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Schema for Ensuring Energy Efficiency for Performing Routing in MANET

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***Abstract*— A mobile Ad-hoc network is a collaboration of portable nodes as well as some computing devices which can be placed arbitrarily anywhere in the network to perform a particular task such as data transmission and message passing etc. The nodes can transmit data in a particular range and the nodes are capable of changing their location. In this infrastructure-less network the node can be deployed in any place of any challenging situation. Since many years the research based on the concept of energy efficiency for routing techniques in the area of mobile AD-hoc network has been considered as an important and challenging field. Mobile Ad-hoc network does not require any centralized support the mobile nodes and the host of the network can be any computing devices with limited power capacity these nodes transmit the data over a short range radio waves. This paper proposes a protocol named "Energy Efficient Routing Cost Protocol (EERC)" for the minimization of the route cost and the energy efficient path. This paper describes various routing protocols like AODV, DSDV and compared and analyses their result using some graphs.**

Keywords- Energy Efficiency; Route Cost; Mobile Adhoc Network

I. INTRODUCTION

In this very recent year the Energy issues and the cost based routing in Mobile Ad-hoc Network has become a very important topic in the area of research. A mobile Ad-hoc network is a self-configuring and a collection of some independent mobile nodes where the network is very much infrastructure less and the location of each node can be changed dynamically whether the nodes can be any type of mobile computing devices made up of necessary communication protocol. The mobile Ad-hoc network is designed as an infrastructure less network where the nodes don't require any centralized support and they do have limited power capacity and here the power consumption constraint is a very important issue due to the limited power capacity of each node and the short range radio propagation that is the functional area of this Mobile Ad-hoc network [1]. Applications of MANET:

Some of the applications of MANET are: It is used in the Military battlefield where a soldier can get advantage of communicating with another soldier during the battlefield and they can send some important information to the Military vehicles and Headquarters also. When some people of an organization are working in a particular project then they need to interact with each other with the help of some computing devices so in that business environment the collaborative work is very much necessary during an outside meeting of a particular project so then MANET will be a efficient way of information exchange between a project team. The application of MANET has been implemented in the local level also where some nodes such as notebook computers are connected in a multimedia network for exchanging some information among participants e.g. conference or classroom environment. Another local level example is a home network which can be a good platform for sharing of information over a Mobile Ad-hoc network. In the field of personal area network where the Bluetooth which is installed in some nodes, in the personal area network those nodes might be cooperative with a person so usually the Bluetooth uses a very short range radio frequency transmission and propagation so it is a useful application of MANET. A simplification of the transmission of radio wave between various mobile node such as laptop and mobile computing devices is done by Bluetooth. For various rescue operations such as flood, fire, terrorist attacks and various disaster management operations the infrastructure less non-existing reliable network communication is needed [2].

Energy Issues in MANET: The issues which are related to the energy consumption of Mobile Ad-hoc network can be mapped at different layers. In the recent years various researchers have focused on the energy optimization techniques in the route cost based MANET. The main issue which is related to a mobile node is that has a very much limited power capacity. In the area of mobile Ad-hoc network the nodes must be portable so that it should carry light weight designed tools and the maximization of power for the battery source will make the node less portable. Apart from these a MANET requires an infrastructure less multi hop routing and communication with limited usage of energy, band-width and CPU with some security so these constraints put some challenges in the field of MANET routing protocol design[3].

This paper focuses on the detailed discussion about the proposed energy efficient routing protocol. The paper is organized as follows. Section III gives review of the proposed system and the section IV provides the implementation details of the proposed system, here the literature survey on the previous related work is described in section II and evaluation of the proposed system is done by comparing the existing EERC protocol with existing AODV and DSDV protocol models. The implementation result of the proposed system along with different parameters has been shown by graphs.

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II. RELATED WORK

The proposed system introduces a framework that ensures Energy –efficiency for large scale MANET system using the concept of route cost maintenance. Roy [4] has introduced system that focuses on the optimization of energy consumption in MANET and the author has adopted three techniques to conserve energy by reducing the number of route request message and two different techniques. And presented the outcomes of the techniques using graph. Gallina et al [5]. Has introduced a framework that focuses on the optimization of time and energy cost of MANET and they have adopted Markov Design Process (MDPs) , probabilistic process calculus , and Probabilistic model checker PRISM and they have analysed how time and energy costs vary when pursuing different power control strategies and the outcomes were evaluated using graphs. Kumar et al [6]. Has introduced a model that focuses on the evaluation of the performance of DSDV, DSR and AODV routing protocols with respect to energy consumption where the outcomes are evaluated using some graphs. Shrivastava et al [7]. Has introduced a model that focuses on methods used in energy based algorithms to reduce the power consumed in the communications between ad hoc network nodes the authors have developed a E-AODV model based on AODV protocol where the outcomes are evaluated using graphs. Fahmy et al [8]. Has introduced a framework that focuses on the performance of the proposed and improved PEEBR algorithm and the performance of the proposed and improved PEEBR algorithm is evaluated in terms of energy consumption efficiency and throughput compared to two state of art Ad-hoc routing protocols and the outcomes were evaluated using graphs. Prabu [9] has introduced a framework that focuses on energy efficient routing the author has adopted new routing algorithm named Energy Saver Path routing Algorithm using Optimized Link State Routing (ESPR_OLSR) where the outcomes have been shown using graphs. Meghanathan [10] has introduced a system that focusses on energy efficient routing protocol the author has adopted energy aware Greedy Perimeter Stateless Routing (GPSR) protocol for mobile Ad-hoc network where the outcomes have been presented using graphs and bar charts. Anil [10] presented a review of prior studies especially focusing on the standard routing techniques as well as some of the significant recent studies to understand the level of effectiveness in the prior techniques. Finally, the paper discusses about the research gaps that are yet to be solved among the research communities.

III. PROPOSED SYSTEM

The proposed system introduces a novel idea termed as Energy Efficiency using Route Cost (EERC) which is defined as a cost-based energy efficient routing protocol. In this cost-based routing protocol technique, the available paths and accordingly the costs related to that path between the source and the destination node will be calculated. Among them the path with minimum link cost, which will be taken under consideration. Here in this proposed system the link cost is very much essential factor. It is not very easy in the field of cost-based energy efficient routing protocols to derive the accurate link cost metric to find an optimal path. A link cost metric has been discussed and derived here also the estimation of parameters required for link cost calculation has been shown here. Here in this proposed system establishment of the EERC protocol over 802.11 MAC sub layer has been seen, so the discussion for the link cost of 802.11 wireless networks has given below.

A. Energy Consumption Model for 802.11

There are two techniques which have been specifically described in the area of IEEE 802.11 MAC. Distributed Coordination Function which is defined as a shared medium of IEEE 802.11 MAC between multiple stations of that Mobile Ad-hoc network. As PCF has some restrictions being a centralized protocol so DCF is considered at MAC layer under our consideration. In this paper concluding the use of DCF in EERC protocol, IEEE 802.11 DCF relies on Carrier Sensing Multiple Access with Collision Avoidance (CSMA/CA) mechanism. Physical Carrier Sensing and Virtual Carrier Sensing these two mechanisms are used where Implementation of Virtual Carrier sensing mechanism uses Network Allocation Vector (NAV). In between the data-packet transmission if a node receives a packet (such as RTS, CTS and data packet) the NAV will be updated automatically with the duration which will be included in the received packet. The duration of the transmission can be measured from the NAV value. During the process of data transmission the sender node first checks its NAV value, if it is larger than zero then it has to wait until the value changes to zero after that the sender node transmit a RTS packet when it sees that the channel is available for a secure data transmission and it is available for a period which is greater than DCF Inter-Frame space and it sends the RTS packet repeatedly if the sender node does not get any CTS within a predefined time interval. So if the sender node gets any ACK then it understands that the whole packet transmission is successful.

B. Parameter Estimation for Link Cost

Here in this cost based energy efficient routing it is easy to define any parameters except the transmission powers ($E_{i,j}$ and $E_{j,i}$) and the packet error rates ($E_{r,i,j}$, $E_{c,j,i}$, $E_{i,j}$, $E_{a,j,i}$). In this section it is discussed about how these parameters have been estimated.

Some assumptions have taken to estimate the parameters:

1) The path loss between two nodes is symmetric on both directions. 2) And here the physical layer can give some information about average power level of a packet (such as RTS/CTS) which is received and the average interference level to MAC layer. These are the general assumptions which are taken in any energy efficient protocol and power control schemes. The attenuation in the wireless signal occurs at the rate of $1/ l^n$ (where l is the distance and n is the path loss exponent) the received power level (E_r) at the receiver side is directly proportional to E_t/d^n where E_T is the transmission power level. That is

$$E_r = K (E_T / d^n) \quad (1)$$

Here the value of k is dependent on the environment. With this formula the value of transmission power can be obtained for other packets based on the received power level of the known packet and the target receiving power.

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$$E_T(B, A) = E_r^{th.}(E_m / E_r) \quad (2)$$

Where E_r^{th} is the minimum necessary received power level. So the per bit transmission power between node A and Node B can be derived. Here in this proposed system the differences between the concepts of collision and interference by the carrier sensing zone are evaluated. If the error occurs in the carrier sensing zone then it is called collision else it is called interference. It is very much easy to detect the interference and noise level as it can be monitored by each node when the channel is free. Based on modulation scheme and the received power level the calculation of the Bit Error Rate (BER) and after calculating the Bit Error Rate it is easy to calculate the packet error rate.

IV. IMPLEMENTATION

A big overhead can be caused by the existing energy based routing scheme during the path discovery and here it is seen that the path set up time is very much lengthy, and also applying some strategy or some routing scheme that would not find any arbitrary path quickly and it will depend on a route maintenance technique to adjust the path and it will convert it to an energy efficient one. As it will create a larger overhead to obtain the route and there is no assurance that such adaption could be able to discover any route which leads to an energy saving coma parable to the minimum energy. So the good technique is to find a path close to the minimum energy one quickly and then set a maintenance technique to adjust the path for further energy optimization. So the EERC protocol that uses strategy for discovering the energy efficient path quickly so that it can be able to give response to the topology and channel changes quickly so in the following the Route Discovery Process and Route Maintenance has been discussed.

A. Route Discovery Process

In this section focuses on the route discovery techniques of EERC, the shortest path routing scheme is the efficient way to find a path between two nodes. However there can exists a number of shortest paths between the source node and the destination node. Among all the shortest paths, it will be a better approach to pick the energy-efficient one (it is called minimum energy shortest path). Suppose the set of paths between the source and the destination is P, the number of hops for path p is N_p and the energy consumption for link I in path p is $I_{i,j}$ then the set of shortest path P_s will be

$$P_S = \arg\min(Np),\ p \in P \quad (3)$$

Even though there are more than one energy shortest path in Lms, so there will be some set of rules to select a unique one such as route request packet arriving time.

Here some efficient searching techniques are discussed:

1) Search for all shortest paths (Minimum no of hops).

2) Pick the paths which are associated with minimum energy.

For implementing this algorithm there should be two types of information carried by route request packet. One should be the Hop count information and other should be the energy consumption. When the route request packets are broadcasted by a source node with both Hop count and energy consumption which are initially set to zero after that when an intermediate node receives that packet, first the updating of the hop count and the energy consumption is done (energy consumption increased by the amount of energy produced between the sender and itself) and the hop count increased by 1. After that this node will re-transmit the route request packets it the following conditions meet the re-broadcast criteria.

1. The first time the node has received that packet or the packet has travelled a shorter path.
2. The packet comes from a path which has same number of hops as the best path which was under consideration till now. And energy consumption of that path is lower.

The first condition decides the selection of the shortest path where the second condition selects the minimum energy path which is selected from all the shortest paths.

B. Route Maintenance

This portion discusses about the route which has been discovered from the minimum energy path selection process and this path is suboptimal and may be it is responsible for the higher end-to-end energy consumption. The network environment also could be change due to some node movements and dynamic channel conditions, and then the previous energy efficient route in that mobile Ad-hoc network will be no longer efficient, so that here the route maintenance scheme is proposed, which is very much critical for energy efficient routing protocols. In this route maintenance scheme the EERC protocol will not use the additional periodic messages as these will consume more energy. An observing node monitors the data packet transmission between its neighborhoods and in an association with its neighborhoods this node will try to discover more energy efficient path. In between the transmission process each node can keep a record of the estimated necessary transmission power and the link cost to its neighboring node when it gets RTS, CTS or broadcast data packets from this node. In this proposed scheme each node will insert the link cost into the IP header and forward it for the next-hop receiver. The data packet exchange will be monitored by every node to calculate the link costs and using this link costs it will be easy to calculate the cost of path segment. The data packets which are transmitted, received or overhead by a node that will be recorded in a maintained table which will contain these following contents

A. Sender

B. Receiver

C. Link cost between the sender and the receiver

D. Source

E. Destination.

F. IP Header ID and

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G. The Current Time.

From the medium access control header it is easy to find A. and B. and from the IP header C. and G can be obtained. So to avoid the storage overhead the information regarding any link will be considered for a short time for getting the accurate information related to the link. Also node A can retain some useful or valuable information regarding how a packet passes through its neighborhood and the total link cost for that path. The information which is recorded in the link cost table based on that a node can optimize the cost of a path segment.

V. RESULT ANALYSIS

The proposed EERC protocol graphically simulated in Matlab and compared with DSDV and AODV protocols.

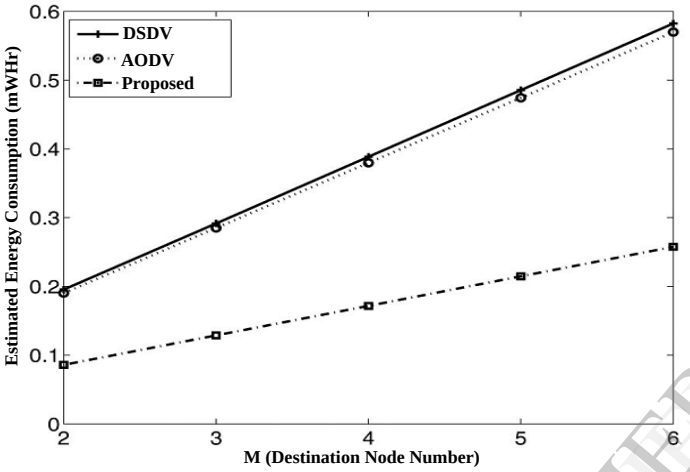

Fig. 1. Evaluation of Rate of Energy Depletion

Figure 1 shows the evaluation of rate of energy depletion. This graph discusses about two parameters one is estimated energy consumption with respect to Y axis and the destination node number with respect to X axis. And the comparison and graphical representation of the rate energy depletion for proposed EERC protocol and another two AODV and DSDV protocols has been given here. To implement the Energy Efficient Route Cost protocol AODV protocol has been used and some changes have been made on it as well as on DSDV also and that have been benchmarked their performance with respect to the route cost and the Energy efficiency. Here in the area of DODV and AODV for both 200 meters distance has been taken under consideration for the Hop to Hop transmission and here the nodes are taken as a reference mobile node. In the implementation of EERC all the intermediate hops are considered for the routing purpose. Here in this area the energy conservation of the proposed system implemented by one of the sender mobile node which performs an adjustment of transmission of the energy with respect to its original spatial distance to the adjacent destination mobile nodes. It is considered that the simulation area is to be of 1000 *x* 1000 m^2 with the pause time of 10 second and different random mobility model is defined here. Initially the system have been configured with the existing transmission energy which is 10-20-30 mW.

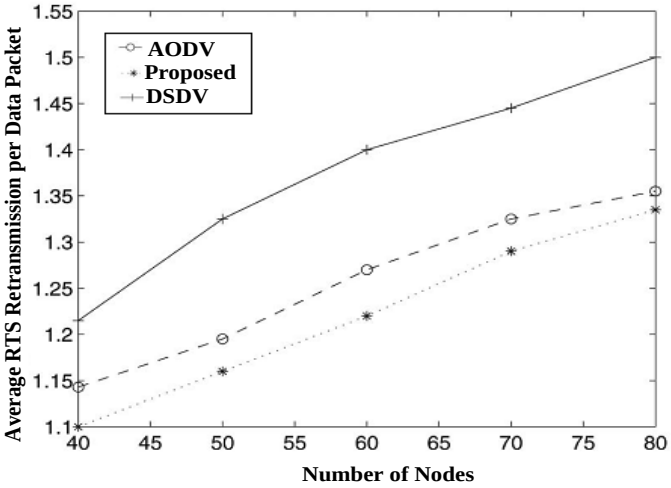

Fig. 2. Analysis of retransmission attempt.

Figure 2 shows the Analysis of retransmission attempt. This graph presents two parameters one is Average RTS retransmission per Data Packet with respect to Y axis and the number of nodes with respect to X axis. And it is compared and graphically represented the analysis of retransmission attempt for proposed EERC protocol and another AODV and DSDV protocol. The figure 2 represents the result for static scenario and the proposed AODV and EERC protocols have almost equal behavior.

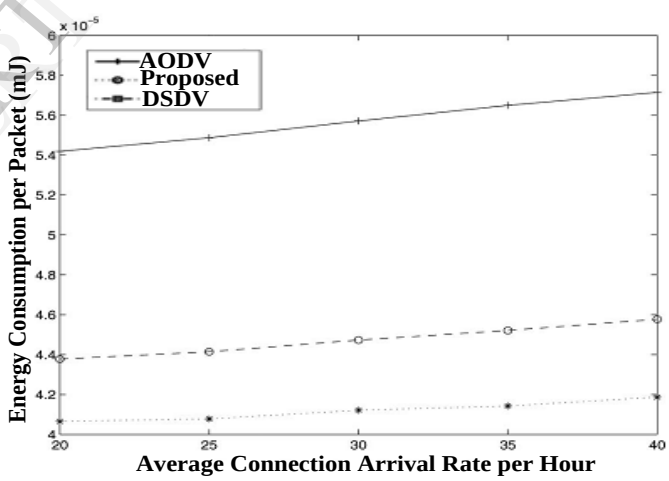

Fig. 3. Analysis of Energy Depletion w.r.t arrival rate

Figure 3 shows the analysis of Energy Depletion with respect to the arrival rate, this graph represents two parameters one is energy consumption per packet with respect to Y axis and another is Average connection arrival rate per hour with respect to X axis. This graph focuses on energy consumption per packet which is very much less in the field of proposed EERC protocol than the AODV protocol and it has been seen that the graphical representation for the energy consumption per packet in the area of DSDV protocol is very much high than other two protocols. Though here the AODV and EERC protocols have some similarities in energy conservation but our proposed EERC protocol is superior to other two protocols. And experiments give better output for route cost and energy efficiency in route discovery process of EERC protocol. The routing over head is quite higher in the case of

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AODV protocol and the request for route search has a higher probability of getting volatile by the intermediate nodes. So here in the case of AODV the energy consumption maximizes with the increase of route overhead.

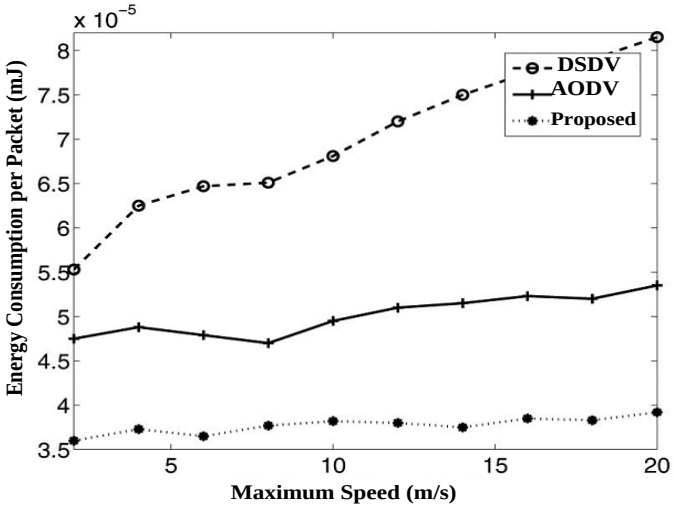

Fig. 4. Analysis of Energy Consumption

Figure 4 shows the energy consumption. This graph analyzes the energy consumption where it is discussed about two different parameters one is energy consumption per packet with respect to Y axis and another is maximum speed with respect to X axis. And here the energy consumption in case of proposed protocol is quite higher than other two protocols and here the energy consumption is done with respect to maximum speed of node is quite higher in the area of DSDV protocol. Though the AODV and EERC protocols have some similarities in energy conservation but it is considered that the proposed EERC protocol is superior to other two protocols. And experiments give better output for route cost and energy efficiency in route discovery process of EERC protocol. This graphs also says that the routing over head is quite higher in the case of AODV protocol and the request for route search has a higher probability of getting volatile by the intermediate nodes. So here in the case of AODV the energy consumption maximizes with the increase of route overhead.

VI. CONCLUSION

This paper proposes an Energy Efficiency using routing cost protocol for mobile Ad-hoc network and the details of the proposed protocol is discussed and analyzed the over here it presents the a brief overview of implementation portion where the discussion about the EERC protocol that uses some strategies like Route discovery process and route maintenance process has done. Here in this paper the analysis of energy depletion has graphically represented and the comparison between DSDV, AODV and the proposed EERC protocol are discussed and this paper analyzes the energy consumption and retransmission attempt with some graphs. This work will be very much useful in future for the analysis of some energy efficient cost based routing protocols.

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