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Enhancing QoS in Wireless Mobile Adhoc Networks with Energy Aware Reliable Routing Algorithm

M. Udhayamoorthi, M. Saravanan, M. Jagadesh, K.S. Mohan and S.M. Swamynathan

Assistant Professor, SNS College of Technology, Coimbatore-641 035, Tamilnadu, India

Abstract: Two novel energy-aware routing algorithms to be proposed for wireless ad hoc networks, called reliable minimum energy cost routing (RMECR) and reliable minimum energy routing (RMER). RMECR addresses three important requirements of ad hoc networks: energy-efficiency, reliability and prolonging network lifetime. 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. RMER, on the other hand, is an energy-efficient routing algorithm which finds routes minimizing the total energy required for end-to-end packet traversal. 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, we consider minute details such as energy consumed by processing elements of transceivers, limited number of retransmissions allowed per packet, packet sizes and the impact of acknowledgment packets. This adds to the novelty of this work compared to the existing studies.

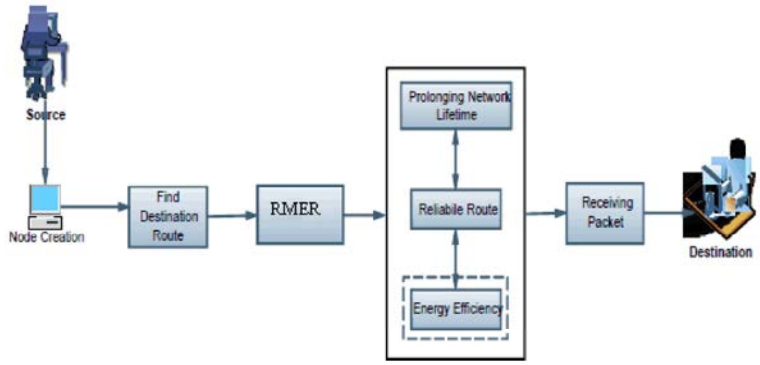
Key words: RMECR · RMER · Wireless ad hoc networks · Hor-by-hop

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 less 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. Whereas, considering the residual energy of nodes in routing can avoid nodes from being overused and can eventually lead to an increase in the operational lifetime of the network.

Energy Efficient Wireless Adhoc Routing: Wireless ad hoc networks have been deployed at an increasingly fast rate and are expected to reshape. For example, wireless ad hoc networks combined with satellite data networks are able to provide global information delivery services to users in remote locations that could not be reached by traditional wired networks. Meanwhile, advances in hardware technology are constantly proliferating various wireless communication terminals to an exploding user population. In many scenarios, designs of wireless ad hoc network protocols are guided by two requirements – energy efficiency and resilience to packet losses. Efficiently handling losses in wireless environments, therefore, assumes central importance. Generally, routes are discovered considering the energy consumed for end-to-end (E2E) packet traversal. Nevertheless, this should not result in finding less 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.

Corresponding Author: M. Jagadesh, Assistant Professor, SNS College of Technology, Coimbatore-641 035, Tamilnadu, India.



Algorithms That Consider the Reliability of Links to Find More Reliable Routes: Although such routes may consume less energy since they require less number of retransmissions, they do not necessarily minimize the energy consumption for E2E packet traversal.A higher priority for reliability of routes may result in overusing some nodes. If there are some links more reliable than others, these links will frequently be used to forward packets. Nodes along these links will then fail quickly, since they have to forward many packets on behalf of other nodes.

Algorithms That Aim at Finding Energy-Efficient Routes: These algorithms do not consider the remaining battery energy of nodes to avoid overuse of nodes, even though some of them, namely, address energy-efficiency and reliability together. They do not consider the actual energy consumption of nodes to discover energy-efficient routes. They only consider the transmission power of nodes neglecting the energy consumed by processing elements of transmitters and receivers. This negatively affects energy-efficiency, reliability and the operational lifetime of the network altogether.

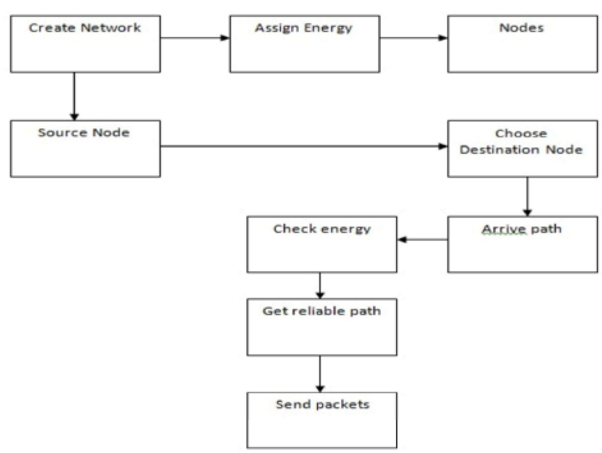
Algorithms That Try to Prolong the Network Lifetime by Finding Routes Consisting of Nodes with a Higher Level of Battery Energy: These algorithms, however, do not address the other two aspects, i.e., reliability and energy-efficiency. Discovered routes by these algorithms may neither be energy-efficient nor be reliable. This can increase the overall energy consumption in the network. The network lifetime may be reduced.

Reliable Minimum Energy Cost Routing (RMECR): Propose a novel energy-aware routing algorithm, called reliable minimum energy cost routing (RMECR) it finds energy efficient and reliable routes that increase the operational lifetime of the network. RMECR is proposed for networks with hop-by-hop (HBH) retransmissions providing link layer reliability and networks with E2E retransmissions providing E2E reliability.HBH retransmission is supported by the medium access control (MAC) layer (more precisely the data link layer) to increase reliability of packet transmission over wireless links.

Advantages:

- Considers energy efficiency, reliability and prolonging the network lifetime in wireless ad hoc networks.
- The impact of limited number of transmission attempts on the energy cost of routes in HBH systems is considered.
- The impact of acknowledgment packets on energy cost of routes in both HBH and E2E systems is considered.
- Energy consumption of processing elements of transceivers is considered.
- RMECR extends the operational lifetime of the network

System architecture



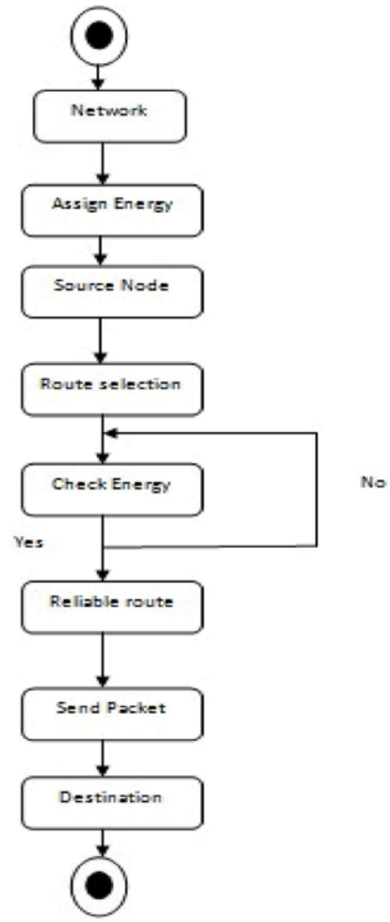
Network Model: Create topology of a wireless ad hoc networks by a graph G(V;E), where V and E are the set of nodes (vertices) and links (edges), respectively. Each node is assigned a unique integer identifier between 1 and N =|V|. Nodes are assumed to be battery powered. The remaining battery energy of node u ^{a}V is represented by Cu. If the battery energy of a node falls below a threshold Cth, the node is considered to be dead. Without loss of generality, we assume Cth =0. A link in the network is denoted by (u; v), in which u and v are sending and receiving nodes, respectively. The criterion for having a link from u to v is as follows: There could be a link from u to v, if the received signal strength by v is above a threshold. This threshold is usually specified in such a way that a targeted link error probability is satisfied.

Energy Consumption for Packet Transmission: The energy consumption for packet is given while activating the individual node in the network. This should be a constant value. Let x bit denotes the size of a packet transmitted over the physical link and E, the energy consumed by a transmitting node u to transmit a packet of length x [bit] to a receiving node v through the physical link (u; v). Let (u;v) (x)[J] denote the energy consumed by the receiving node v to receive and process the packet of length x [bit] transmitted by u. The energy consumed by nodes during packet transmission could be abstracted into two distinct parts. The first part represents the energy consumed by the transmission circuit excluding the power amplifier of the transmitter. The second part represents the energy consumed by the power amplifier to generate the required output power for data transmission over the air.

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. 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, the Dijkstra's shortest path routing algorithm is only a heuristic solution for finding MECP, but under some circumstances it could be the optimal solution.

Energy-Aware Reliable Routing: This module 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. It is designed energy-aware reliable routing algorithms for HBH and E2E systems. They are called reliable minimum energy cost routing and reliable minimum energy routing (RMER). In RMER, energy cost of a path for E2E packet traversal is the expected amount of energy consumed by all nodes to transfer the packet to the destination.

Activity Diagram:



CONCLUTION

In-depth study of energy-aware routing in ad hoc networks is done and proposed a new routing algorithm for wireless ad hoc networks, namely, reliable minimum energy routing (RMER). RMER can increase the operational lifetime of the network using energy-efficient and reliable routes. In the design of RMER, a detailed energy consumption model is used for packet transfer in wireless ad hoc networks. RMER 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. 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, it is observed that RMER finds routes that their energy-efficiency and reliability high paths.

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