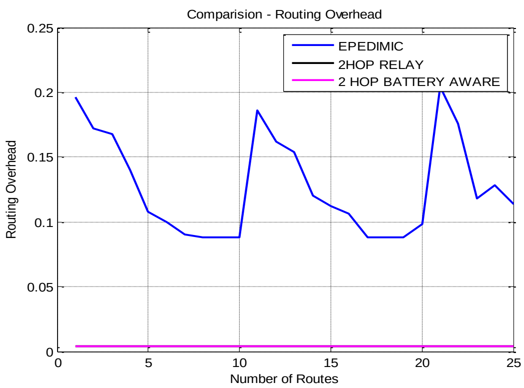

Fig 19: Routing Overhead

Fig 19 shows the graph of routing overhead. As shown in the fig 19 two hop relay battery aware and two hop relay has the same amount of overhead and then epedimic algorithm has the highest value of energy. The lesser the routing overhead the better is the performance of the algorithm.

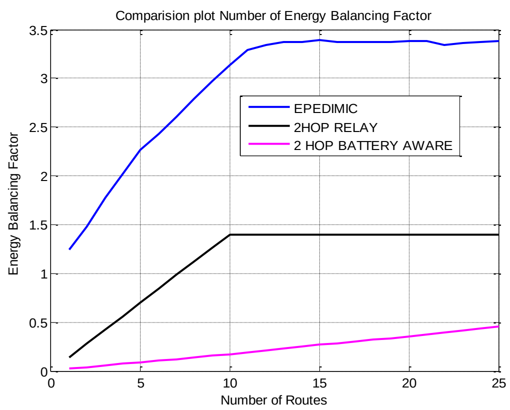

Fig 20: Energy Balancing Factor

Fig 20 shows the graph of Energy Balancing Factor. As shown in the fig 20 two hop relay battery aware has the low energy balancing factor, followed by two hop relay and epedimic algorithm.

VI. CONCLUSION

In this paper two hop relay battery aware algorithm is proposed which modifies the two hop relay by introducing the residual energy and security factors in the selection of relay node which improves the performance of the proposed method in terms of delay, energy consumption, number of alive nodes, number of dead nodes, lifetime ratio, routing overhead, residual energy and energy balancing factor. From the simulation results of all the three algorithms we have proved that the proposed two hop relay battery aware works in an optimized fashion

REFERENCES

1. Elisa Pievanelli ; Alina Plesca ; Riccardo Stefanelli ; Daniele Trinchero,"Dynamic wireless sensor networks for real time safeguard of workers exposed to physical agents in constructions sites", 2013 IEEE Topical Conference on Wireless Sensors and Sensor Networks (WiSNet), 20-23 Jan. 2013.
2. Y. T. Hou, Y. Shi, J. Pan, and S. F. Midkiff, “Maximizing the lifetime of wireless sensor networks through optimal single-session flow routing”, IEEE Trans. Mobile Comput., vol. 5, no. 9, pp. 1255–1266, Sep. 2006.
3. J. Gao, F. Li, and Y. Wang, “Distributed load balancing mechanism for detouring routing holes in sensor networks”, in Proc. IEEE Veh. Technol. Conf., Sep. 2012, pp. 1–5.
4. R. Machado and S. Tekinay, “A survey of game-theoretic approaches in wireless sensor networks”, Comput. Netw., vol. 52, no. 16, pp. 3047–3061, 2008.
5. A. Behzadan, A. Anpalagan, and B. Ma, “Prolonging network lifetime via nodal energy balancing in heterogeneous wireless sensor networks,” in Proc. IEEE Int. Conf. Commun., Jun. 2011, pp. 1–5.
6. H.-Y. Shi, W.-L. Wang, N.-M. Kwok, and S.-Y. Chen, “Game theory for wireless sensor networks: A survey”, Sensors, vol. 12, no. 7, pp. 9055–9097, 2012.
7. Ying Cai,Yanfang Fan,Ding Wen, "An Incentive-Compatible Routing Protocol for Two-hop Delay Tolerant Networks", IEEE Transactions on Vehicular Technology,0018-9545 (c) 2015.

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