# Network Life Time Prolonged Energy Efficient Routing in Adhoc Networks

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*Abstract* – **Energy aware routing algorithms called Reliable Minimum Energy Cost Routing and Reliable Minimum Energy Routing (RMER) are proposed for wireless adhoc networks. RMECR defines the requirements of adhoc networks like energy-efficiency, reliability, reliability and prolonging the network lifetime. It consider energy consumption and the remaining battery energy of the nodes. RMER finds routes minimizing the total energy required for end to end packet traversal. RMECR and RMER both ensure reliability using hop by hop or end to end packet retransmission. Energy consumed by processing elements of transceivers, limited no of transmission allowed per packet, packet size, the impact of acknowledgement packet are considered in wireless adhoc network.**

**Index Terms - Energy-aware routing, battery-aware routing, end-to-end and hop-by-hop retransmission, reliability, wireless ad hoc network.**

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## I. INTRODUCTION

The adhoc network have come into existence in order to overcome the limitations of wired network and infrastructure based network. The main advantage for using adhoc networks are that there is no need to install base stations and they are temporary set up. Adhoc networks are well suited to free unlicensed spectrum. It supports inherent scalability with power control and cooperative relaying in which each user contributes of the capacity of network. There is no need of Access Point for communication of data. Each node can forwards the packet in the network because there is no central control head. The node has limited battery power so it is very important to use their energy very efficiently. In order to save power the physical layer transmit power according to the distance between the nodes. The main purpose of energy routing protocol is to maximize the network lifetime. The value of average power can be acquired by control packet. Routes are discovered considering the energy consumed for end-to-end (E2E) packet traversal. In order to ensure reliability of links we should choose a path which contains higher battery power of the node otherwise consider the residual energy of the node. Quality of service can be increased by finding reliable routes. The residual energy of the node is found to denote whether that node can be used for transmission or not. Although different algorithm are proposed for aiming reliability, energy-efficiency and to increase the lifetime of the networks (e.g., [3], [9], [12]).This does not ensure quality of links to the maximum level because if reliable path is chosen for transmission of data in wireless networks leads to overusing of same node. Generally energy efficient routing is very effective mechanism for reducing energy cost in adhoc networks.

## II. RELATED WORKS

There have been many algorithm proposed considering the reliability of nodes for eg Expected transmission count ETX is calculated to find reliable route which consists of links acquiring less number of retransmission. This method do not minimize the energy consumption for E2E data traversal. Considering higher priority of nodes leads to overusing of same nodes so soon it gets expires for eg consider a node which is near to the destination, a node which is close to the destination will be frequently used to forward the packet on behalf of other nodes so soon this node will fall quickly.

The next category includes algorithm that finds energy-efficient routes. Some of the algorithm addresses energy-efficiency and reliability but they do not consider the remaining battery powder of the nodes to avoid overuse of nodes (eg,[2],[10],[11]). Energy efficient algorithm proposed have a disadvantage to discover energy efficient route, they do not consider the actual energy consumption of the nodes (eg, [6],[7]). They consider only the output power of the amplifier neglecting the energy consumed by processing elements of transmitter and



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receivers (eg [1],[4]). Many algorithms have been proposed by finding routes consisting of nodes with a higher level of battery power inorder to extend the network lifetime (eg [5],[8]) .The major drawback is that they do not concentrate on reliability and energy-efficiency. The routes discovered by these algorithm is neither reliable nor energy efficient path leads to more energy consumption.

## III. PROPOSED WORK

In our work we combine the energy efficiency, reliability and prolonging the network lifetime for packet traversal in wireless adhoc networks. Reliable minimum energy cost routing (RMECR) consider the energy consumption and the remaining battery energy of the nodes. Reliable minimum energy routing (RMER) find routes minimizing the total energy required for end to end packet traversal. Both these algorithm ensure reliability using hop by hop or end to end transmission. MAC layer support HBH retransmission to increase reliability.

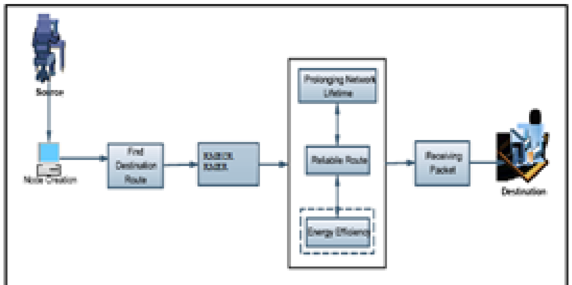


Fig 1: System Architecture Design

We address three important problem of energy efficiency. 1) Limited no of transmission on energy cost of the routes. The retransmission occurs after the expiration timer. Duration of the time is long enough to prevent unnecessary retransmission. 2) Considering the impact of acknowledgement packet on energy cost of routes. In HBH system, a lost packet is retransmitted by the sender to ensure link level reliability and acknowledgement is transmitted by the receiver to the sender. If sender does not receive the ACK either due to packet or its ACK lost or corrupted, the sender retransmit the packet. This is allowed till maximum no of transmission attempt is reached. 3) Considering the energy consumption of processing elements. In this work we consider the energy consumed by the transmission circuit and energy consumed by the power amplifier for data transmission over the air.

## IV. SYSTEM IMPLEMENTATION

### *A. Creation of Network formation*

Create a set of neighbors, represented by a Graph G(W,IE) where W is the set of nodes (vertes) and IE is the link (Edges). Nodes are assumed to be battery powered. $C_u$ represents the remaining battery energy of node n ϵ w. we assume $C_{th}$ = 0 without loss of generality. The node is considered to be dead if the battery energy of a node falls below threshold $C_{th}$ .The threshold is specified such that targeted link error is satisfied. $p_{u,v}(x)$ is the packet delivery ratio PDR of u,v for packet size x. It is the probability of error free reception of packet. Assume that nodes support adjustable transmission power. $P_{u,v}$ representstransmission power from node u to node v. $S(u) = \{P_1(u), P_2(u) \ldots P_m(u)\}$ where is the allowable number of transmission. It satisfies the targeted link error probability. The data rate of the physical link does not change by adjusting the transmission power. $P(n_1,n_{h+1}) = \{n_1,n_2,\ldots n_h,n_{h+1}\}$where $n_k$ is the identifier of $k^{th}$ node of the path. $n_1$ is the source node, $n_{h+1}$ is the destination node. r be the date rate at the physical layer in bits. $\varepsilon_{u,v}(x)$ denote energy consumed for transmitting a per bit of a packet and is denoted by

$$\in_{u,v}(x) = \left( A_u + \frac{P_{u,v}}{k_u} \right) \frac{x}{r} \qquad (1)$$

Let $A_u$ represents the power required to run the processing circuit of the transmitter node u. $P_{u,v}$be the transmission power of node u to node v.

$\omega_{u,v}(x)$ denote energy consumed for receiving a per bit of a packet

$$\omega_{u,v}(x) = \left( \frac{B_u}{r} \right) x \ (2)$$

Let $B_u$ be the power required to run the receiver circuit of the wireless interface.

### *B. Energy-Aware Reliable Routing Algorithm in HBH System*

In HBH system, a lost packet is retransmitted again to ensure link level reliability.If the destination does not receive the acknowledgement due to packet or its Ack lost or corrupted the sender retransmit upto $Q_u$



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times. $E[n_{u,v}(L_d)]$ is the expected number of times u need to transmit a packet of length $L_d$

$$E[n_{u,v}(L_d)] = \frac{1-(1-p_{u,v}(L_d)p_{u,v}(L_h))^{Q_u}}{p_{u,v}(L_d)p_{v,u}(L_h)} \quad (3)$$

$E[m_{u,v}(L_h)]$ is the expected number of Ack of length $L_h$ for a data packet

$$E[m_{u,v}(L_h)] = \sum_{i=0}^{Q_u} i \Pr\{m_{u,v}(L_h)\} = L \quad (4)$$

$a_{u,v}(L_d)$ is the total energy consumed by the transmitting node u. $\varepsilon_{u,v}(L_d)$ is the energy consumed by u during a single transmission of a packet. $\omega_{u,v}(L_h)$ is the energy consumed by u during a single reception of the ACK.

$$a_{u,v}(L_d) = E[n_{u,v}(L_d)] \in_{u,v} (L_d) + E[m_{u,v}(L_h)]\omega_{u,v}(L_h) \quad (5)$$

$b_{u,v}(L_d)$ is the total energy consumed by the receiving node. $\varepsilon_{u,v}(L_h)$ is the energy consumed by u during a single transmission of a ACK. $\omega_{u,v}(L_d)$ is the energy consumed by u for receiving a single data packet.

$$b_{u,v}(L_d) = E[n_{u,v}(L_d)]\,\omega_{u,v}(L_d) + E[m_{u,v}(L_h)] \in_{u,v} (L_h) \quad (6)$$

Let $C(P(n_1, n_{h+1}))$ be the expected energy cost to route a data packet along the path.Energy cost of a route is calculated using

$$C(P(n_1, n_{h+1})) = \sum_{i=1}^{h} [R_{n_i}(L_d) e_{n_i, n_{i+1}}(L_d)] \quad (7)$$

*C. Energy-Aware Reliable Routing Algorithm in E2E System*

$N_p(L_d)$ is the expected number of times that a data packet length $L_d$ is transmitted from source to destination.

$$N_p(L_d) = \frac{1}{R_{n_{h+1}}(L_d)R'_{n_1}(L_e)} \quad (8)$$

$M_p(L_e)$ is the expected number of times that a E2E Ack of length $L_e$ is transmitted by the destination to source node.

$$M_P(L_e) = \frac{1}{R' n_1(L_e)} \quad (9)$$

$N_p(L_d)$ and $M_p(L_e)$ is similar to $E[n_{u,v}(L_d)]$ and $E[m_{u,v}(L_h)]$ in () and ().

Expected energy cost of a path in E2E system during single transmission from a source to the destination multiplied by expected number of times that the source retransmit a packet

$$C(P(n_1, n_{h+1})) = N_P(L_d) \sum_{i=1}^{h} [R_{n_i}(L_d) e_{n_i}, e_{n_{i+1}}(L_d)] + M_P(L_e) \sum_{i=1}^{h} [R'_{n_i}(L_e) e_{n_{i+1}}, {}_{n_i}(L_e)] \quad (9)$$

where $e_{u,v}(L), L \in \{L_d, L_e\}$ is the energy cost of packet transmission over a link in the E2E system.

RMECR and RMER describe the procedure to find MECP, for which they require complete network topology. This is done with the help of optimized link state routing (OLSR) which help to share its view in network topology. Nodes use becons to find its neighboring nodes. RMECR & RMER follows the same pattern of Dijkstra's algorithm in order to find the shortest path between the nodes for transferring data. We could also implement it using Bellmen-Ford Algorithm. For which we have to calculate link weight and route cost. Using link quality estimation we can find out the PDR packet delivery ratio of the link. Expected number of PDR can be determined by using SNR- to-PDR profile mapping. For data transfer in HBH and E2E ACK may be in different sizes. So their delivery ratio will differ. In order to find reliable packet transmission to neighboring node $P_{u,v}$ each node send packet to neighboring node to calculate the minimum transmission power required for packet delivery.

## V. RESULT AND ANALYSIS

Let us compare the performance of RMECR and RMER.



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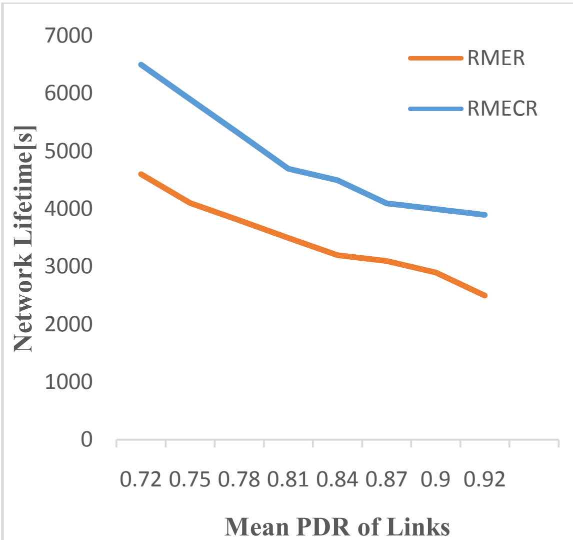


Fig 2 Packets delivery before node failure

The above figure clearly shows that RMECR can significantly delay the first node delay compared to RMER. This shows the ability of RMECR to avoid node being overused, which in turn increase the network lifetime.

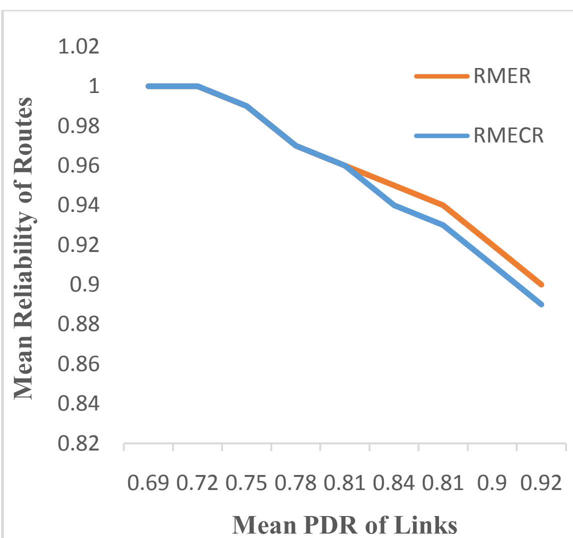


Fig 3 Average E2E Reliability of Selected Nodes

This figure shows that RMER is similar to RMECRto find more reliable routes for data transmission.

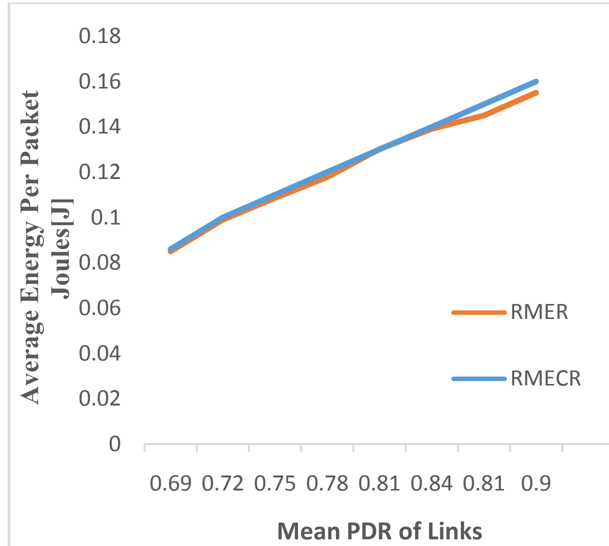


Fig 4 Energy Consumed to Route Packet

The figure shows that similar to RMER, RMCER is able to find energy efficient routes which consume less amount of energy to route a packet from source to destination. RMECR increase the operational lifetime of the network by finding more reliable and energy efficient routes.

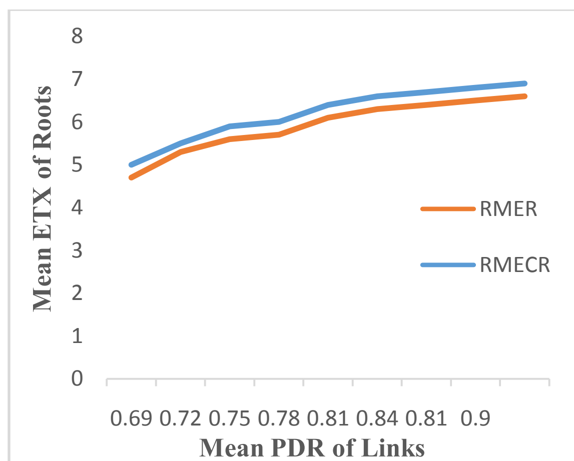


Fig 5 Average ETX of Selected Notes

The figure shows how RMCER is able to find routes in which accumulated ETX is very close to the accumulated ETX ofroutes which are selected by min ETX. This is same in case of RMER algorithm.



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## VI. CONCLUSION

RMECR and RMER is used to find reliable routes which minimize energy cost for E2E packet traversal.Energy cost of a route is related to reliability i.e) If routes are less reliable the probability of packet retransmission increases. Thus larger amount of energy will be consumed. In RMECR battery cost of nodes is the expected energy cost of a path to transfer a packet from source to destination. In RMER the amount of energy consumed by all nodes to transfer the packet from source to destination is the anticipated energy cost of a path.

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