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Reliable Energy Aware End to End Delivery Routing Protocol for Mobile Adhoc Networks

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Abstract

Energy conservation is important for mobile ad hoc networks where devices are expected to work for longer period of time without the need for charging their batteries. Link stability is becoming a crucial factor in the design of protocols and algorithms Often energy aware and link-stability can be two contrasting efforts and trying to satisfy both of them can be very difficult. Therefore there is a need of an intelligent routing protocol that can minimize overhead and ensure the use of minimum energy routes.In this paper a novel routing strategy is proposed. In this we propose, a more accurate analytical model to track the link-stability, and a simple energy efficient routing scheme Reliable Energy aware End to end Delivery routing protocol(REEDRP) to improve the performance during path discovery and in mobility scenarios with maximum life time. The proposed Reliable Energy aware End to end Delivery routing protocol gives good performance results in terms of packet delivery ratio, packet drop, energy consumption and delay compared with Local link Failure Recovery Algorithm (LFRA).

1 INTRODUCTION

1.1 MANET

MANET is a wireless network that is having no fixed infrastructure. It consists of a set of mobile devices that can communicate to each other without having cabled network. They are made up of nodes that are self-contained and having ability to connect to nearby wireless node and configure them without having dependency on any pre-defined network infrastructure. Since MANETs are infrastructure-less, self-organizing, rapidly deployable wireless networks, they are highly suitable for applications involving special outdoor events, communications in regions with no wireless infrastructure, emergencies and natural disasters, and military operations.

1.2 Routing in MANET

Routing is one of the key issues in MANETs due to their highly dynamic and distributed nature. Because of the antenna's limited transmission range, the nodes in the network may act as a router to forward packets to other nodes, and then a routing protocol is needed for this process. Each mobile node function as both a router and a terminal node which is a source or destination, thus the failure of some nodes operation can greatly hinder the performance of the network and also affect the basic ease of access to the network. Since the mobile nodes in MANET have limited battery power, so it is essential to proficiently use energy of every node in MANET.

1.3 Energy routing in MANET

Energy is an important resource that needs to be preserved in order to avoid early termination of a node or a network.Typical metrics used to evaluate ad hoc routing protocols are shortest hop, shortest delay and locality stability. However, these metrics may have a negative effect in MANETs because they result in the over use of energy resources of a small set of nodes, decreasing nodes and network lifetime.

In this work, we proposed a Reliable End to end Delivery routing protocol(REEDRP) and the performance metrics were studied. Since mobile nodes are powered by battery, efficient utilization of battery energy is very important. When a node exhausts its available energy, it ceases to function and the lack of mobile hosts can result in network partitioning. For that reason, power aware is an important issue in Mobile ad hoc networks. Therefore there is a need of an energy aware routing protocol that can minimize the routing overhead and ensure the end to end data delivery without any interruption.

2 OBSERVATION AND MOTIVATION

In [W.Creixell, and K. Sezaki,2007] a life time prediction based routing, focused on the minimization of the variances of the nodes remaining energies in the network is proposed.In this protocol each node tries to predict the future energy expenditure, but its estimation depends on many factors such as node distances, residual power, hop count and node mobility.

In [N.Meghanathan, 2007]the link stability probability is determined by considering the signal stability. However, this approach cannot be suitable because it assumes that the signal strength can be affected by environmental conditions and its value can change a lot also for the same node distance.

In [C.K- Toh,2007] the authors propose a Power efficient reliable location based routing scheme in order to increase the delivery ratio of GPRS and select the more stable route. However, energy is not considered in the packet forwarding and the route selection is based on too many parameters.

[F.DeRango, et al., 2008]Other techniques relay on the use of special devices, such as the global positioning system, to detect the exact position and a protocol is applied, which determinates or requests the position for the other nodes. This approach is also criticized, because in some environments, such as indoors or where the mobile nodes are greatly limited in energy, the GPS is not functional.

Opportunistic routing [A. Trivino-Cabrera, S. Canadas-Hurtado,2011] selects a best forwarder at each hop according to some metrics such as distance to the destination, link stability etc.To prevent routing information from becoming stale Geographic routing [Dazhi Chen, Pramod K. Varshney,2007] is used to exploit the one-hop neighbor's geographic information. A routing hole is said to be encountered when no forwarders are found.Hence, a back-up mode algorithm is required to enable routing around the hole in an effective and efficient manner.

[Rozner, Seshadri et al, Mehta, Y. Lili Qiu,2009] proposed Simple Opportunistic Adaptive Routing Protocol (SOAR) [4] which is a proactive link state routing protocol. Every node periodically measures and disseminates link quality in terms of Expected Transmission Count (ETX). Based on this information, a sender selects the default path and a list of forwarding nodes.This protocol achieves high throughput and deals efficiently with fairness. However, periodic measurement and dissemination of link quality drains node energy. Each node maintains a routing table adding to memory overhead.

In [Mohammad A. Mikki ,2009] proposed an Energy Efficient Location Aided Routing (EELAR) Protocol for MANETs that is based on Location Aided Routing (LAR). This Protocol makes significant reduction in energy consumption of the nodes battery by limiting the area of discovering a new route to a smaller zone. Thus overhead of control packet are significantly reduced. To show the energy efficiency of this proposed protocol they present simulations using NS-2. Results of the simulation show that this protocol makes significant improvement in delivery ratio and control packet overhead compared to DSR, AODV, and LAR protocols. This protocol makes significant reduction in the energy consumption of the mobile nodes battery through limiting the area to discover a new route. Thus overhead of the control packets are significantly reduced and the mobile nodes lifetime is increased.

An energy efficient routing protocol called as Progressive Energy Efficient Routing (PEER) is proposed in [J. Zhu, X. Wang,2011]. It takes into account the energy consumption during the route discovery phase. The cost metric is a summation of total power required to successfully transmit and receive a packet. The peer route discovery process works by first estimating the shortest paths with a minimum number of hops. Then from the shortest path set it selects the most energy efficient one. The route maintenance process in order to prevent excessive energy consumption due to extra signaling messages does not use any additional periodic messages. This leads to significant savings of channel capacity/bandwidth. PEER protocol is able to speed up path setup while adaptively adjusting the routing path to improve transmission, performance, and minimize end-to-end energy consumption.

In [F. De Rango, F. Guerriero, P. Fazio,2012] a location based Link Stability and Energy Aware Routing (LAER) protocol for distributed wireless networks is proposed that uses a greedy scheme for data forwarding. Routes are selected based on minimizing the energy consumption and maximizing the link stability. For applications requiring more emphasis on energy savings, energy metric is given more priority and for applications requiring reduced delay more emphasis is given to link stability metric. Due to transmission capabilities controlled by residual energy levels of a node LAER is able to save energy consumed per packet however mobility has a negative effect on the link stability metric.

Energy consumption is important for mobile ad-hoc networks where devices are expected to work for longer periods of time without the need for charging their batteries. Therefore there is a need of an intelligent routing protocol that can minimize overhead and ensure the use of minimum energy routes and to improve energy efficiency by minimizing congestions and reducing loss of packets.

3 PROPOSED ROUTING MECHANISM

If any node wants to send a packet, then it searches from its transmission area, if the destination is within the transmission range, then the packets are forwarded directly and the routing process ends. Otherwise the nodes inside the transmission are prioritized based on distance from sender, the node with the longest distance gets highest priority become the next forwarder. If more than one node gets the equal highest priority then one node which has the good link stability (persistence) becomes the next forwarder. The sender will send a RREQ packet to the next forwarder. The next forwarder will become a sender now. The process will repeat until the sender finds the destination.

If any node in the path who’s residual energy is less than the required energy then it will generate one agent , this agent find one node who’s residual energy is greater than or equal to the required energy as alternate node, from the intersection area of the sender and half transmission area of the next forwarder. All other nodes in the half transmission area of the next forwarder will go to sleep mode until gets another route request packet. When this next forwarder receives RREP packet then it attaches alternate node address along the RREP packet.When Destination node receives RREQ packet sends a RREP packet to the source along the reverse path.

When source node receives RREP packet, send data packet to the next forwarder. Alternate node also catches the packet and it listen the next forwarder transmission for some period of time. If the next forwarder fails to transmit the data packet, then the alternate node will transmits the packet. Otherwise, drop the cached packets.

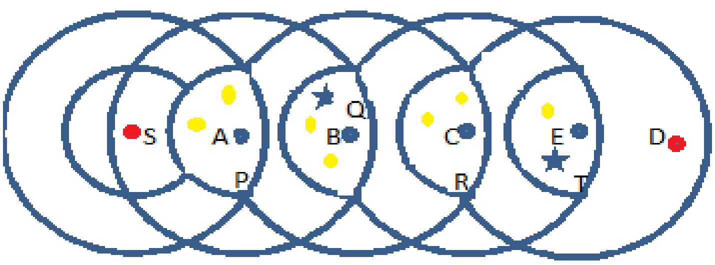

Fig.1 Routing mechanism

In figure 1, S is the source and D is destination. Selected path is S → A→ B→ C→ E→ D .Node B and E are weakest next forwarder when these nodes receive RREP packet append alternate node address in to it. Alternate nodes of E and B are T, Q respectively. Energy-aware metrics and Link-stability metrics are applied to get stable node.

Algorithm 1:
Next Forwarder and Alternate node Selection

1.If any node wants to send a packet then it will send a RREQ packet to destination
1.1. Check if Destination node is in the Transmission area.
1.2. If found, deliver the packet directly then exit.
Else
3. For all the nodes in the transmission area, do the following:
3.a .find the distance
3.b. Select one node which has longest distance from sender
3.c.If more than one node has the same distance then select one node which has good link stability as next forwarder
3.d. Repeat 3 until reach the destination
4.At the destination, destination send a RREP to the source along the reverse path
5.If any next forwarder gets the route reply packet,
5.1forward RREP to the next forwarder along the reverse path
5.1. Weak next forwarder attach alternate node address along the reverse path
5.2. All other nodes in this area go to sleep mode until get the any route request packet
6.If source receives a RREP packet ,it start sending data packets.
7.Alternate node do the following
7.1. Catch the data packet
7.2. Listen next forwarder transmission
8.If the next node fails to transmit the data packet,
8.1. The alternate node start to transmit the packet
else
8.2.Wait for a period of time and drop the cached packet.

4. SIMULATION RESULTS

4.1 Simulation Model and Parameters

The Network Simulator (NS2) [14], is used to simulate the proposed algorithm. In the simulation, the mobile nodes move in a 1000 meter x 1000 meter region for 700 seconds of simulation time. All nodes have the same transmission range of 250 meters. The simulated traffic is Constant Bit Rate (CBR).The simulation settings and parameters are summarized in table.

Table1: Simulation Parameters

Parameter	Value
-Area of simulation	1000 x 1000m^2
-Number of nodes	100
-Simulation time	700 sec
-MAC layer protocol	802.11
- Mobility model	Random Way Point
-Battery model	Linear
-Energy model	Mica Z
-Transmission power	3dBm
-Transmission Range	250m
-Minimum velocity	10ms
-Maximum velocity	20ms
-Traffic type	CBR

4.2 Performance Metrics

The proposed Reliable Energy aware End to end Delivery Routing Protocol (REEDRP) is compared with Local Failure Recovery Algorithm. The performance is evaluated mainly, according to the following metrics.

- **Packet Delivery Ratio:** It is the ratio between the number of packets received and the number of packets sent.
- **Packet Drop**: It refers the average number of packets dropped during the transmission
- **Energy Consumption**: It is the amount of energy consumed by the nodes to transmit the data packets to the receiver.
- **End to End Delay**: It is the amount of time taken by the nodes to transmit the data packets.

4.3 Results

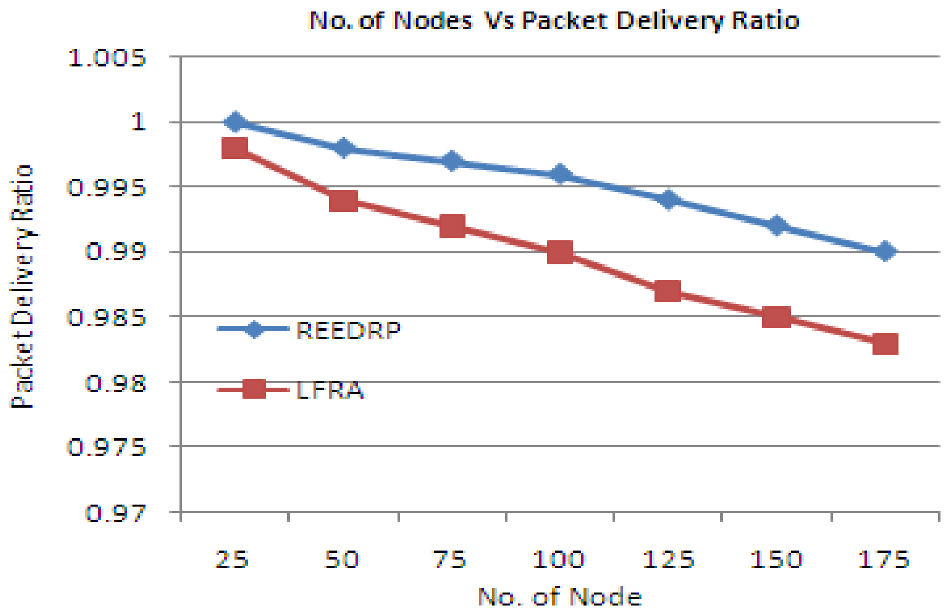

Fig.2 No. Of Nodes Vs Packet Delivery Ratio

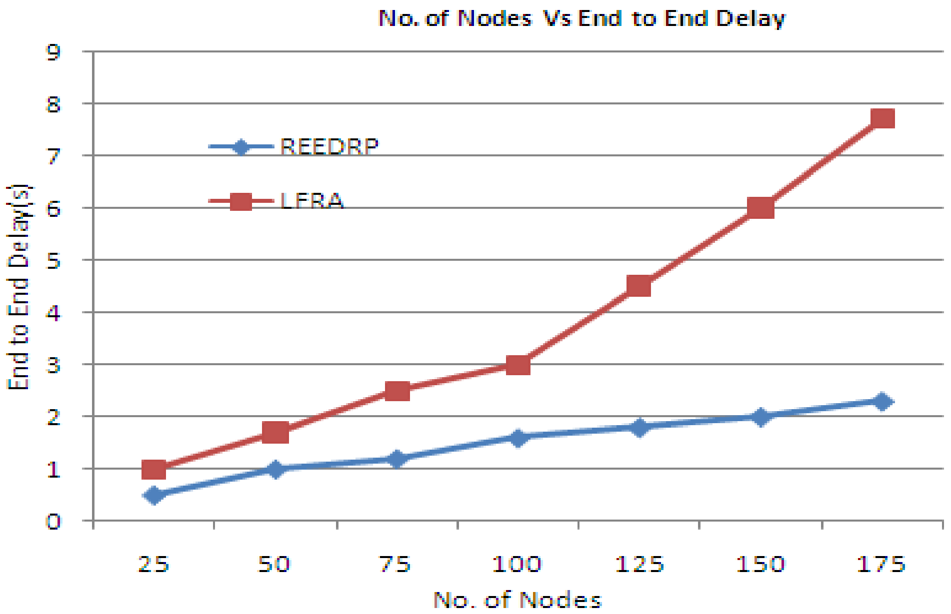

Fig.3 No. Of Nodes Vs End to End Delay

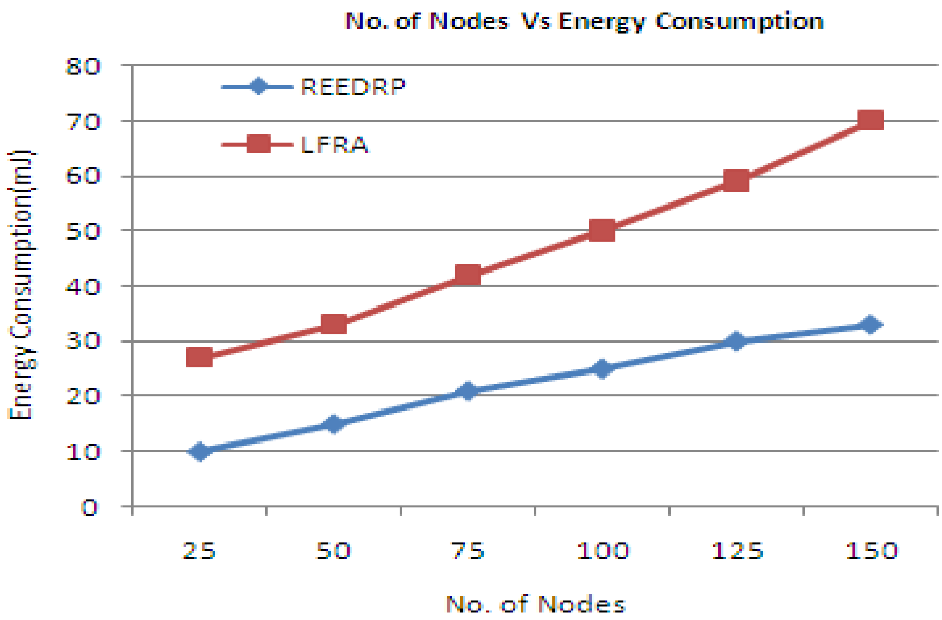

Fig.4 No. Of Nodes Vs Energy Consumption

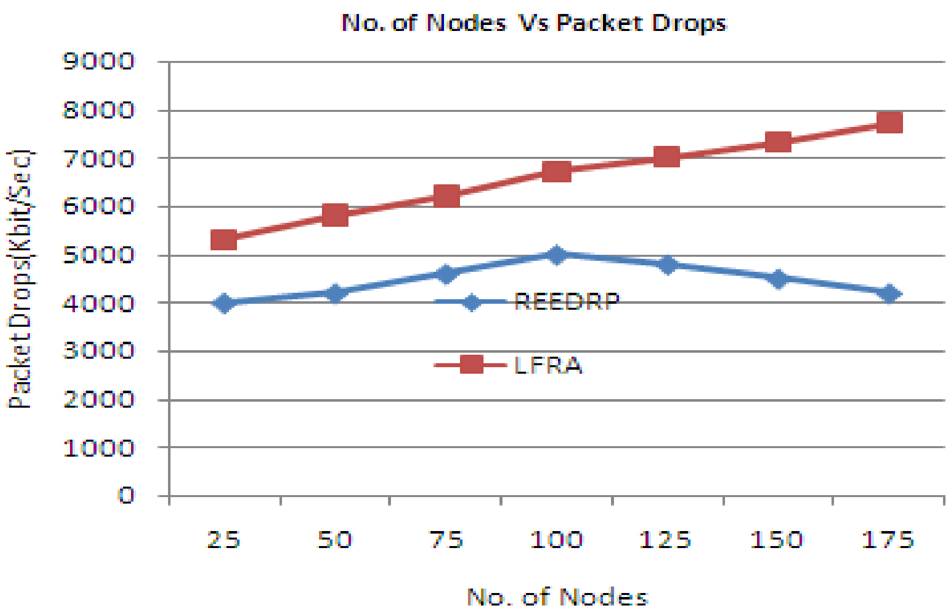

Fig.5 No. Of Nodes Vs Packet Drops

In our experiment we vary the number of nodes as 25,50, 75,100,125,150 and 175.

Figures 2,3,4 and 5 show the simulation results of REEDRP and LFRA protocols. From Figures 3,4 and 5 it is concluded that the REEDRP protocol has 10%, 20% and 15% less than LFRA in terms of End to End Delay ,Energy Consumption and packet drops for different number of nodes respectively. Figure 3 shows the Packet Delivery Ratio of REEDRP and LFRA for different number of nodes. It is concluded that the delivery ratio of the proposed REEDRP protocol has 15% higher than LFRA.

5. CONCLUSION

In this approach (REEDRP), the aim is to reduce the energy consumption by only the selected nodes are active during data transmission period. The simulation study has been conducted using Ns2 for the performance comparison of LFRA. The simulation results shows that the Reliable Energy aware End to end Delivery Routing Protocol (REEDRP) performs better for various number of nodes . The overall energy consumption of the network has decreased to almost 15% and at the same time REEDRP provides better results than LFRA in terms of end-to-end delay, packet drop and packet delivery ratio. Thus this algorithm is the best suited one compared with Local link Failure Recovery Algorithm for the applications in which the Reliable Energy aware End to end Delivery among nodes.

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