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MAX-MIN Energy based Routing Scheme for Reducing Power Consumption in MANET

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Abstract—The battery power in Mobile Ad hoc Network (MANET) is the significant issue for communication. However, the portable communications devices in ad hoc networks are unfettered batteries operated and have limited energy, so the network is an energy-constrained system. The Energy efficient routing is required to minimize the energy consumption of mobile nodes. In this research proposed Maximum Minimum (MAX-MIN) Energy based Routing scheme selecting the nodes in routing that is having the sufficient energy for routing packets and data packets in network. Routing protocols are finding shortest path, that is, the least hops routing, which do not consider the energy efficient problem. How to preserve the nodes energy and prolong the lifetime of the network gradually plays an important role on evaluating the performance of ad hoc network proposed MAX-MIN scheme. The MAX-MIN scheme routing strategies are scalable because the protocol can minimize the energy consumption under not just some specific operative conditions such as lower mobility, light traffic load or low number of node but also in dense and loaded network. The This means that the design of an energy efficient routing protocol should consider also scalability issue in order to apply it in wider scenarios and to be sure that the MAX-MIN performance do not degrade too much when the energy degrades because of set of energy threshold value. In proposed scheme routing protocol either to route data through the path with maximum energy or to minimize the routing overhead, end to end delay and improves network life time of network.

Index Terms—MANET, Energy, Routing, MAX-MIN, Performance, Network life

I. INTRODUCTION

All Mobile ad hoc network (MANET) is formed by a set of mobile hosts which communicate among themselves by means of the air. Those hosts establish dynamically the network without relying on a support infrastructure and cooperate to forward data in a multi-hop fashion without a central administration [1, 2]. MANET were initially proposed for military applications and currently their use has been enlarged. Examples of application include emergency disaster relief, military battle field communication, sensing or controlling a region, sharing information during a lecture or conference, and so on [3]. MANET's hosts must ensure functionalities and guarantees provided by support structures in wired networks. Routing, access control and node authentication are examples of network functionalities that must be performed by node cooperation. Nevertheless, those hosts present characteristics, such as constraint resources (processing, memory, bandwidth, energy and others), mobility and wireless communication that limit their capacity to execute dense activities and increase the complexity on providing network management, control and security.

Routing protocols [4] generally establish the shortest path based on the number of hops between the source and the destination. In MANET, the routing protocols have to route the packets depending on the MANET constraints such as battery power in addition to the shortest path. The limited battery supply to mobile node in MANET forces the routing protocols to minimize the power consumption and maximize the network life time.

II. ENERGY EFFICIENCY ISSUE

Nodes in Mobile Ad hoc Networks (MANETs) [5, 6] are battery driven. Thus, they suffer from limited energy level problems. Also the nodes in the network are moving, if a node moves out of the radio range of the other node, the link between them is broken. .Thus, in such an environment there are two major reasons of a link breakage:

1) Node dying of energy exhaustion
2) Node moving out of the radio range of its neighboring node.

Hence, to achieve the route stability in MANETs, both link stability and node stability is essential.
Since most wireless nodes in ad hoc networks are not connected to a power supply and battery replacement may be difficult, optimizing the energy consumption in these networks has a high priority and power management is one of the most challenging problems in ad hoc networking.

Energy consumption in ad hoc node can be due to either useful or wasteful source. Useful energy consumption can be due to:-

(1) Transmitting / Receiving data,
(2) Processing query requests,
(3) Forwarding queries / data to neighboring nodes.

Wasteful energy consumption can be due to-:

(1) Idle listening to the media,
(2) Retransmitting due to packet collision,
(3) Overhearing, and
(4) Generating/handling control packets.

In general, radios in an ad hoc network node can operate in four distinct modes of operation: transmit, receive, idle, and sleep [7]. Transmit and receive modes are for transmitting and receiving data. In the idle mode, the radio can switch to transmit or receive mode. Idle is the default mode for an ad hoc environment. The sleep mode has extremely low power consumption. Therefore, taking advantage of the sleep mode is very important in energy efficient protocols. As noted above, energy efficient routing is important and necessary.

Therefore it is imperative that at any moment some specific number of nodes having sufficient energy and the rest remain are not able to take part in communication. We keep number of sufficient energy nodes in desirable way, so network lifetime will be prolonging by far. If energetic nodes can cover desirable level of network, less number of energetic nodes will be required in total network and will not be the empty space of energetic node. We balance energy consumption of nodes by means of selecting reliable energy nodes for forwarding data. It has been shown [8] that energy consumed in the retransmit operations is responsible for a considerable amount of energy consumption. Since this case cannot be avoided with the use of energy-efficient algorithms [9]. In this paper the proposed scheme is utilized the energy of mobile nodes and provides the reliable routing in dynamic network. The selection of mobile nodes are dependent on the higher energy level of neighbors and also the nodes having energy is below the threshold value then that nodes are not participating in routing that minimizes the packet loss and improve network performance.

III. PREVIOUS WORK ACCOMPLISHED

The majority of energy efficient routing protocols for MANET try to minimize energy consumption by means of an energy efficient routing metric. The some work that has done is mentioned in this section.

In this paper [1] proposed a Reliable Minimum Energy value Routing (RMECR) energy efficient scheme. RMECR will increase the operational time period of the network victimization energy efficient and reliable routes. Within the design of RMECR, we tend to use a close energy consumption model for packet transfer in wireless ad hoc networks. RMECR was designed for two forms of networks: those within which hop-by-hop retransmissions guarantee dependability and people within which end-to-end retransmissions guarantee dependability. the final approach that we tend to employed in the planning of RMECR was wont to conjointly devise a progressive energy-efficient routing rule for wireless ad hoc networks, i.e., Reliable Minimum Energy Routing (RMER). RMER finds routes minimizing the energy consumed for packet traversal. RMER doesn't take into account the remaining battery energy of nodes, and was used as a benchmark to review the energy-efficiency of the RMECR rule. intensive simulations showed that RMER not solely saves additional energy compared to existing energy economical routing algorithms, however an will increase the dependability of wireless impromptu networks.

In this paper [10] they planned economical Power Aware Routing (EPAR) that is largely associative in improvement on DSR. This study has evaluated an power-aware ad hoc routing protocols in numerous network surroundings taking into thought network time period and packet delivery magnitude relation. Overall, the findings show that the energy consumption and turnout in small size networks didn't reveal any vital variations. However, for medium and huge ad-hoc networks the DSR performance proven to be inefficient during this study. Particularly, the performance of EPAR, MTPR and DSR in tiny size networks was comparable. however in medium and huge size networks, the EPAR and MTPR created sensible results and also the performance of EPAR in terms of turnout is good in all the eventualities that are investigated. From the assorted graphs, we are able to with success prove that our planned rule quite outperforms the normal energy economical algorithms in a clear manner.

In this paper increased Power management mackintosh Protocol EPCMAC [11] protocol transmits all the packets with optimum transmission power and sporadically will increase the facility of the information packets to an appropriate level to eliminate the collisions. The periodic pulse power is found supported increasing the data rate, reducing the carrier sensing vary and considering the Signal to Interference magnitude relation. It reduces the quantity of superfluous back-off nodes and permits victorious coincidental transmission with restricted interference at the neighborhood nodes. Our simulation result shows that the EPCMAC theme achieved additional total knowledge delivered per joule. this implies that the EPCMAC theme will achieves a high reduction within the energy consumption.

In this paper [12], we tend to study the energy economical topology management drawback with CC model by taking the energy potency of routes into thought. Taking advantage of physical layer style that enables combining partial signals to get the entire knowledge, we tend to formally outline cooperative energy hand tool within which the smallest amount energy path between any two nodes is absolute to be energy economical compared with the best one within the original cooperative communication graph. we tend to then introduce the energy-efficient topology management drawback with

CC (ETCC), that aims to get a cooperative energy hand tool with minimum total energy consumption, and prove its NP-completeness. Therefore, as solutions for ETCC, we tend to propose two topology management algorithms to create energy-efficient cooperative energy spanners. each algorithms will guarantee the delimited energy stretch issue and are straightforward to be enforced in a very distributed and localized fashion.

This paper [13] planned a completely unique rule is use the best power assignment for each link specified the expected power consumption of the unicast from the supply node to each different node within the network is that the minimum among all potential power assignment. They take into account two totally different scenarios: either the link layer dependability or the transport layer dependability is enforced. Notice that, in observe, bound link layer dependability is already enforced within the Mac layer. Our second contribution is that the study of integrated power assignment and energy economical routing using multipath routing techniques. Our third contribution may be a multicast technique that integrates the best power assignment and energy economical multicast tree construction. In our multicast technique, we tend to assume associate degree overlay based mostly multicast. The proposal in theory proves that their multicast routing is sort of optima it means that the expected total power consumption of the created multicast tree is at intervals atiny low constant issue of the optimum. Simulations show that their protocols considerably cut back the expected energy consumption of routing..

IV. PROPOSED SCHEME TO IMPROVE ENERGY EFFICIENCY

Mobile Ad-hoc Network is emerging technology in recent trend because that easily deploy where static network not available but also faces measure problem of some constrain like energy issue, each device operate with the help of limited battery power and every device contain the power on the bases of charge pulse storage limitation equipment and that power backup maximum up to three to four hours if any user continue communicate with other device, so that point encourage to work in the field of energy utilization minimization area under MANET.

In this paper we proposed Maximum-Minimum (MAX-MIN) Energy based Routing scheme as well as threshold base energy consumption approach and indentifies the reliable path between senders to receiver communication, for achieving the goal of minimum energy consumption of the network. we modified the internal architecture of simulator in wireless physical channel, energy model and god package and simulate the enhance approach.

In this mechanism if any sender want to send data to receiver node, than sender broadcast the route packet in the network and that time we measure the energy of each node and if we get energy higher than the threshold limit so that node participated else node, after that if we get more than two path between sender to receiver than create the energy table of all path at the receiver end and select minimum energy contain node from each path and compare that minimum energy node to other path minimum energy node, and we select higher energy node out of them. That proposed work gives better reliability with minimum energy consumption and also improved quality of service of the network with respect all network parameter.

In next section we provide detail description of internal package enchantment.

Here we describe internal .cc updating module description and its connectivity, for threshold base as well as Max-Min base routing and compilation process, very first we detail read about NS-2 internal structure and sensor network layer architecture and as we get energy is physical parameter for layer architecture, for that case very first we update wirless-phy.cc file, than energy-model.cc and god.cc.

A. Wireless-phy.cc

Wireless-Phy.cc exist in ns-allinone-2.31/ns-2.31/mac directory, that file basic use for physical parameter setting of sensor node's and our work are related of physical parameter as well as routing parameter so in physical parameter firstly update node on condition is 10 joule and according to that threshold value data and routing message flooded in the network and if the energy is less than 10 joule than node treated like died node, and if greater than the 10 joule so we find channel is ideal or busy in current time and if we get ideal than route request packet flooded to the network, and second condition we check each discrete time updated energy of each existing route node's and according to power consumption (that consumption on the bases of energy-model.cc file that describe in next section) we get updated energy of each node, and if energy greater than 10 joule so that information send to trace file for further analysis.

```
node_on_=10;
if (em()->energy() > 10)
{
double txtime = hdr_cmn::access(p)->txtime();
double start_time = MAX(channel_idle_time_, NOW);
double end_time = MAX(channel_idle_time_, NOW+txtime);
double actual_txtime = end_time-start_time;
  if (start_time > update_energy_time_)
{
 em()->DecrIdleEnergy(start_time -
update_energy_time_, P_idle_);
 update_energy_time_ = start_time;
 }
else {
if (em()->energy() > 10) {
```

```
((MobileNode *)node_)->log_energy(1);
        }
        Packet::free(p);
        return;
        }
        }
```

B. Energy-model.cc

Energy-model.cc file exist in the ns-allinone-2.31/ns-2.31/mobile directory, that file connected to wireless-phy.cc file and god.cc file, in this basically describe energy depletion scheme that is transmission, ideal, receives and sleep case on the bases of time and required power of transmission, receiving, sleeping and ideal time consumption, and calculate each discrete time energy discharging rate and if we get energy of sensor node is equal or less than 10 joule than we compute new route because we set threshold as 10 joule but that compute route function define in god.cc file so we describe that module in next section.

```
if (energy_ <= 10.0 )
{
God::instance()->ComputeRoute();
}
```

C. God.cc

God.cc file play important role in our module because in that file bases we compute new route and get MAX-Min energy of each sensor nodes, very first we describe about distance and energy of path between i^{th} to j^{th} node if both are true than follow the next section, if any established route are break in case of energy less than of 10 joule, than re-initiate energy base routing scheme or initial path established case compute new route we verify energy of node is greater than of threshold or not, and if greater than threshold than execute Floyd warshall algorithm, in this algorithm we find minimum distance base as well as maximum energy of each path and if we get new path energy is greater than the existing path than we set new path as a updated path and according to that we create route between sender to receiver all the that module base we execute our module and compilation module describe in below.

```
if ((d.length() < RANGE) && (mb_node[j-1]->energy_model()->energy() <mb_node[j]->energy_model()->energy())) //dhaval
if (mb_node[i]->energy_model()->energy() > 10.0) {
  floyd_warshall();
  ComputeNextHop();
  Rewrite_OIF_Map();
  CountConnect();
  CountAliveNode();
  prev_time = NOW;
  num_compute++;
  if (allowTostop == false)
    return; }
void God::floyd_warshall()  //Dhaval
{
  int i, j, k;
double a ,b,c;
  ComputeW();           // the connectivity matrix
  for(i = 0; i < num_nodes; i++) {
     for(j = 0; j < num_nodes; j++) {
         for(k = 0; k < num_nodes; k++) {
            MIN_HOPS(j,k) = MIN(MIN_HOPS(j,k), MIN_HOPS(j,i) + MIN_HOPS(i,k));
        a = mb_node[i]->energy_model()->energy();
        b = mb_node[j]->energy_model()->energy();
        c = mb_node[k]->energy_model()->energy();
MAX(b,c) = MAX(MAX(b,c),MAX(b,a) + MAX(a,c));
         }
     }
  }
  for(i = 0; i < num_nodes; i++)
     for(j = 0; j < num_nodes; j++) {
        assert(MIN_HOPS(i,j) == MIN_HOPS(j,i));
        assert(MIN_HOPS(i,j) <= INFINITY);
        assert(MAX(b,c) == MAX(c,b));
        assert(MAX(b,c) <= INFINITY);
     }
```

V. SIMULATION TOOL USED

Simulation of proposed MAX energy based routing is performed and compared with normal Energy based AODV using NS-2 [14] to evaluate the protocol. A total of 50 nodes were simulated for duration of 100s in an area of 800m × 800m.The mobility model is the random way point to model the mobility of the nodes in the network with the simulation time of 100 m/s. The MAC layer protocol used was IEEE 802.11. The transmission range for each node was 250m and the channel capacity was 512 kbps. The initial energy of the node is set randomly in network in joules.

The energy aware Routing Mechanisms are compared with following energy efficiency metrics:

- **The relative routing overhead**: It is the ratio of the number of control packets over the number of delivered data packets.
- **The delivery ratio:** It is the Ratio of number of packets delivered over the total number of packets sent.
- **UDP Packet loss:** It is the number of packets that not reach to destination or loss in network.
- **The end-to-end delay**: It is the average of delays between each pair of a communication session.

VI. SIMULATION OUTCOME

In this section the simulation results are evaluated in case of normal energy routing and proposed MAX-MIN scheme.

A. Routing Overhead Analysis

The numbers of routing packets are required in MANET to ascertain connection in between senders and receivers. The energy is also consumed for deliver routing packets in network. For improving energy efficiency it is essential to deliver less number of routing packets in network. In this graph the routing overhead analysis in case of normal energy based and proposed MAX-MIN energy based is considered. Here the in normal case about 7500 routing packets are deliver in network and only with respect to that 3272 packets are received in network mentioned in table 2. As compare to that in case of proposed MAX-MIN energy based routing about 1300 packets are deliver in network and with respect to that 3755 packets are received in network also mentioned in table 2. The routing overhead in case of normal energy routing is very high because of assortment of low energy nodes in routing, that are lost their energy before completing the packets transmission, by that overhead enhanced but in case of proposed always selected node that has maximum energy.

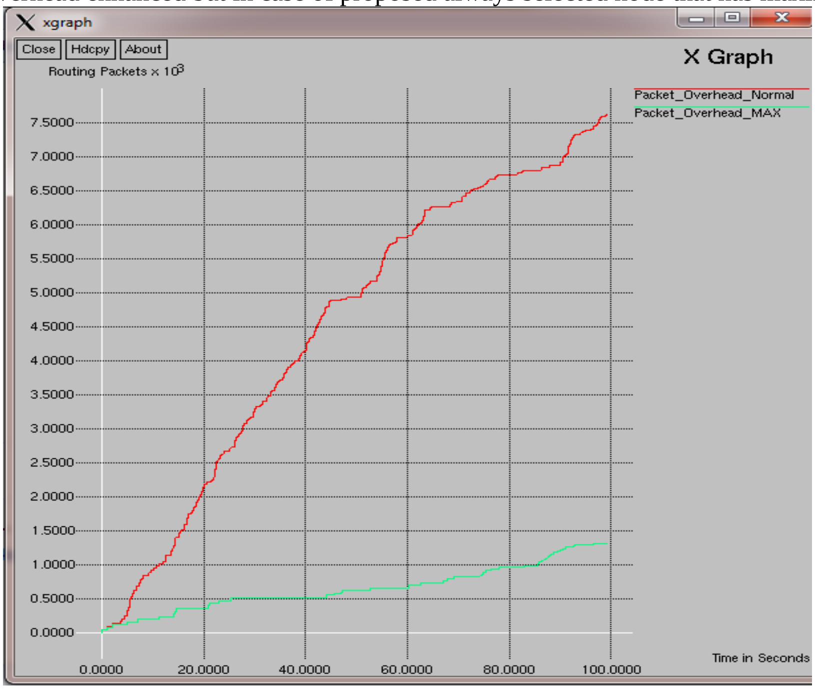

Fig. 1 Routing Overhead Analysis

B. PDR Analysis

The number of data packets are sending and receiving in network is also maintaining on the reliability of link in network and the superior selection of nodes in terms of energy are maintain the strong link in MANET. The Percentage of data received in network is evaluated through Packet Delivery Ratio (PDR) Performance matrices. In this graph the PDR performance in case of normal energy routing is about maximum 80 % but in consideration of proposed MAX-MIN scheme the PDR value is more than 91 percent at the end of simulation but in time between 10 sec. to 70 sec. the performance is up to 96% in network. The strong connection establishment in dynamic network also provides the better result to improve the routing procedure in network. The normal energy routing is by default work on shortest path selection procedure that reduces the path but also minimizes the possibility of reliable communication in MANET.

Fig. 2 PDR Analysis

C. UDP Packets Loss

The confirmation of data delivery is important to convey about the successful transmission in network. The connection less mechanism is not reliable for communication because no confirmation of data receiving is delivered by receiver to sender in network. The UDP (User Datagram Protocol) is the connection less transport layer end to end protocol for data transmission in network. In this graph the packet loss in case of normal energy routing and proposed MAX-MIN energy routing is observed and find that in case of proposed scheme the energy consumption in routing is minimizes and packet receiving is increases and loss in network decreases. In this graph the packet loss in case of normal energy is about 930 and in case of proposed scheme the packet loss is about 220. The difference in packet loss represents that the energy consumption in case of normal energy routing is more.

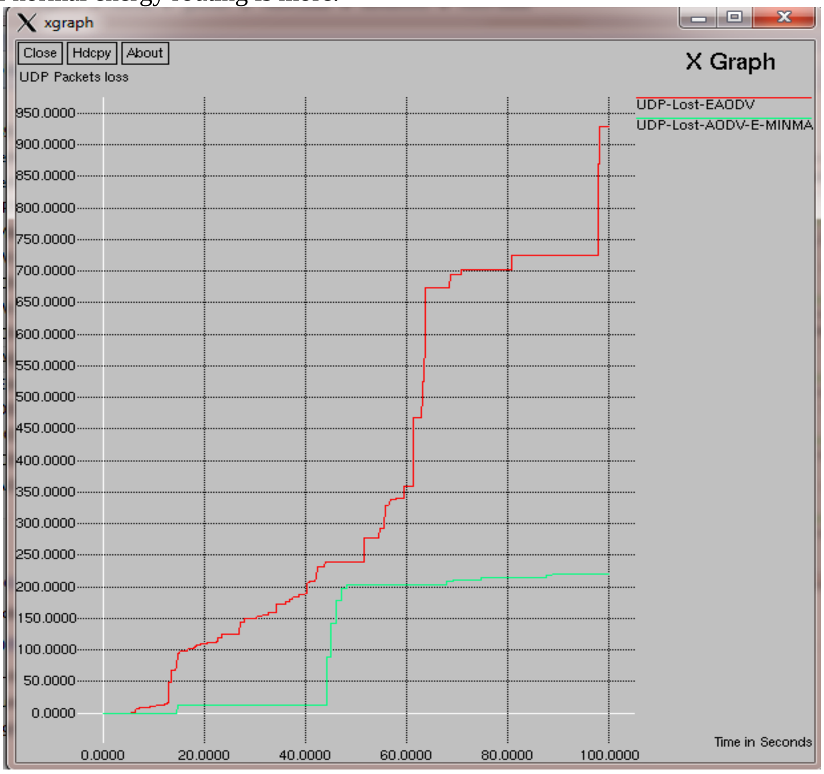

Fig. 3 UDP Packet Loss Analysis

D. Node Existing Energy loss Analysis

The nodes in network at certain time interval loss their communication capability in network. That means the energy of nodes is fully depleted or loss in network. The energy loss in case of that kind of nodes is mentioned in table 2. Here the some nodes that are loss their energy in a particular interval of time is only given in normal energy routing but in case of proposed MAX-MIN energy routing not a single node is loss their complete energy in network, that shows the utilization of energy and minimizes energy overheads.

Table 2 Energy Loss Analyses

Normal Energy		**Proposed MAX**	
Node No	Time	Time	Node No
1	15.55611	-	-
2	90.63922	-	-
3	95.7	-	-
6	90.24789	-	-
10	92.51006	-	-
11	97.92667	-	-
13	99.9381	-	-
20	97.84071	-	-
25	95.90032	-	-
34	34.84858	-	-
35	9.078792	-	-

E. Summarized Performance of Normal Energy based Routing

The overall summarized performance in case of normal energy routing and proposed MAX-MIN energy based routing is mentioned in Table 1. The energy efficient proposed scheme is minimizes the energy consumption in network and provides the better performance. The packets receiving and routing overhead in case of proposed scheme is improved by that the nodes unnecessary energy depletion is also minimized.

Table 1 Absolute Summarized Performance

Performance Parameters	Normal Energy	Proposed MAX Energy
Send	4048	4113
Receiving	3272	3755
Routing Packets	7617	1313
PDF	80.83	91.3
NRL	2.33	0.35
No. of dropped data (packets) =	776	358

VII. CONCLUSION AND FUTURE PLANNING

Battery power of mobile nodes is consumed in MANET during the transmission and reception of data, propagation of control packets, retransmission and overhearing. In this paper the proposed MAX-MIN scheme is selecting the node for routing that is maximum energy among all neighbors and consumes the minimum energy at the time if routing. The minimization of power consumption during the transmission and reception of data is improves the energy utilization efficiently in network. The MAX-MIN scheme minimizes the energy consumption between the nodes to compute the energy required to transmit the data from a node to its neighboring node up to destination. The performance matrices in case of proposed MAX-MIN energy based routing is better as compare to normal energy routing. The performance of proposed scheme utilizes the battery power of mobile nodes in dynamic network elegantly in terms of reduces the possibility of retransmission. The energy computed is involved in the selection of the optimal path which requires minimum energy to route the data from source to destination that maximizes the life of network as compare to normal energy routing.

The nodes in MANET of fast mobility are not reliable for communication. Now in future the proposed scheme is also applied with prediction of the mobility of mobile nodes that reduces the loss of energy due to speedy nodes in MANET.

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