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An Improved Energy Efficient Routing Algorithm for MANETs

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Abstract
A mobile ad hoc network (MANET) comprises of accumulation of mobile nodes which are not enclosed in any type of infrastructure. The nodes in a MANET can do communication with one another and can move everywhere with no restriction. This easy deployment and non restricted mobility features of MANETs make them suitable and popular for military and emergency operations. The nodes are mobile in nature. The constant changing topology of the network most often leads to link breakage in the network. The nodes have to rebroadcast the control messages in order to maintain the link between them. This often leads to energy consumption by the nodes. There must be routing protocol which is aimed at increasing the lifetime of the network by reducing the energy consumption. Our work aims at improving the quality of the network mainly by reducing the energy consumption.
Keywords: Routing, MANETs, AODV, DSDV

1. Introduction

Wireless network has turned out to be progressively well known during the previous decades. There are mainly two varieties of wireless networks: infrastructured and infrastructureless networks. In the infrastructured networks, communication among terminals are built up and kept up through controllers which are centric. Examples incorporate wireless local networks and cellular networks (IEEE 802.11). Infrastructureless networks are commonly alluded to as wireless ad hoc network. Such type of network is sorted out in a manner which is ad hoc, in which terminals have ability of setting up connections independent from anyone else and communicate with one another in a manner which is multi-hop without assistance of infrastructure which is fixed. This infrastructureless property makes ad hoc networks be immediately deployed in a given region and gives strong operation. Example applications include home networking, wireless sensor networks, disaster services and emergency services. [1]

During the recent past, huge advancement in the communication has turned out into a critical part for individuals for exchanging information to anyplace. With the fast improvement of wireless communication and computers, the mobile computing has turned into the prime center for any researchers. Mobile ad hoc networks are wireless networks comprises of gathering of nodes which do not have infrastructure which is fixed. These nodes are in charge of sending packets of data from source to destination particularly when two end points are not straightforwardly connected inside of their range. MANETs has been a broad area of research in these days. [2]

MANET (Mobile Ad hoc Network) is a progressively reconfigurable network which is wireless network having no settled infrastructure. Every node acts as a host and router and it moves in a dynamic way. MANET has as of late been the topic of extensive research. The enthusiasm for such network originates from their capacity to give instant and temporary solutions of wireless networking in situations in which cellular infrastructures are missing and are infeasible and expensive to convey. Because of their inherently dispersed nature, MANETs are more robust than their cellular counterparts against single point disappointments and have adaptability for rerouting against nodes which are congested. In numerous ad hoc networks, every node is powered by a battery and has restricted supply of energy. After some time, different nodes will exhaust their supplies of energy and drop out of the network. Unless nodes are recharged or replaced, the network will become partitioned inevitably. In an expansive network, generally few nodes might have the capacity for directly communicating with their destinations intended. Rather majority of the nodes might be dependent upon different nodes for sending their packets. A few nodes might be particularly critical for sending these packets since they give the only path between certain pair of nodes. Energy is rare by the way that there are mobile devices i.e. they should be little and in this way can't be fitted with large packs of battery. [3]

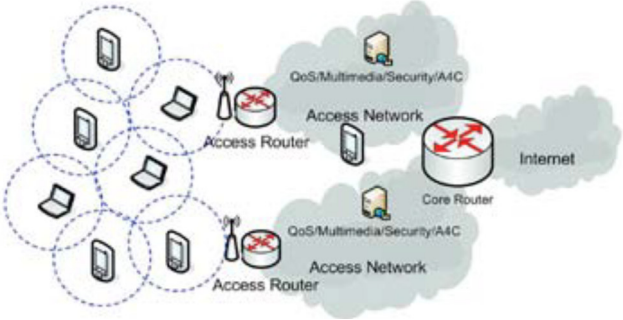

Figure 1 Mobile Ad-Hoc Network [5]

2. Routing in MANETs

Routing is the procedure of choosing paths in a network along which to send network traffic. A protocol of routing is a protocol that determines how routers perform communication with one another, dispersing information that empowers them to choose routes between any two nodes on a network of computers, the decision of the route being completed by algorithms of routing. A protocol of routing shares this information among immediate neighbors firstly, and after that throughout the network. Along these lines, routers pick up knowledge of the topology of the network.

3. Classification of Routing Protocols

There are various types of routing protocols which are discussed below [6]:

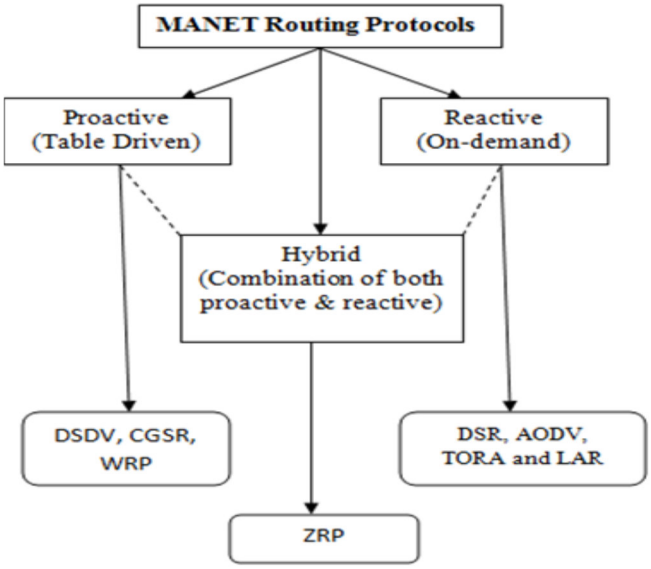

Figure 2 Classification of MANET routing protocol [12]

3.1 Proactive Routing Protocols: A proactive routing protocol is likewise known as "table driven" routing protocol. Utilizing a proactive routing protocol, nodes in a mobile ad hoc network evaluate routes continuously to all nodes reachable and endeavor to keep up reliable, up-to-date information of routing. Along these lines, a source node immediately can get a routing path on the off chance it needs one. Examples are the Fisheye State Routing (FSR), Wireless Routing Protocol (WRP), and the Destination Sequence Distance Vector (DSDV).

3.2 Reactive Routing Protocols: Reactive routing protocols for mobile ad hoc networks are additionally known as "on-demand" routing protocols. In a reactive routing protocol, paths of routing are looked at the moment when needed. An operation of discovery of route summons a procedure of determination of route. The procedure of discovery terminates either when a route has been discovered or no route accessible after examination for all permutations of route. Examples are Ad hoc On- demand Distance Vector routing (AODV) and Dynamic Source Routing (DSR)

3.3 Hybrid Routing Protocols: Hybrid routing protocols are proposed to consolidate the benefits of both reactive and proactive routing protocols and overcome their weaknesses. Appropriate reactive routing approach and proactive routing approach are exploited in various levels of hierarchy, respectively. Examples are Hybrid Ad hoc Routing Protocol (HARP), Zone-based Hierarchical Link State routing (ZHLS) and Zone Routing Protocol (ZRP). [6]

Table 1: Comparison of Routing [13]

Characteristics	Proactive	Reactive	Hybrid
Network Organization	Flat Hierarchical	Flat	Hierarchical
Topology Dissemination	Periodical	On-Demand	Both
Route Latency	Always available	Available when needed	Both
Mobility Handling	Periodical Updates	Route Maintenance	Both
Communication Overhead	High	Low	Medium

4. AODV

AODV is an on-demand protocol for routing. It does not keep up routes for each node to every another node in the

network. At whatever point there is a requirement of route to the destination, it starts a procedure of discovery of route and the routes remains as long as they are vital. AODV is free from loop at all times. The initial configuration of AODV is dependent upon DSDV (Destination-Sequenced Distance-Vector) routing algorithm. AODV is basically a combination of both DSDV and DSR. It acquires the fundamental on-demand mechanism of Route Discovery and Route Maintenance from DSR, in addition to the utilization of hop-by hop routing, sequence numbers, and periodic beacons from DSDV.

Path Discovery: The procedure of path discovery is started at whatever point a source node requires to communicate with another node for which it has no information of routing in its table. Each node keeps up two counters which are separate: a broadcast id and sequence number of a node. The source node starts discover of path by broadcasting a packet of route request (RREQ) to its neighbors.

Route maintenance: This phase is in charge for keeping up the routes. On the off chance that route is not accessible, then message of error will be sent, and all nodes will be notified. [4]

5. Energy Efficient Routing Algorithms

Energy is a restricting factor in ad-hoc networks. Routing in ad hoc networks has some exceptional attributes. Firstly- energy of nodes is very critical and relies on battery which has constrained supply of power. Secondly- there can be movement of nodes in a manner which is uncontrolled and hence frequent failures of route are conceivable. Thirdly- wireless channels have lower bandwidth which is more variable contrasted with wired network. Energy efficient routing protocols are the only available solution for above environment. Thorough research has been done in the communication which is energy efficient for achieving communications which are multi-hop and power efficient in ad hoc networks. [7]

Considering channels of multi hop communication from A to B and C is an intermediate node

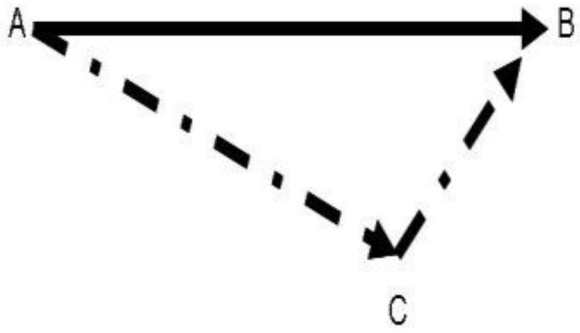

Figure 3 A Simple Scenario for Energy Consumption in Multi-hop Networks [7]

The possible states of working for the modules which are wireless (incorporating receiver or transmitter) could be sleeping, idle, receiving or transmitting. The relating power consumed in these states could be represented by P_s, P_{id}, P_{rx},P_{tx}(SNR(d)), where SNR (d) is the ratio of signal to noise for assured transmission which is reliable over some range of communication. Hence P_{tx} is the function of d, which is range of transmission between A and B or C. If A sends data to B directly then

$$P_1 = \frac{R}{W}P_{tx}(|AB|) + \frac{R}{W}P_{rx} + 2(1 - \frac{R}{W})P_{id} + P_s.$$

If A sends data to B through C then

$$P_2 = \frac{R}{W}(P_{tx}(|AC|) + P_{tx}(|CB|)) + 2\frac{R}{W}P_{rx} + (3 - 4\frac{R}{W})P_{id}.$$

5.1 Transmission Power

As per the model of propagation, the power of signal received attenuates as d^{-n} where d is the distance of transmission and normally for short distances n=2 and for long distances n=4. The MTR utilizes the power of transmission as cost metric. The cost function is defined as [8]:

$$C_R = \sum_{i=0}^{k-1} P_T(i)$$

For representing the constrain hop count and energy cost more accurately, the power cost $P_R(i+1)$, for transceiver at node v_{i+1} for receiving a packet, is additionally added to the cost function defined above:

$$C_R = \sum_{i=0}^{k-1} (P_T(i) + P_R(i+1))$$

5.2 Remaining Energy Capacity

The lifetime of network is characterized as duration of time from starting of the set up of network to the initial reduction of a node in the network. MTPR can reduce the consumption of energy per packet but it may cause depletion of nodes. The authors have proposed MBCR (Minimum Battery Cost Routing) which utilized the remaining energy capacity as metric of cost and the function of cost is defined as [8]:

$$C_R = \sum_{i=1}^{k-1} f(E_r^i(t))$$

Where

$$f(E_r^i(t)) = \frac{1}{E_r^i(t)}$$

6. Related Work

In paper [9], author gave idea of energy efficient routing algorithm for maximizing network lifetime of MANETs. Nodes in MANETs have restricted power of battery. Due to this reason, energy efficient routing has turned into important criteria of optimization in MANETs. The traditional protocols of routing don't take into account nodes energy at the time of choosing routes which results in network partitioning and fast exhaustion of nodes. The algorithm proposed in this paper finds the energy of transmission between the nodes with respect to distance and analysis of performance of algorithm is done between two metrics: Maximum Number of Hops and Total Transmission energy of route.

Reference [10] provided a study on energy efficient routing protocols in MANETs with impact on selfish behaviour. The characterization of MANETs is done with dynamic topology. This dynamism results in loss of path, multipath propagation, interference and nodes mobility. A difficult goal in MANETs is to give routes which are energy efficient as it is one of the major factors of limiting in mobile nodes. MANETs are particularly powered by batteries which have restricted reservoir of energy and it might not be recharged or replaced on the way. As a result, power consumption turned out to be an imperative issue and this deficiency of power with nodes turned into selfish behaviour between the nodes in MANETs.

Paper [11] presented energy efficient multipath routing for mobile ad hoc networks. In ad hoc networks, consumption of energy is an important issue as mobile nodes are powered with battery. This system takes into account residual energy and transmission power of nodes as metrics of energy for maximizing the lifetime of network and also for reducing consumption of energy of mobile nodes. The objective of this proposed system was to find a route which is optimal dependent upon two metrics of energy while selecting a route for transfer of data packets. The system was implemented by using NS-2.34.

In Reference [12], authors proposed energy efficient routing algorithm in MANET using optimized Euler Digraph. Euler Diagraph is utilized for transmission of data from one node to another in the form of spanning tree. In this digraph, it is tried to create shortest path for sending and receiving packet of data and tried to avoid those nodes which have taken part in this path earlier. It is also tried for balancing the consumption of energy among nodes in the path selection from sender to receiver. So this effective approach for routing overcomes the issue of dissipation of energy for few particular nodes.

Paper [13] discussed about energy efficient multicast routing protocol for MANET. Ad hoc network is an accumulation of arbitrarily located, dynamic, wireless and mobile nodes. The high mobility of nodes brings about quick change in routes, hence needing some mechanism for discovering new routes having minimum consumption of bandwidth and overhead. The specific protocols of routing of IETF are shortest routing protocols and do not take into account problem of energy aware. The energy saving of network is vital instead of shortest path. The existing protocols of multicast routing have numerous drawbacks. This paper presented a protocol known as "Energy Efficient Multicast Routing Protocol (EEMRP)" which has expanded the lifetime of every mobile node by energy utilization which is even.

7. Motivation

In the study done by Divya Sharma et al. the authors have modified the route reply phase for the ad hoc on demand distance vector routing protocol. In normal AODV, the destination node upon receiving the route request message

reply back to source node via paths from which the route request came. The source node chooses the path having lowest hop count to forward the data to destination.

However in modified AODV, the authors have divided the route reply in two phases. In First phase, destination node will reply to one of the intermediate nodes with minimum distance. In Second phase, threshold is being set for all the nodes and if any node suffers from inefficient power than it will not acknowledge the RREP packet, and the packet will be forwarded through different route with second lowest minimum distance. In this way not only energy is being conserved but also minimal distance is also selected for communication.

This approach has a drawback that the reply phase depends upon acknowledgement procedure to confirm if the node has energy greater than threshold value. Secondly, the route request phase also causes redundant broadcasting of request packets. For example, a node might receive multiple request packets from the different nodes. This process leads to delay and more energy being consumed in the network.

The research is based on following objectives:

1. To find a route to destination from source node using modified route request phase.
2. To find a route to destination from source node using MAODV.
3. Compare the performance of the network on the basis of parameters like energy consumption, delay and throughput.

8. Proposed Scheme

In the proposed work, we aim at reducing the energy consumption in the route request process while the packets are being forwarded in search of path for destination node. The nodes in the proposed route request phase will forward their energy levels and location of the destination to the neighbor nodes along with route request packets. We are using destination's location to make intelligent route request forwarding. Every node will find the neighbors to which the route request needs to be broadcasted. Then it will compare the location of the neighbors with the location of the destination node. If any neighbor node is lying in the quadrant that is towards the destination node only then it will be considered for forwarding the packets. Also if any node is receiving multiple route request packets then it will not accept the redundant request packets. This modified route request forwarding phase will save energy and will lead to increase in lifetime of the network.

When the route request will reach the destination node, the destination node will calculate the energy value of the nodes received. It will choose the path having highest energy instead of following the ACK procedure.

9. Results & Discussions

The tool used for the simulation of results is NS-2. It is discrete event simulator for networking research and works at packet level. The simulation results are shown below:

9.1 Base Paper Results

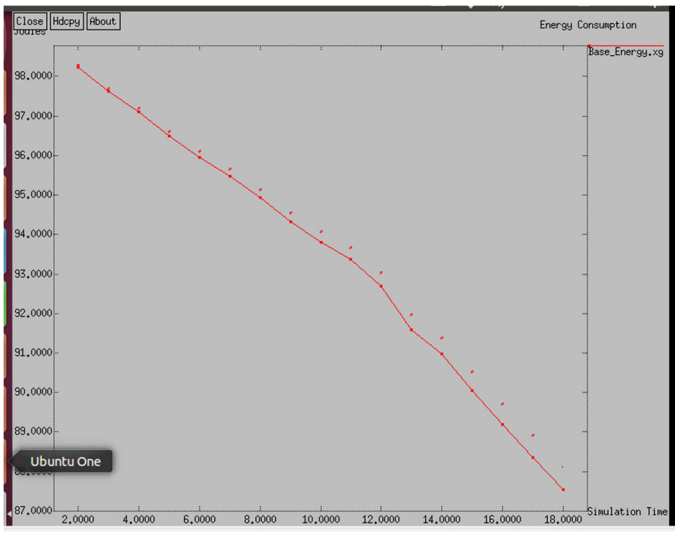

Figure 3 Energy graph

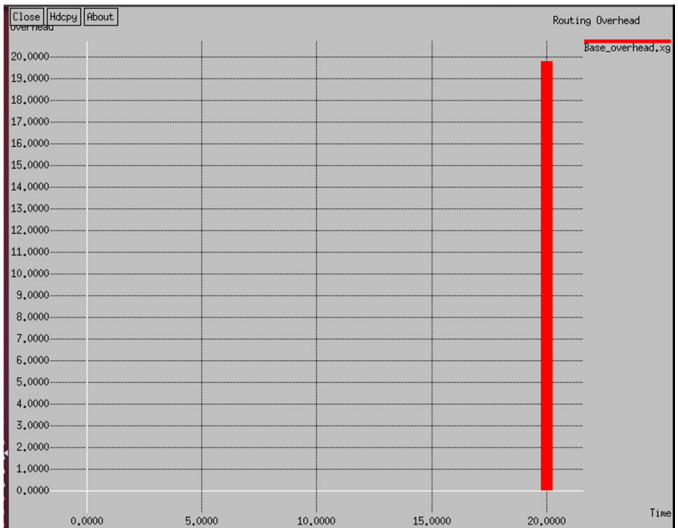

Figure 4 Overhead graph

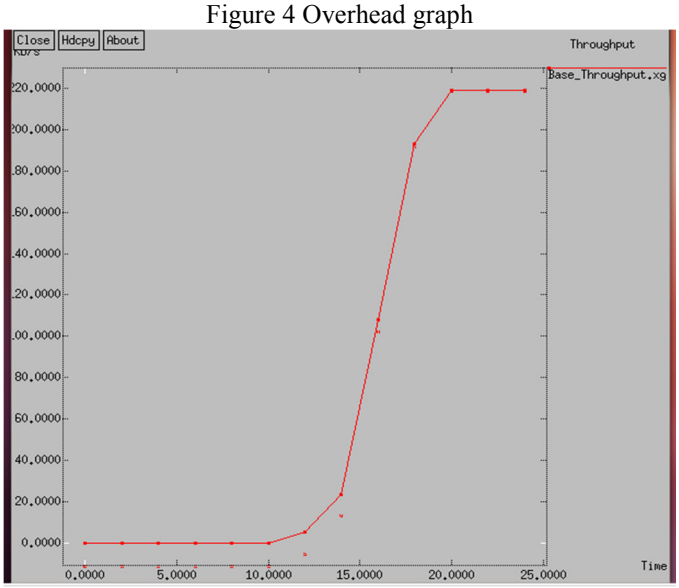

Figure 5 Throughput graph

9.2 Proposed Work Results

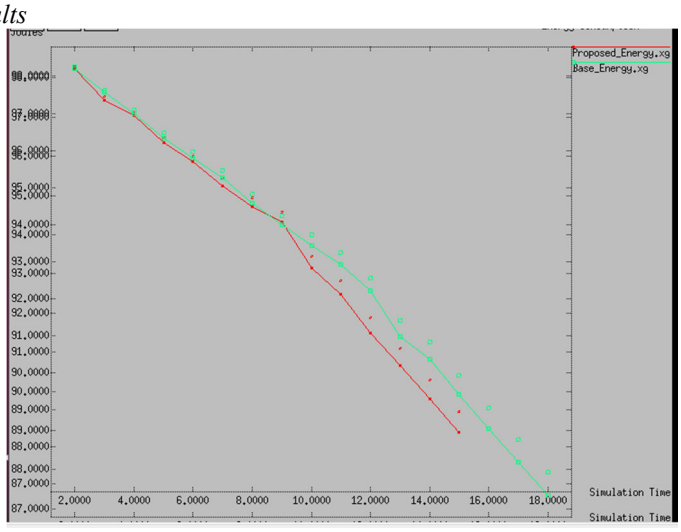

Figure 6 Energy graph

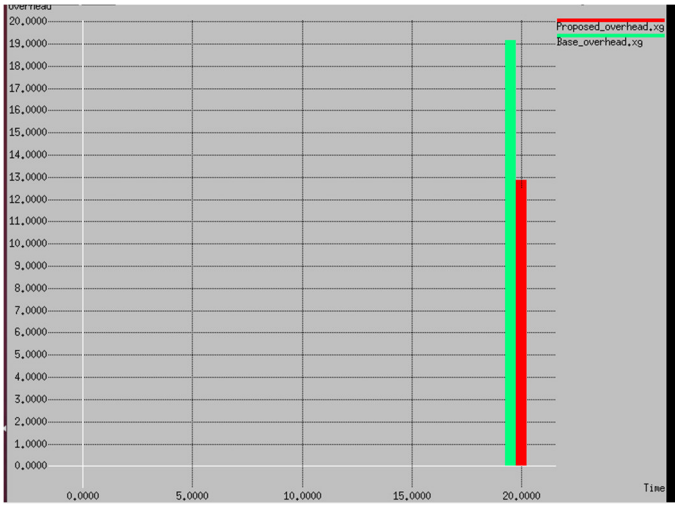

Figure 7 Overhead graph

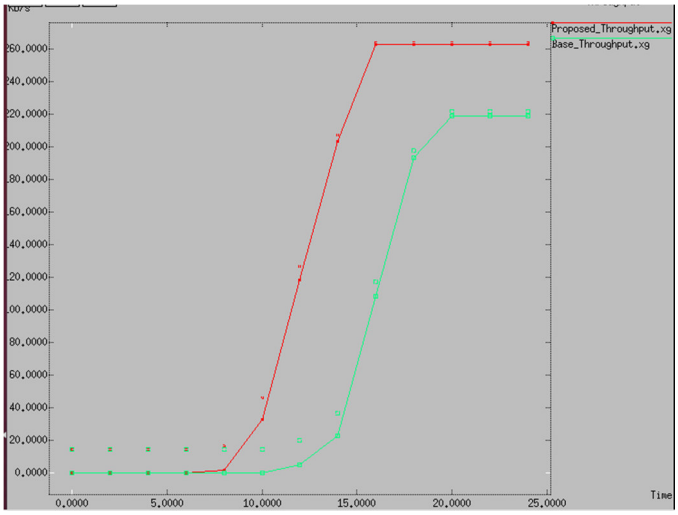

Figure 8 Throughput graph

10. Conclusion and Future Scope

The main aim of this research is to propose a technique for consumption of energy in the process of route request. The minimal distance is also selected for the process of communication. The performance of the network is compared on the basis of the parameters like energy consumption, delay and throughput.

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