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Implementation of Fault Tolerant Topology for Increasing Network Lifetime in MANET

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Abstract- *In recent years, many energy-efficient routing protocols have been proposed. However, very little efforts have been taken in studying the energy consumption of individual node, overhead and route maintaining issues. While not considering the design of energy efficient routing protocol, it may perform very worst than the normal routing protocol. Here, we have proposed On Demand Based Energy Efficient Routing Protocol (ODBEERP). The main aim of proposed protocol is to discover the minimum power-limitation route. The power limitation of a route is decided by the node which has the minimum energy in that route. So compared with the minimum node energy in any other route, the minimum node energy in the minimum power-limitation route has more energy. We have also proposed a more accurate analysis to track the energy consumptions due to various factors, and improve the performance during path discovery and in mobility scenarios. The proposed protocol is evaluated with object oriented discrete event simulator environment. Simulation results shows that the ODBEERP achieves good throughput, less delay, high packet delivery ratio and good energy efficiency than the existing protocol PEER.*

Keywords- *MANET, Packet Delivery Ratio, DoS attack, detection efficiency and overhead.*

I. INTRODUCTION

Mobile Ad hoc networks (MANETs) are combination of mobile nodes without existence of any centralised control or pre-existing infrastructure. Such kind of networks generally use multi-hop paths and wireless radio communication channel. Thus, communication between nodes is established by multi-hop routing. Also, new nodes join or leave the network at any time. Owing to the dynamic nature, topology is often changing. Therefore performance of network deteriorates rapidly. So, the development of a secure routing protocol [1, 2] is a critical concern.

II. Previous Work

Azim [3] has proposed energy efficient routing protocol for sensor networks. Here, scheme consists of short range and non distance communication between the sensor nodes. Here the author did not focus on the outside of the transmission region. The node occupies high energy consumption with limited distance.

Ouadoudi et.al [4] explored a energy efficient clustering protocol based on decentralised clustering algorithm. Here, the energy is distributed to all sensor nodes in the network in order to prolong the network life time. Incase if the unauthenticated node is entering in to a cluster, the retransmission of packet will occur which leads to the high energy consumption. So the network connectivity may be damaged. Here they have focussed only on increasing the network life time. But due to clustering the network vulnerability may be induced.

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Lim et.al [5] proposed energy efficient communication scheme for MANET to identifies four parameters like sender ID, number of neighbor nodes, mobility and remaining battery energy based on overhearing the nodes. All nodes consistently operate in power save mode and the level of overhearing and rebroadcast level are determined based on the number of neighbors. Here they have not considered any mobility parameter to improve the energy of node.

Sujatha et.al [6] developed a load balancing mechanism for improving energy efficiency based on traffic interference between the neighboring nodes. Here, the energy efficiency of the protocol is evaluated using energy metrics average energy consumed variance and network lifetime.

Yang Qin et.al [7] developed power and traffic balance scheme which incorporates traffic factor ,energy factor and minimum number of hops without considering the impact of interference caused due to the neighboring nodes for Load Balancing. The protocol suggests a combined Load Balancing scheme that attains traffic and energy balancing mechanism that can significantly improve the performance of a routing protocol.

Li et.al [8] explored a distributed protocol to construct a minimum power topology and also developed an algorithm to find the shortest path. The length of the path is measured in term of energy consumption. This proposed algorithm used only local information between the neighboring nodes.

Li et al. [9] proposed a protocol called localized minimum spanning tree (LMST). The protocol generates a strongly connected communication graph. The topology is made symmetric by removing asymmetric links without impairing connectivity.

Sheu, Tu, and Hsu [10] used energy efficient dynamic path is maintained to send data from source to destination for MANET. Each node in a data path dynamically updates the path by adjusting its transmission power and determines its power for data transmission and control packets transmission according to the received beacon messages from its neighbors.

III. Overview of ODBEERP Protocol

The ODBEERP is a source-initiated, on-demand routing scheme. The main aim of proposed scheme to discover the minimum power-limitation route. The power limitation of a route is decided by the node which has the minimum energy in that route. So compared with the minimum node energy in any other route, the minimum node energy in the minimum power-limitation route has more energy. In other words, the value of that node’s energy is the maximum of all minimum node energy in all selectable routes.

In routing Process of On Demand Based Energy Efficient Routing Protocol (ODBEERP), The following assumptions are made:

- A node can find the value of its current energy.
- Links are bidirectional.

A. Route Discovery

In ODBEERP, nodes that are not on a selected path do not maintain routing information or participate in routing table exchanges.

The route discovery of the EECS is as follows.

Step1: When the source node wants to send a message to the destination node and does not already have a valid route to that destination, it initiates a path discovery process to locate the other node. The source node disseminates a route request (RREQ) to its neighbors. The RREQ includes such information as destination Internet ID, power boundary (the minimum energy of all nodes in the current found route), destination sequence number, hop count, lifetime, Message Authentication Code (MAC) is for providing certificate authority to the nodes and Cyclic Redundancy Code (CRC) for error detection and correction. The destination sequence number field in the RREQ message is the last-known destination sequence number for this destination and is copied from the destination sequence number field in the routing table. If no sequence number is known, the unknown sequence number flag must be set. The power boundary is equal to the source’s energy. The hop count field is set to zero. When the neighbor node receives the packet, it will forward the packet if it matches.

Step 2: When a node receives the RREQ from its neighbors, it first increases the hop count value in the RREQ by one, to account for the new hop through the intermediate node. The creator sequence number contained in the RREQ must be compared to the corresponding destination sequence number in the route table entry. If the creator sequence number of the RREQ is not less than the existing value, the node compares the power boundary contained in the RREQ to its current energy to get the minimum. If the creator sequence number contained in the RREQ is greater than the existing value in its route table, the relay node creates a new entry with the sequence number of the RREQ If the creator sequence number contained in the RREQ is equal to the existing value in its route

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table, the power boundary of the RREQ must be compared to the corresponding power boundary in the route table entry. If the power boundary contained in the RREQ is greater than the power boundary in the route table entry, the node updates the entry with the information contained in the RREQ.

During the process of forwarding the RREQ, intermediate nodes record in their route tables the addresses of neighbors from which the first copy of the broadcast packet was received, so establishing a reserve path. If the same RREQs are later received, these packets are silently discarded.

Step 3: Once the RREQ has arrived at the destination node or an intermediate node with an active route to the destination, the destination or intermediate node generates a route reply (RREP) packet. If the generating node is an intermediate node, it has an active route to the destination; the destination sequence number in the node's existing route table entry for the destination is not less than the destination sequence number of the RREQ. If the generating node is the destination itself, it must update its own sequence number to the maximum of its current sequence number and the destination sequence number in the RREQ packet immediately. When generating an RREP message, a node smears the destination IP address, creator sequence number, and power boundary from the RREQ message into the corresponding fields in the RREP message.

Step 4: When a node receives the RREP from its neighbors, it first increases the hop count value in the RREP by one like,

Hop count = Hop count +1

When the RREP reaches the source, the hop count represents the distance, in hops, of the destination node from the source node. The creator sequence number enclosed in the RREP must be compared to the corresponding destination sequence number in the route table entry. If the originator sequence number of the RREP is not less than the existing value, the node compares the power boundary contained in the RREP to its current energy to get the minimum, and then updates the power boundary of the RREP with the minimum. The power boundary field in the route table entry is set to the power boundary contained in the RREP.

B. Route Maintenance

A node uses a Hello message, which is a periodic local broadcast by a node to inform each mobile node in its neighbourhood to maintain the local connectivity. A node should use Hello messages if it is part of an active route. If, within the past delete period, it has received a Hello message from a neighbor and then does not receive any packets from that neighbor for more than allowed-Hello-loss Hello-interval milliseconds, the node should assume that the link to this neighbor is currently lost. The node should send a route error (RERR) message to all precursors indicating which link is failed. Then the source initiates another route search process to find a new path to the destination or start the local repair.

C. Analysis of the Proposed Protocol

The ODBEERP is a pure on-demand routing protocol, as nodes that are not on a selected path do not maintain routing information or participate in routing table exchanges. It allows mobile nodes to obtain routes quickly for new destinations and respond to link breakages and changes in network topology in a timely manner. The operation of ODBEERP is loop free and, by avoiding the "counting to infinity" problem, offers quick convergence when the ad hoc network topology changes (typically, when a node moves in the network). When links break, ODBEERP causes the affected set of nodes to be notified so that they are able to invalidate the routes using the lost link. As in the AODV, the shortest routing is found when the source initiates a route discovery with a new destination sequence number. But one distinguishing feature of ODBEERP is its use of a power boundary as a selection criterion. The power boundary is the minimum of all nodes' energy in the route. Using a power boundary ensures the updated route has the greater power boundary. Given the choice between two routes to a destination, a requesting node is required to select the one with the greatest power boundary. The ODBEERP selects the shortest path at first, which decreases the average relaying load for each node and therefore increases the lifetime of most nodes. At the same time, the ODBEERP updates the route using the power boundary as metrics, which can prevent nodes from being unwisely overused by extending the time until the first node powers down and increasing the operation time before the network is partitioned. This avoids additional control overhead and power consumption to perform a new route discovery process to find a path to the destination. When the energy is nearly exhausted, the Operating System (OS) and Basic Input–Output System (BIOS) will take actions in preparation for power down, which needs more power. So the maximum power boundary route can reduce the additional information operations and conserve energy. In a word, the ODBEERP can optimize power utilization.

We have also proposed one more scheme which is used to reduce the energy consumption of the MANET.

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IV. Performance Evaluation

A. Simulation Model and Parameters

The Proposed protocol is implemented with the object oriented discrete event simulator. In our simulation, 50 mobile nodes move in a 1200 meter x 1200 meter square region for 50 seconds simulation time. We assume each node moves independently with the same average speed. All nodes have the same transmission range of 250 meters. The simulated traffic is Constant Bit Rate (CBR).

Our simulation settings and parameters are summarized in table 1

No. of Nodes	50
Area Size	1200 X 1200 m^2
Mac	802.11
Radio Range	250m
Simulation Time	50 sec
Traffic Source	Constant Bit Rate (CBR)
Packet Size	512 bytes
Mobility Model	Random Way Point
Max.& Min.Speed	10 & 0.5 m/s

B. Performance Metrics

We evaluate mainly the performance according to the following metrics.

Throughput and delay: Throughput is generally measured as the percentage of successfully transmitted radio-link level frames per unit time.

Transmission delay is defined as the interval between the frame arrival time at the MAC layer of a transmitter and the time at which the transmitter realizes that the transmitted frame has been successfully received by the receiver.

Data packet delivery ratio: The data packet delivery ratio is the ratio of the number of packets generated at the sources to the number of packets received by the destinations.

End-to-end delay: This metric includes not only the delays of data propagation and transfer, but also all possible delays caused by buffering, queuing, and retransmitting data packets.

Energy Consumption per Packet: It is defined by the total energy consumption divided by the total number of packets received. This metric reflects the energy efficiency for each protocol.

Energy efficiency: Energy efficiency can be defined as where the total bits transmitted is calculated using application-layer data packets only, and total energy consumption is the sum of each node's energy consumption during the simulation time. The unit of energy efficiency is bit/Joule, and the greater the number of bits per Joule, the better the energy efficiency achieved.

The simulation results are presented in the next part. We compare our ODBEERP scheme with the existing technique PEER [12] and MTRTP [11].

C. Results

Nodes actual behaviors comply with the Bernoulli trial, which means that the probability that a node acts good is predetermined.

Figure 1 show the results of No.of Nodes Vs Energy Consumption per packet (mJ) under Different Node density (Static) scenarios for the 10,20,30,40,50 nodes. Clearly our ODBEERP Protocol consumes less energy per packet than the PEER and MTRTP protocol.

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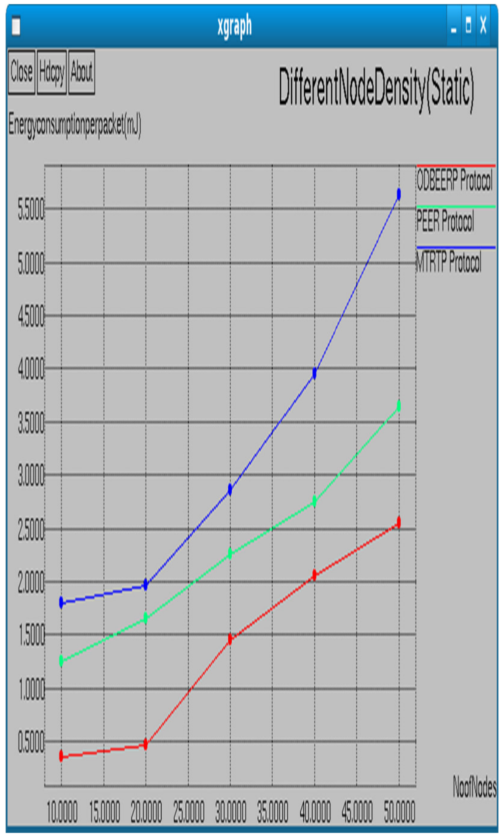

Figure 1. Different node density(Static)

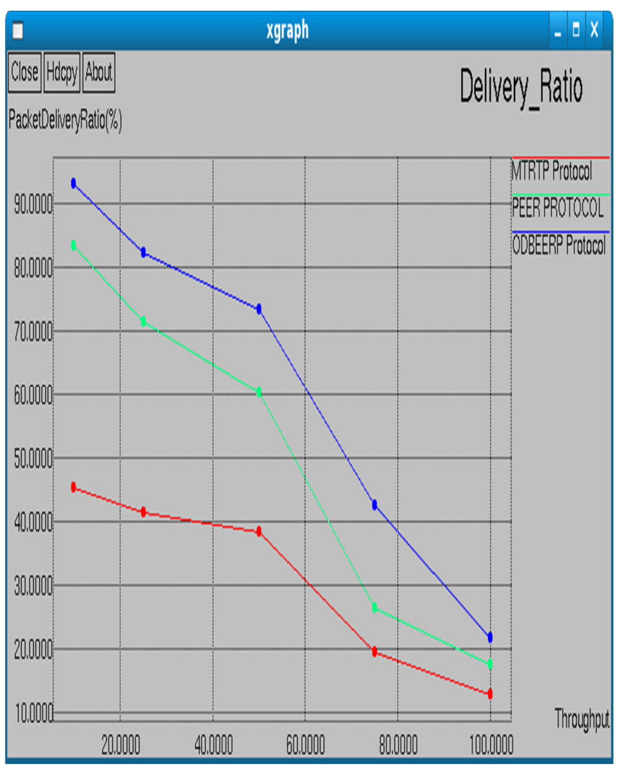

Figure 2.Throughput Vs Packet Delivery Ratio

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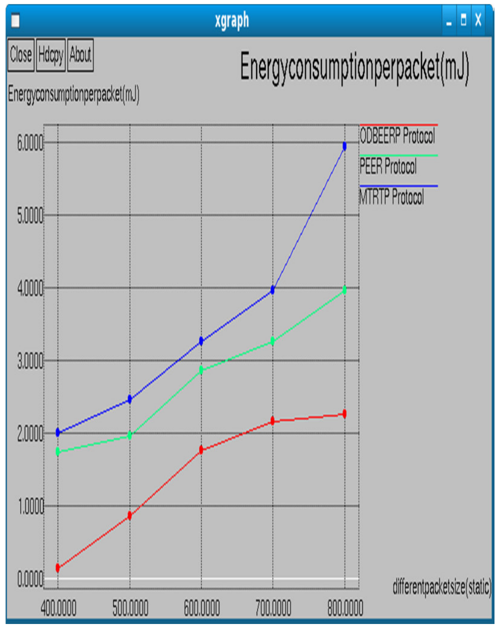

Figure 3.EnergyConsumption per Packet

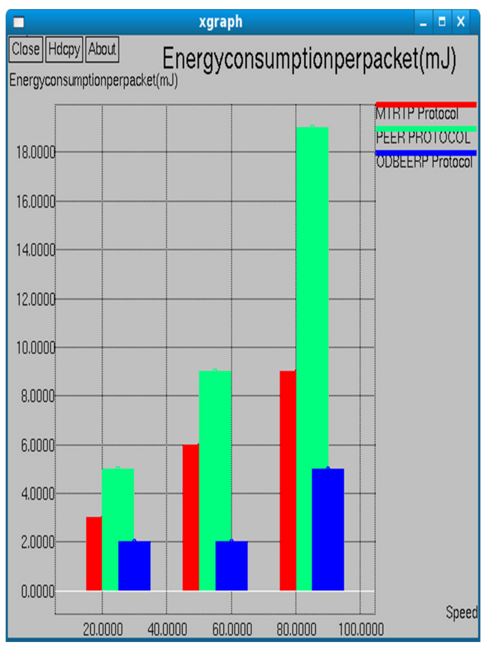

Figure 4. Speed Vs Energy Consumption

Figure 2 shows the results of packet delivery ratio for the throughput. Clearly our ODBEERP achieves more packet delivery ratio than the PEER and MTRTP.

Figure 3 shows the results of Different packet size of Nodes Vs Energy Consumption per packet (mJ) under Different Node density (Static) scenarios varied from 400 to 800 packet size. Clearly our ODBEERP Protocol consumes less energy per packet than the PEER and MTRTP protocol.

Figure 6 shows the results of Speed Vs Energy Consumption per packet (mJ) under Different Node density (Static) scenarios for the 10,20,30,40,50 …..100 speed. Clearly our ODBEERP Protocol consumes less energy per packet than the PEER and MTRTP protocol.

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V. Conclusion

In MANET, it is very important to design energy-efficient routing protocols. Incase if we have not considered a careful design, an energy-efficient routing protocol could have much poor performance than a normal routing protocol. In this paper, we first derived an analytical model to more track the energy consumption. We have also discussed the energy consumption technique using Topology Control Approach. Based on these observations and our analysis, we propose a ODBEERP protocol with a quick and low overhead path discovery scheme and an efficient path maintenance scheme for reducing energy consumption. Our performance studies show that ODBEERP protocol reduces routing overhead and path setup delay as compared to PEER and MTRTP, and is highly adaptive to the environment change. ODBEERP performs much better than normal energy-efficient protocol in both static scenario and mobile scenario, and under all circumstances in terms of node mobility, network density, and load. In mobile scenarios, ODBEERP can reduce transmission energy consumption up to 50 percent in all simulation cases compared to the conventional energy efficient routing protocol MTRTP and PEER.

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