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Energy Aware hop-by-hop Multipath Routing Protocol for MANET

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***Abstract*— Energy conversation is an important approach in Internet, generally different amount of data distributed on over link which it can consume more resource. Energy conversation on different traffic amount is a challenging factor to preserve network resources. In this project we design an efficient green routing scheme, where the routing can lead traffic in a way that is green. We design a Energy Aware hop-by-hop Multipath Routing Protocol with hop-by-hop routing mechanism, validates the routers for balancing traffic. The project organizes the routing phase to achieve better Quality-of-Service. We further analyze the power saving ratio, the routing dynamics, and the relationship between hop-by-hop green routing and Quality-of-Service requirements**

Index Terms*— *MANET, M-LEACH, Cluster Based Routing Protocols, H*op-by-hop routing, *Quality of Service

I. Introduction

Energy efficiency is a key factor to evaluate the communication performance in the communication technology industries, the resource utilization in communication system plays vital role due to the lack of constrained environment in wireless systems. In addition, imbalanced resource

Provision and only few percentages of resources effectively use which affect the more amount of energy waste [4]. This means that the energy consumption does not decrease when the traffic is low and that it would be possible to save large amounts of energy by organizing efficient routing and by proper resource allocation.

Energy consumption of communication systems is becoming a primary concern and, among all the sectors, wireless access networks are largely responsible for the increase in consumption. In addition to the access segment, wireless technologies are also gaining popularity for the backhaul infrastructure of cellular systems mainly due to their cost and easy deployment. In this context, Mobile Ad-hoc Network (MANET) are commonly considered the most suitable architecture because of their versatility that allows flexible configurations

Due to use of less percentage of resource utilization, lack of infrastructure, huge amount of data size, node co-ordination failure in mesh network continuous transmission problem arises. In addition High Energy consumption for high data rate transmission is the other problem arises in mesh networks. This can be minimized with the help of proposed rate allocation policy, energy efficiency can be improved in terms of bit rate performance

Mobile Adhoc networks have entirely different characteristics from the conventional wire-line networks. QoS provisioning, can become a challenging task for the wireless networks. Even though a number of QoS solutions exist for WLANs, but mobile adhoc networks present a new paradigm as they have unique requirements and limitations. Based on the importance of energy efficiency on CSMA based wireless networks, we present some of the key reasons why QoS provisioning is a challenging task in CSMA wireless multi-hop networks :

Unpredictable wireless medium - The wireless medium is unpredictable and link qualities vary over time. There are a number of factors which affect link quality including multi-path propagation, signal fading, interference and noise. These factors cause random variations in the link quality which cause packet losses and packet corruption and can make it difficult to accurately predict link bandwidth and delay.

Energy Limitations: In Mobile Ad hoc Networks and particularly Wireless Sensor Networks, energy efficiency is the cornerstone of routing. The nodes have limited energy and QoS provisioning must take into account the residual battery power as well as the rate of power consumption. The QoS solution needs to corresponding to resource utilization. Thus, QoS solutions must be power efficient.

Route Maintenance - Route maintenance is relatively a trivial task in wired network as the topology remains static. However in wireless multi-hop networks, routes can break due to a number of reasons including node mobility, power-outage at some nodes and channel conditions. Route maintenance in terms of ensuring that the route being used is supporting the required QoS is a non-trivial task for multi-hop wireless networks. QoS solutions must have efficient route maintenance mechanisms.

The scope of the project is to build a energy efficient hop-by-hop routing for MANET to reduce unnecessary energy consumption for different network traffic by balancing load traffic with choosing of optimal routing.

In this paper, we design a novel hop-by-hop approach to minimize energy consumption by discovering optimal route to avoid energy wastage. Determine a finest hops using shortest path routing algorithm such as Dijsksta. Here the proposed novel hop-by-hop routing algorithm computes a path weight to determine next level hop weights so that the forwarder node or device can select an appropriate end device to organize efficient communication. In this technique, we minimize computational complexity with an adoption of neighbour discovery and path weight, it chooses a path even if the path is free to distribute a data. Based on optimal path selection it can improve energy wastage and manage resources very efficiently

II. Energy Aware hop-by-hop Multipath Routing Protocol

Energy AwareHop-by-hop Routing builds the foundation and support for adhoc networks. It is defined as the routing decisions that fabricate at each and every router independently. To achieve loop-free hop-by-hop routing, we proposed following Algorithms. These algorithms are used to improve the energy conservation.

A. Algorithm 1: Node selection algorithm

Forward ($nodep, dataq, TTLt$)
1: discovery q at node p;
2: if do not found q then
3: $t = t + 1$;
4: if $t <= 0$ then
5: return;
6: end if
7: Divide t evenly, consider three sub-hops t_i and $t = \sum_{i=1}^{n} t_i$
8: select one node p_r from distant neighbors of p;
9: choose the min t_{min} from t_i;
10: Forward(p_r, q, t_{min});
11: choose two nodes $p1; p2$ from intermediate neighbors of p;
12: forward q to $p1; p2$ with rest hops of t_i;
13: else
14: send identified results to the initiator of q;
15: end if

B. Algorithm 2: Node Join

Join(node p)
1: select so of nodes as seed neighbors from group of nodes
2: while the neighbor list in p is not full
do
3: adopt random walk to discover more applicant nodes;
4: compute distance d_i for each applicant node p_i;
5: select the nodes whose distance $d_i < D_t$ (Threshold distance) is less than which are as the local neighbors;
6: select the nodes whose $d_i < D_t$ as the remote neighbors;
7: end while

C. Algorithm 3: Optimal route selection algorithm

RP (route R, target t)
1: for each r_i in R do
2: compute path weight W_i;

$$W_i = \frac{D(r_t, r_i)}{\sum_{j=1}^{n} D(r_t, r_i)}$$

deploy a distance function $D(r_t, r_i)$ it computes the distance between node r_t and node r_t.
routing path $R = r_1, r_2, r_3, \ldots\ldots\ldots, r_n$
3: end for
4: select the node p with max W_i;
5: build caching for t at node p;

III. Proposed Model

The main of EAH-HMR(energy efficient hop by hop multi path routing) is to find energy from source to destination. It consists of following techniques in EAH-HMR:

- Route selection
- Route Discovery
- Route Maintenance

A. Route selection using node's Cost function:

This is used to select the best and flawless path to increase the network's lifetime. It is mainly occupied by cost function. The main aim of cost function is to increase weight or cost of the nodes with less energy to increase the life time. Let,

C_i^t - Battery capacity of node n_i (residual energy)

$f_i(C_i^t)$ – Battery cost function of node n_i,

Therefore, the battery cost function of node is inversely proportional to the battery capacity of the node. $f_i(C_i^t) = 1/C_i^t$.

$$f_i(C_i^t) = \rho_i \times \left[\frac{F_i}{C_i^t}\right] \times w_i \quad (1)$$

Where, $f_i(C_i^t)$: Cost of node n_i at time t

ρ_i : Transmit power of node n_i

F_i: Full charge capacity of node n_i

C_i^t : Residual energy (Remaining battery capacity) of a node n_i at time t.

w_i : weight factor which depends upon various factors, like battery's quality, battery's capacity, life time, battery's back up, and price.

B. Cost of the path:

Let P_j be the path from source to destination d through intermediate nodes $n_1 - n_2 - \cdots \ldots\ldots\ldots\ldots n_{k-1} - n_k - d$ at time t.

$$P_j^t = s - n_1 - n_2 - \cdots \ldots\ldots\ldots\ldots n_{k-1} - n_k - d$$

We consider two different costs for each path. The first cost is chosen as maximum cost of any intermediate node on the path P_j at time t, it is also called as primary cost, and it is denoted by

$$C'(P_j^t) = \max\{f_i(C_i^t)/\forall n_i \in P_j^t\} \quad (2)$$

Where max is function that selects the maximum cost of interrelate node on the path P_j at time t .The second cost is average cost it is sum of cost of all intermediate nodes on the path P_j at time t divided by total number of intermediate nodes, it is also called secondary cost, it is denoted by

$$C'(P_j^t) = \frac{\sum_{i=1}^{k} f_i(c_i^t)}{k} \quad (3)$$

C. Route Section Techniques in EAH-HMR:

There are two different route selection techniquesare proposed such as path cost technique and cost resulting technique, which are definedas follows:

1) First technique:

In this technique we give importance to the primary cost first and next to the secondary cost. Thus, primary cost selects all the feasible paths and secondary cost selects the best paths.

2) Second Technique by using Resulting Cost of path:

An optimization problem involving multiple objective functions is known as a multi-objective programming problem. In this technique, we give equal priority to both costs and the route is selected by combination of both costs primary cost and secondary cost and is called resulting cost. The resulting cost is denoted by

$$RC(P_j^t) = C'(P_j^t) + C''(P_j^t)$$

D. Route Discovery of EAH-HMR:

The EAH-HMR is the extension of M-LEACH is used to find energy aware disjoint paths with some changes. For each destination a node keeps an advertised_hop count to define maximum hop count for all the paths present. Each duplicate route advertisement receives by a node and is defined as an alternate path to the destination. The proposed modifications made an analysis as follows:

*1) **Modifications of Control Packets Format:** There are three types of control packets used in the AOMDV*

- RREQ packet
- RREP packet
- RERR packet

RREQ and RREP packets are used in route discovery technique, where RERR packet is used in the route maintenance technique.

*2) **Modification of Functions of Nodes:** In this, we consist of three nodes as follows:*

Source node:

In this, when the source node wants to deliver the data to destination, first it checks whether the it contains any route to destination or not. Suppose, in case if it finds the destination, then it replies to the source by sending RREP. If it finds unexpired route to the existed destination then it makes use of this route to deliver the data. If the source code doesn't contain such route then it initiates the route discovery process by revealing a route request (RREQ) packet to neighbors. In Energy Aware On-Demand Multipath Routing (EAOMR), the source node functions are similar but the only difference is that it maintains unexpired energy aware node- disjoint Multipath to a destination in its cache.

Intermediate node:

The main functions of an intermediate node in EAH-HMR(energy efficient hop by hop multi path routing) are as follows:

- Preventing loops by using Route Update Rule
- Updating Routing Table for maintaining multiple paths
- Setting Reverse Path for sending RREQ packets
- Setting Forward Path for data transmission

Each node must and should follow the route update rule for preventing loops as well as to update its routing table to maintain multiple paths when it receives RREQ Packet or RREP packet from its neighbor node.

Destination node:

In this node reverse routes are set up as in intermediate nodes. It adopts a looser reply policy. It replies the copies of RREQ and later regardless of firsthops are taken by these RREQs. Further, the RREP follows the reverse routes which are set up already. Note: Looser reply policy is possible for the trajectories of RREPs to cross at an intermediate node.

A. Route maintenance:

The EAH-HMR is the extension of M-LEACH and EAH-HMR route maintenance is similar to M-LEACH. Suppose, when a link breakage is occurred due the movement of node away, the previous node makes responsible for sending the Route Error message (RERR) back to the source to inform about the breakage. Thus, to maintain the connection continuously, it selects alternative routes. It checks the routes, if it doesn't find any routes, then it will start a new route discovery.

IV. Simulation Results

We use Network Simulator Version-2 (NS2) to simulate our proposed algorithm. In our simulation, the channel capacity of mobile hosts is set to the same value: 2 Mbps. We use the distributed coordination function (DCF) of IEEE 802.11 for wireless LANs as the MAC layer protocol. It has the functionality to notify the network layer about link breakage.

In our simulation, mobile nodes move in a 1000 meter x 1000 meter region for 10 seconds simulation time. 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	50,100,150 and 200
Area Size	1000 X 1000
Mac	802.11
Radio Range	250m
Simulation Time	100 sec
Traffic Source	CBR
Packet Size	512
Receiving Power	0.395
Sending power	0.660
Idle Power	0.035
Initial Energy	10.3 J
Rate	40 Kbp

TABLE 1: SIMULATION SETTINGS

A. *Performance Metrics*

We evaluate mainly the performance according to the following metrics.

Average Packet Delivery Ratio: It is the ratio of the number .of packets received successfully and the total number of packets transmitted.Packet delivery ratio is defined as the ratio of data packets received by the destinations to those generated by the sources. Mathematically, it can be defined as:

$$PDR = S1/S2$$

Where, S1 is the sum of data packets received by the each destination and S2 is the sum of data packets generated by the each source.

Average Packet Drop: It is the average number of packets dropped by the misbehaving nodes.Mathematically,

$$Avg.\ packet\ drop\ = total\ no.packet\ send - total\ no.of\ packe$$

Delay: It is the time taken by the packets to reach the receiver.The average time it takes a data packet to reach the destination.This includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue. This metric is calculated by subtracting time at which first packet was transmitted by source from time at which first data packet arrived to destination. Mathematically, it can be defined as: $Avg.\ EED = S/N$

Where S is the sum of the time spent to deliver packets for each destination, and N is the number of packets received by the alldestination nodes.

Energy Consumption: It is the amount of energy consumed by the nodes for the data transmission.

Energy Consumption =Total no. of nodes * (etx+erx)

Where etx is energy of transfer node and erx energy of receive node

We compare our Dynamic Energy Efficient Routing Protocol with the M-LEACH technique.

B. *Results*

In our first experiment we vary the number of nodes as 50,100,150 and 200.

From figure 1, we can see that the delivery ratio of our proposed EAH-HMR is higher than the existing M-LEACH technique.

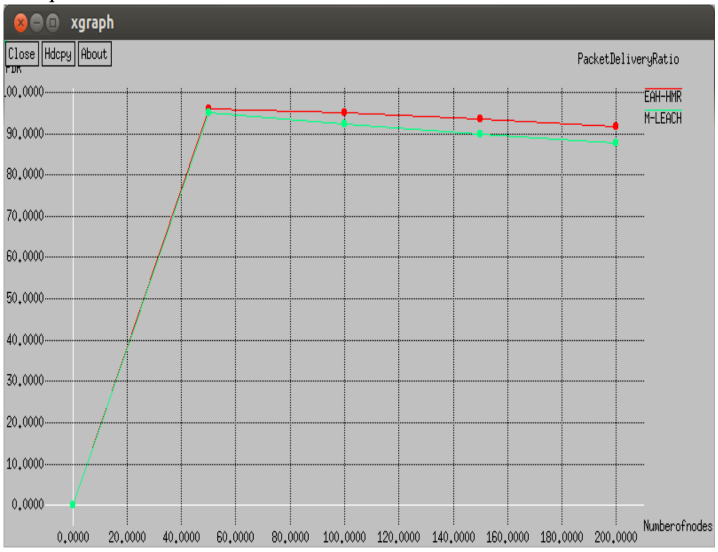

Fig 1: PDR: EAH-HMR vs M-LEACH

From figure 2, we can see that the delay of our proposed EAH-HMR is less than the existing M-LEACHtechnique.

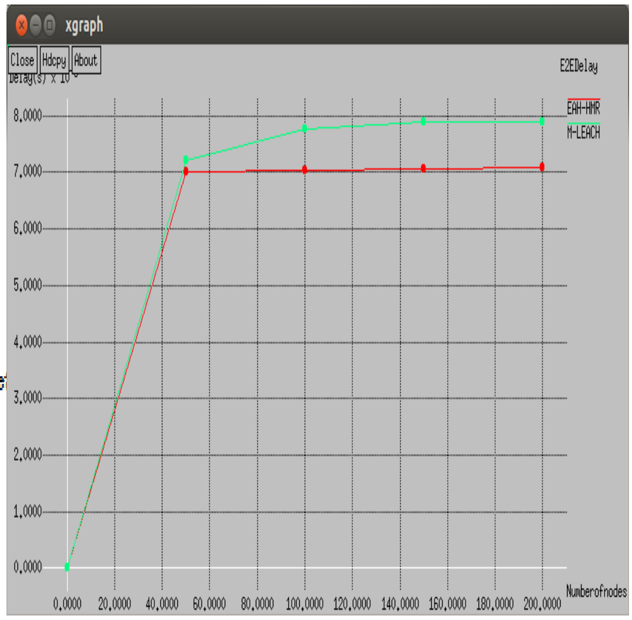

Fig 2: End-to-End Delay: EAH-HMR vs M-LEACH

From figure 3, we can see that the throughputrate of our proposed EAH-HMR is greater than the existing LEACH technique.

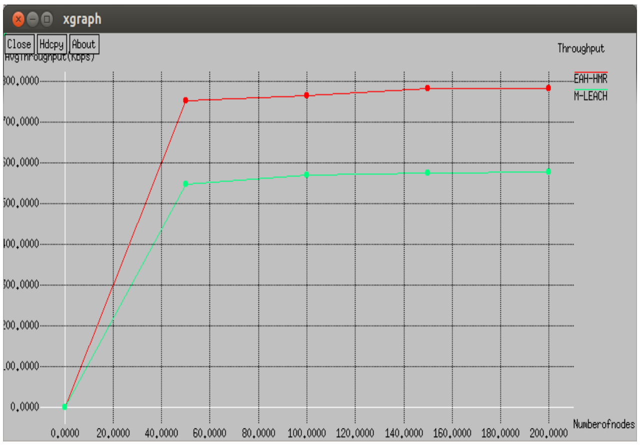

Fig 3: Average Throughput: EAH-HMR vs M-LEACH

From figure 4, we can see that the energy consumption of our proposed EAH-HMR is less than the existing LEACH technique.

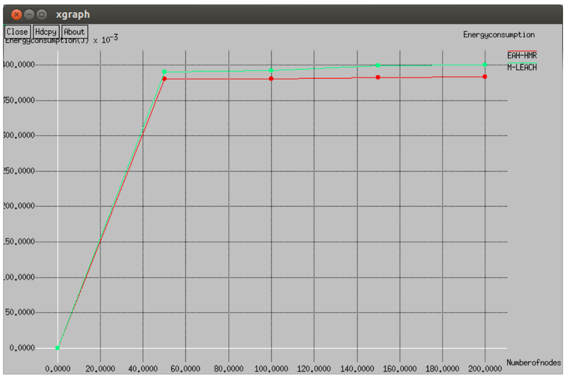

Fig 4: Energy Consumption : EAH-HMR vs M-LEACH

V. CONCLUSION

In this project we designed a novel hop-by-hop routing approach to improve problems in the existing mechanism are solved with the proposed route allocation policy and hop-by-hop algorithm. We employed shortest path routing algorithms to determine path efficiency to discovery optimal path. Based on efficient hop-by-hop route selection the energy is saved up to 22% using adaptive stream rate and power transmitter(1W). The no of transmissions can be reduced using Hop by hop algorithm in terms of performance metrics for signal overhead, packet delivery ratio, energy remaining and delay. We simulated this experiment to determine routing efficiency to achieve better quality-of service. Based on the simulation results, the EAH-HMR protocol have less energy consumption and have better throughput compare to M-LEACH.

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