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Enhancement of Lifetime Using Residual Energy Based Routing In Wireless Ad Hoc Networks

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***Abstract*— The most important issue that must be solved in designing a data transmission algorithm for wireless ad hoc networks is how to save sensor node energy while meeting the needs of applications/users as the sensor nodes are battery limited. While satisfying the energy saving requirement, it is also necessary to achieve the quality of service. In case of emergency work, it is necessary to deliver the data on time. Achieving quality of service in is also important. In order to achieve this requirement AODV (ADHOC on demand distance vector) routing protocol using alternate path for wireless ad hoc networks is proposed that saves the energy by efficiently selecting the energy efficient path in the routing process.. RMER and RMECR are proposed for networks in which either hop-by-hop or end-to-end retransmissions ensure reliability. Simulation studies show that RMECR is able to find energy-efficient and reliable routes similar to RMER, while also extending the operational lifetime of the network. This makes RMECR an elegant solution to increase energy-efficiency, reliability, and lifetime of wireless ad hoc networks. In the design of RMECR consider minute details such as energy consumed by processing elements of transceivers, limited number of retransmissions allowed per packet, packet sizes.**

***Keywords*—** Energy-aware routing, battery-aware routing, end-to-end delay, Hop-by-Hop retransmission, reliability, wireless ad hoc networks

1. Introduction

ENERGY-EFFICIENT routing is an effective mechanism for reducing energy cost of data communication in wireless ad hoc networks. Generally, routes are discovered considering the energy consumed for end-to-end (E2E) packet traversal. Nevertheless, this should not result in finding essential reliable routes or overusing a specific set of nodes in the network. Energy-efficient routing in ad hoc networks is neither complete nor efficient without the consideration of reliability of links and residual energy of nodes. Finding reliable routes can enhance quality of the service. A wireless AD HOC network consists of AD HOC nodes capable of collecting information from the environment and communicating with each other via wireless transceivers. The collected data will be delivered to one or more sinks, generally via multi-hop communication. Since multi-hop routing is generally needed for distant AD HOC nodes from the sinks to save energy, the nodes near a sink can be burdened with relaying a large amount of traffic from other node AD HOC nodes are resource constrained in term of energy, processor and memory and low range communication and bandwidth. Limited battery power is used to operate the AD HOC nodes and is very difficult to replace or recharge it, when the nodes die. This will affect the network performance. Optimize the communication range and minimize the energy usage, conserve the energy of AD HOC nodes. AD HOC nodes are deployed to gather information and desired that all the nodes works continuously and transmit information as long as possible.

AD HOC nodes spend their energy during transmitting the data, receiving and relaying packets. Hence, designing routing algorithms that maximize the life time until the first battery expires is an important consideration. Designing energy aware algorithms increase the lifetime of AD HOC nodes[2]. In some applications the network size is larger required scalable architectures. Energy conservation in wireless AD HOC networks has been the primary objective, but however, this constraint is not the only consideration for efficient working of wireless AD HOC networks. There are other objectives like scalable architecture, routing and latency.

2. Related work

There have been many algorithms proposed considering the reliability of nodes for e.g. 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 receivers (eg [1],[4]). Many algorithms have been proposed by finding routes consisting of nodes with a higher level of battery power in order 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.

3. SYSTEM DESIGN AND DEVELOPMENT

Wireless links in ad hoc networks are usually prone to transmission errors. This necessitates the use of retransmission schemes to ensure the reliability. Either HBH or E2E retransmissions can be used.

a. Routing in Wireless Ad Hoc Networks

Routing protocol supports the delivery of packets. It is the fundamental part of network infrastructure. Today network security has attracted more attention than before but the security concern for routing protocols has not been fully aware by the public

b. Hop-by-Hop and End-to-End Retransmission Systems

In the HBH system, a lost packet in each hop is retransmitted by the sender to ensure link level reliability. An acknowledgment (ACK) is transmitted by the receiver to the sender when the receiver receives the packet correctly. If the sender does not receive the ACK (because either the packet or its ACK is lost or corrupted), the sender retransmits the packet. In the E2E system, the ACKs are generated only at the destination and retransmissions happen only between the end nodes. The destination node sends an E2E ACK to the source node when it receives the packet correctly.

c. Energy-Aware Reliable Routing

Main objective is to find reliable routes which minimize the energy cost for E2E packet traversal. To this end, reliability and energy cost of routes must be considered in route selection. The key point is that energy cost of a route is related to its reliability. If routes are less reliable, the probability of packet retransmission increases. Thus, a larger amount of energy will be consumed per packet due to retransmissions of the packet. By defining two different ways of computing the energy cost of routes, two sets of energy-aware reliable routing algorithms for HBH and E2E systems are designed.

Minimum Energy Cost Path

The minimum energy cost path (MECP) between a source and a destination node is a path which minimizes the expected energy cost for E2E traversal of a packet between the two nodes in a multihop network.

4. DISTRIBUTED ALGORITHM

a. ENERGY AWARE RELIABLE ROUTING ALGORITHMS FOR THE HBH SYSTEM

This section presents design of RMER and RMECR algorithms for networks supporting HBH retransmissions. To this end, it analyzes the energy cost of a path for transferring a packet to its destination. Considering the impact of limited retransmissions across each link, the size of data and ACK packets, and the reliability of E2E paths is the added value of this analysis, which distinguishes this project work. Based on this in-depth analysis, it designs a generic routing algorithm for finding MECP between every two nodes of the network. By defining appropriate link weights, RMER and RMECR algorithms are derived as two flavours of this generic routing algorithm.

i. Analysis of Energy Cost of a Path

The energy cost of a path is analyzed in four steps:

1. Analyzing the expected transmission count of data and ACK packets,
2. Analyzing the expected energy cost of a link taking into account the energy cost of retransmissions,
3. Analyzing the E2E reliability of a path,
4. Formulating the energy cost of a path taking into account the energy cost of links and E2E reliability of the path.

This in-depth analysis of the energy cost lays the foundation for designing RMER and RMECR algorithms for the HBH System.

ii. Design of a Routing Algorithm for Finding MECP

Here, a generic routing algorithm for finding MECP between every two nodes in the network was designed. Since energy cost is an additive metric, it may seem that the Dijkstra's shortest path routing algorithm could be used to find MECP in the HBH system. However, it shows that the Dijkstra's shortest path routing algorithm is only a heuristic solution for

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finding MECP, but under some circumstances it could be the optimal solution.

b. ENERGY AWARE RELIABLE ROUTING ALGORITHMS FOR THE E2E SYSTEM

This section presents design of RMER and RMECR algorithms for networks supporting E2E retransmissions. Similar to the HBH system, First, analyze the energy cost of a path for transferring a packet to its destination. Here, also consider the impact of E2E ACKs, Then in section 4.3.2, a generic routing algorithm is designed for finding MECP in the E2E system. In section 4.3.3 RMER and RMECR algorithms are derived for the E2E system.

i. Analysis of Energy Cost of a Path

In the E2E system, the energy cost of a path depends on the number of times that the packet and its E2E ACK are transmitted. This, in turn, depends on the E2E reliability of the path. To determine the energy cost, we start with formulating the E2E reliability of the path for data packets and E2E ACKs. Then, the expected energy cost is calculated.

ii. Design of a Routing Algorithm for Finding MECP

Here, again the question is whether the Dijkstra's algorithm to find MECP in the E2E system can be used. If the recursive in Dijkstra's algorithm is used, using similar approach used to prove Lemma 1, it can show that it cannot find MECP using the Dijkstra's algorithm. Here, the problem is not only the dependency of the path cost to the E2E reliability of the forward and reverse paths, but also the dependency of the path cost to the energy cost of the reverse path for transferring ACKs (referred to as downstream-links dependency). In this project, it proposed two heuristic solutions for the E2E system to find MECP using a modified version of Dijkstra's algorithm. To be able to refer them in the sequel, name them H1 and H2.

5. SYSTEM MODULES

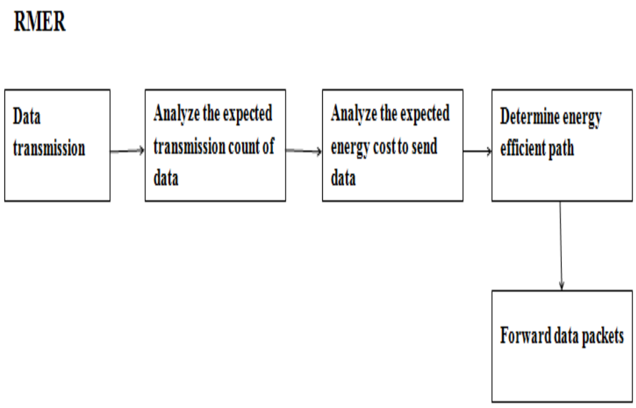

Fig. 1Block diagram for RMER protocol

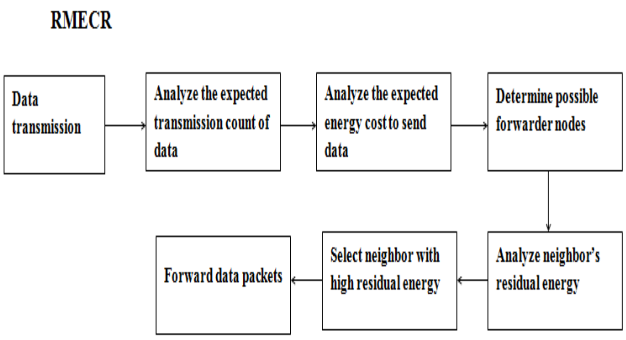

Fig. 2 Block diagram for RMECR protocol

a. Creation of wireless ad hoc networks

In this module, a wireless adhoc network is created. All the nodes are configured and randomly deployed in the network area. The nodes connected with each other through wireless links. The wireless nodes are equipped with battery resource which is not connected with fixed power supply. A routing protocol AODV is implemented in the network. Sender and receiver nodes are randomly selected and the communication is initiated between the nodes using CBR agent.

b. Energy efficiency analysis

In this module, the performance of the hybrid network and QoS parameters are analyzed. Based on the analyzed results X-graphs are plotted. Throughput, delay, energy consumption are the basic parameters considered here and X-graphs are plotted for these parameters.

c. Implementation of RMECR method

In this module, RMECR method is implemented across the network. It considers the energy consumption and the remaining battery energy of nodes as well as quality of links to find energy-efficient and reliable routes that increase the operational lifetime of the network.

d. Implementation of RMER method

In this module, RMER method is implemented in the network. RMER is an energy-efficient routing algorithm which finds routes minimizing the total energy required for end-to-end packet traversal. RMER mainly considers the total energy required to complete the transmission rather than the residual energy of the nodes.

e. Performance analysis

In this module, the performance of the RMECR, RMER methods is analyzed. Based on the analyzed results X-graphs are plotted. Throughput, delay, energy consumption are the

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basic parameters considered here and X-graphs are plotted for these parameters.

Finally, the results obtained from this module is compared with previous results and comparison X-graphs are plotted. Form the comparison result, final RESULT is concluded.

6. RESULT ANALYSIS

We use NS2 as our simulating tool. We assigned a network consisting of 40 nodes from node 0 to node 39.Initially, each node find its neighbor node by transmitting HELLO Messages. The HELLO Messages is transmitted periodically for every HELLO period second. The default transmitting range for HELLO Message is 250m. After finding its one hop and two hop neighborhoods, a node start transmitting its packet .The source node sends constant bit rate traffic to destination node. The traffic sources are carried by transport layer protocols User Datagram protocol (UDP) or Transmission control protocol (TCP). At the end of simulation, the trace file is created and the NAM is running (since it is invoked from within the procedure finish{}).Trace file gives the details of packet flow during the simulation.NAM trace is records simulation detail in a text file, and uses the text file the play back the simulation using animation.

Here we are assigning 40 nodes from node 0 to node 39 and they are apart from each other.

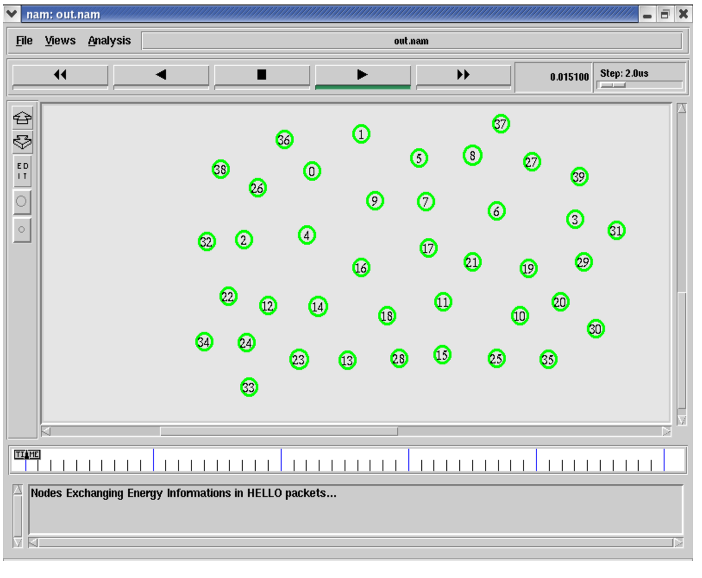

Fig. 3 Node Initialization

All the nodes find its neighbor node by sending HELLO Message. They transmit HELLO Messages periodically for every hello period second. A node is deleted from its neighbor list if no hello message is received from that neighbor in three consecutive hello periods.

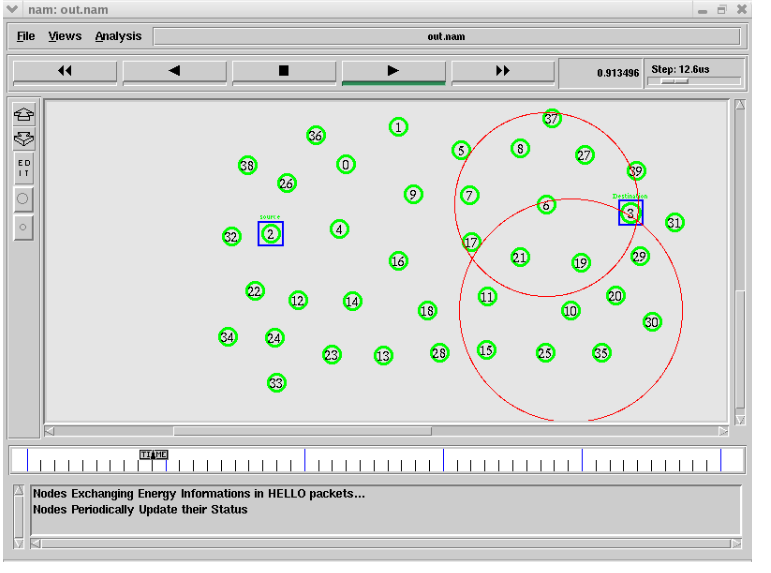

Fig.4 Neighborhood Identification & Node Configuration

The source and destination node are identified separately by naming them as source and destination and highlighting these nodes by giving them a rectangle shape.

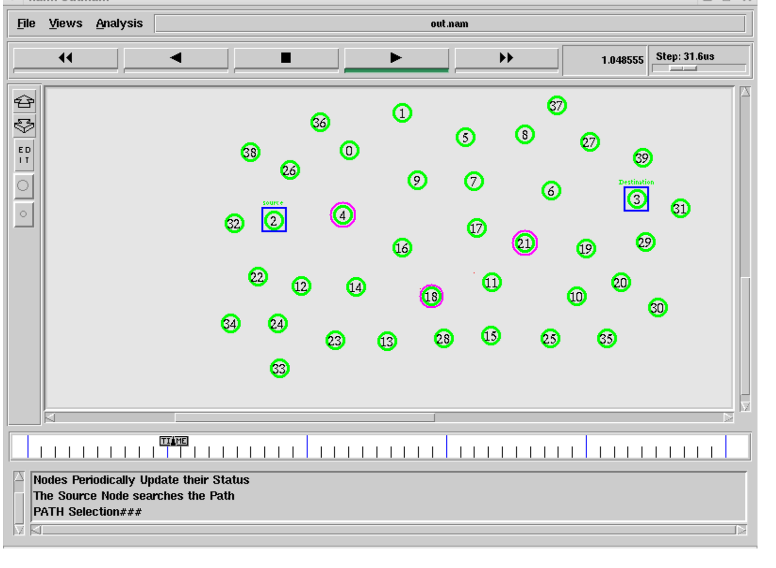

Fig.5 Estimation of Shortest Path

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Figure 5 shows, that the shortest path can be found by using the Dijkstra's Algorithm.

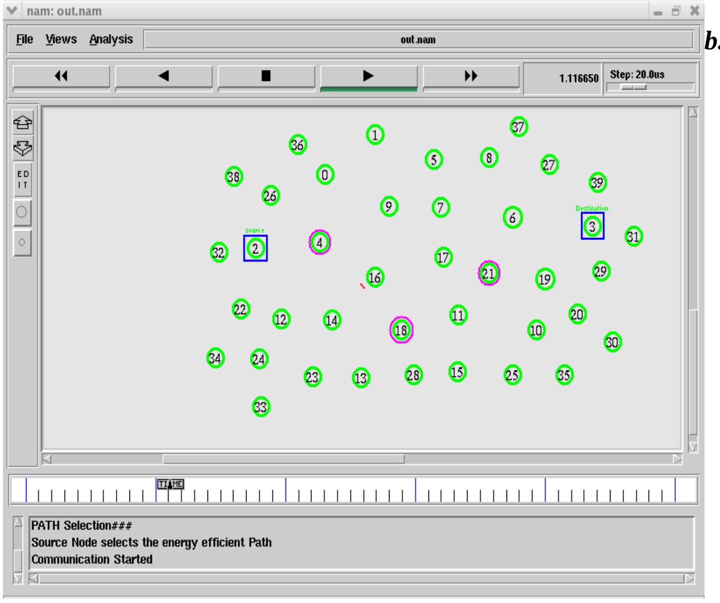

Fig.6 Energy Efficient and Reliable Routing Using RMECR Algorithm

Figure 6 shows that, Wireless Ad Hoc Networks with Energy Efficient and Reliable Routing. It improves the lifetime of the networks.

a. XGRAPH FOR THROUGHPUT

The graph in Figure 7 shows the throughput comparison for RMER and RMECR. The throughput is high for RMECR compared to RMER.

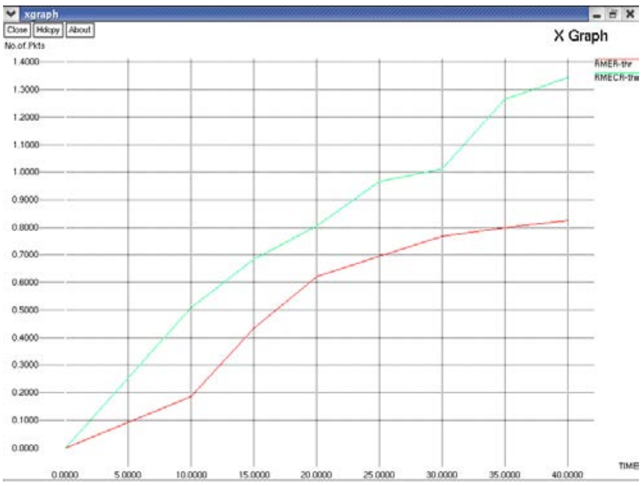

Fig 7 Xgraph for Throughput

b. XGRAPH FOR ENERGY CONSUMPTION

The graph in Figure 8 shows the energy consumption parameter comparison for RMER and RMECR. The energy consumption is less in the case of RMECR compared to RMER

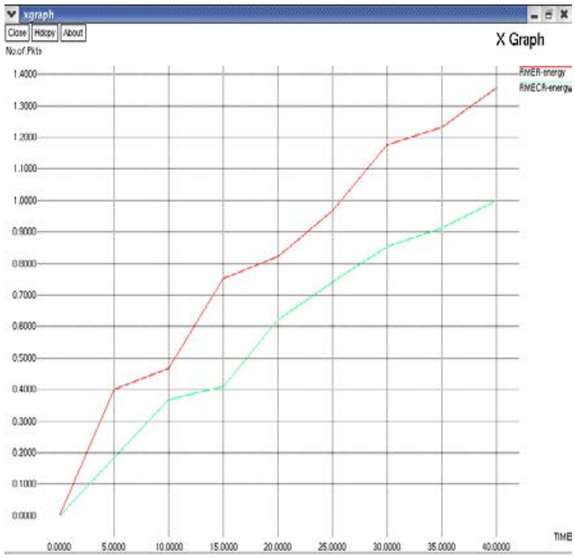

Fig 8 Xgraph for Energy Consumption

c. XGRAPH FOR DELAY

The graph in Figure 9 shows the delay comparison for RMER and RMECR. The delay is less in the case of RMECR compared to RMER

Fig 9 Xgraph for Delay

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7. CONCLUSION AND FUTURE WORK

This paper presented an in-depth study of energy-aware routing in ad hoc networks, and we proposed a new routing algorithm for wireless ad hoc networks, namely, reliable minimum energy cost routing (RMECR). RMECR can increase the operational lifetime of the network using energy-efficient and reliable routes. In the design of RMECR, it used a detailed energy consumption model for packet transfer in wireless ad hoc networks. RMECR was designed for two types of networks: those in which hop-by-hop retransmissions ensure reliability and those in which end-to-end retransmissions ensure reliability. The general approach that it used in the design of RMECR was used to also devise a state-of-the-art energy-efficient routing algorithm for wireless ad hoc networks, i.e., reliable minimum energy routing (RMER). RMER finds routes minimizing the energy consumed for packet traversal. RMER does not consider the remaining battery energy of nodes, and was used as a benchmark to study the energy efficiency of the RMECR algorithm. Extensive simulations showed that RMER not only saves more energy compared to existing energy efficient routing algorithms, but also increases the reliability of wireless ad hoc networks. Furthermore, we observed that RMECR finds routes that their energy-efficiency and reliability are almost similar to that of routes discovered by RMER. However, RMECR also extends the network lifetime by directing the traffic to nodes having more amount of battery energy.

In future work, propose and implement a new and efficient intrusion-detection system specially designed for MANETs. In the proposed method we incorporated digital signature in our proposed scheme. In order to ensure the integrity of the IDS, proposed system requires all acknowledgment packets to be digitally signed before they are sent out and verified until they are accepted to overcomes the weaknesses like false misbehavior, limited transmission power, and receiver collision and increasing PDR.

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