An Energy Efficient Routing Approach based on AODV

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Abstract- **An Ad-hoc Network is a self organizing and self configuring wireless network. It is a temporary network established without the aid of stand-alone infrastructure. The topology of an ad-hoc network changes dynamically. The topology changes due to departure or arrival of a node. The nodes in mobile ad-hoc network acts as host as well as routers that routes the packets to the destination node. The mobile ad-hoc network is established for a single session and it does not require router of a base station. In this research three routing protocols have been studied and compared with each other on various performance factors. The protocols that have to be examined are Dynamic Source Routing (DSR), Ad-hoc On Demand Distance Vector (AODV) and Destination Sequenced Distance Vector (DSDV). The main concentration is laid on the energy consumed by the nodes during the transfer of data. The energy is the main issue of concern in ad-hoc networks so after examining the energy consumed by the above stated protocols, a new approach is proposed which uses a load balancing technique which is based on AODV protocol. The approach uses a load balancing technique that saves energy and follows best optimal path to route the data and maintains the lifetime for a node.**

Keywords—
AODV, DSR, DSDV, Mobile Ad-hoc Network, load balancing.

1. INTRODUCTION

Mobile ad hoc networks (MANETs) are rapidly evolving as an important area of mobile mobility. An ad-hoc network is a group of wireless mobile hosts forming a temporary network with the aid of any standalone infrastructure. MANETs have fewer infrastructures and are wireless in which there is use of number of routers which are free to move arbitrarily and can mange themselves in same manners. The topology used by MANETs is dynamic topology as they have characteristics that network topology changes very rapidly and unpredictably in which many mobile nodes moves to and from a wireless network without any fixed access point where routers and hosts move. It has to support multi-hop path for mobile nodes to communicate with each other and can have multiple hops over the links, also the connection point to the internet may also change. The mobile nodes which are within the communication range of each other, then source node during data transfer can send message to the destination node directly otherwise it can send through intermediate node. Mobile ad hoc networks are self organizing and self configuring multi-hop wireless networks so the structure of the network changes dynamically. The Node in the network not only acts as a host but also acts as a router that can route data to the other nodes in the network.
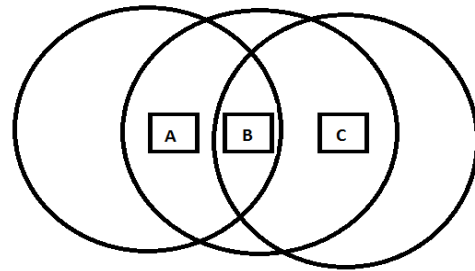

Figure1: A Simple Mobile ad-hoc network

Now day's mobile ad-hoc networks have efficient operation in mobile wireless networks as it can includes routing functionality into the nodes which is more than just mobile hosts and reduces the routing overhead and saves energy for other nodes. The nodes in a network use the same wireless channel which is randomly selected co-operates in a friendly environment for engaging themselves in multi-hop forwarding. Hence, MANETs are very useful when infrastructure is impractical or expensive because it can be deployable without prior planning or any existing infrastructure. And it is an autonomous system in which mobile hosts connected by wireless links are free to be dynamic and sometimes act as routers at the same time. All nodes in a wireless ad hoc network act as a router and host as well as the network topology is in dynamical, because the connectivity between the nodes may vary with time due to some of the node departures and new node just arrived.
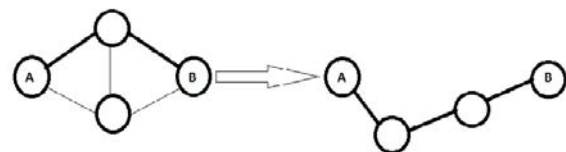

Figure 2: Dynamic Topology

The special features of MANET bring this technology great opportunity together with some challenges. All the nodes or devices responsible to organize themselves dynamically the communication between the each other and to provide the necessary network functionality in the absence of fixed infrastructure, it implies that maintenance, routing and management is needed to be done between all the nodes. One another challenging environment is the multicast in MANET is that a MANET is a self-organizing collection of wireless nodes that form a temporary wireless networks

dynamic in nature by a group of mobile nodes on a wireless channel. A session for communication is achieved by single hop if the node is in transmission range of the source node or by relaying in which the data is transferred using various intermediate nodes between source and destination. However the transmission range of low power node is limited and out of range nodes are routed through immediate nodes. The advancement of mobile computing and communication devices is driving a revolutionary change in our information society. Now we can access whatever information we require from anywhere and from any part of the world. The latest technologies and using devices that supports such features of remotely connecting to a network and accessing any kind of information has made wireless networks the easiest solution for their interconnection. Mobile users can use their cellular phone to check the e-mail, browse internet and travellers with portable computers can access the internet from airports, railway stations and from other public locations where there is facility to connect to the network, tourists can use Global Positioning System (GPS) terminals installed inside the cars and now in mobiles to locate driving maps and tourist attractions. Using this technology people can exchange files and other information by connecting portable computers via wireless LANs during conferences from homes. The users can also synchronize their data and transfer files between portable devices and desktops.

1.1 Ad-hoc Networking Protocols

MANET uses various routing protocols which basically faces a lot of challenges because of frequently changing topology, low transmission power and asymmetric links. The protocols that we are discussing here are the flat routing protocols in which the routing information is distributed to all connecting nodes without the use of any structure between them. The Routing protocols can be classified into two parts:
•   Table Driven
•   Source Initiated (On demand)

Proactive (Table Driven) Routing Protocols: Proactive routing protocols maintain one or more routing tables for nodes in the network. The routing table is updated in these protocols periodically or in response to change in the topology of the network. In these types of protocols the source node does not need route-discovery procedures to find a route to a destination node. Proactive protocols continuously evaluates the routes within the network so that when we are required to forward the packet route is already known and immediately ready for use. There is no time delay takes place. Various Table Driven protocols are: DSDV, Fish eye state routing (FSR), Optimized link state routing (OLSR), Cluster gateway switch routing (CGSR) etc. **Reactive (On-Demand) Routing Protocol:** Reactive protocols are the on demand protocols which have no network information at nodes if there is no communication. These protocols do not maintain or constantly update their route tables with the latest route topology. If a node wants to send a packet to another node then this protocols searches for the route and establishes the connection in order to transmit and receive the packet. It is more efficient than proactive routing and most of the current work and modifications have been done in this type of routing. The

main approach of routing is to search a route between a source and destination whenever that route is needed. Discovery of route on demand avoids the cost of maintaining routes and controls the traffic of the network. The various on demand protocols are: Dynamic source routing (DSR), ad-hoc on demand distance vector (AODV).

2. REVIEW OF LITERATURE

Mobile ad-hoc network is an emerging technology that provides support to self organizing mobile networking infrastructures that follows a dynamic topology. The nodes in a mobile ad-hoc network act as a host and as a router too to route the packets from source to destination. The node which is in range of the sending node can easily get the data from sender using the simple phenomenon but for the nodes which are out of the range of the sending node has to follow the principle of relaying. The sender uses various intermediate nodes to transfer data to the destination. A lot of research is going on Mobile ad-hoc networks and the routing protocols that are used on MANET.

In 1999, M.Scott Corson and Joseph Macker [3] had worked on an internet based mobile ad-hoc networks. They carried out the research to analyse that how this technology can be used for future commercial and military application. The research gives the long term rationale of the use of internet based protocols approach in wireless networks. The research defines the significance of the Mobile ad-hoc networks and their relationship to the existing networks. The IP based approach for the wireless networks is discussed in which a MANET containing two wireless networks and their logical union is done which thus formed a router fabric. The research also explains the future quality of service aspects of this technology.

Nicklas Beijar [2] of Helsinki University of technology, Finland has take the study further by taking approach known as Zone Routing which is capable to route packets to the destination which is not in the range of the sender. The emphasis is laid on the fact that the topology of the MANET's is dynamic and change whenever there is departure of a node or due to the arrival of a new node. The research tells us how the zone routing protocol works, the research exhibits the working of the zone routing protocol in which it divides the nodes into Zones, whenever the packet has to be transferred from one zone to another, the node of first zone which is connected to the node of the second zone is responsible for the transfer. These two nodes maintain the routing information of the Zones and also exchange the information between them whenever there is change in the topology.

In 2003, Imrich Chlamtac [1], Marco Conti and Jenifer Liu of university of Dallas, USA had research on the imperatives and challenges in the mobile ad-hoc networks. The research helps us to know about the advancement going on in the mobile ad-hoc networks and how these are facilitating the users. In his research he also explained about 4G and Ad-hoc networks. He explained in the study that how wireless networks can reduce the cost for network build out and maintenance. In it researchers had discussed the architecture of MANET and the middleware and other applications used in the implementation of MANET.

The Challenging thing in a MANET is to provide energy efficient routes as mobile nodes operation times is very critical on this issue Chansu Yu, Cleveland State University, Ben Lee, Oregon State University, Hee Yong Youn [4], Sungkyunkwan University has done a thorough research. The Proactive and Reactive routing protocols have been explained briefly. The brief discussion on On-Demand routing Technique has been done in the research. The phenomenon to reduce energy required for the nodes are also discussed. The methods mentioned in the research are transmission power control and sleep/power-down methods are discussed. The models used in transmission power control i.e. constant power model and variable power model are briefly explained in the research. The load operation approach used to minimize the power requirement of the nodes has been explained in the research which gives great idea about how the energy requirement for the nodes can be minimized.

In 2008, Luo Junhai, Xue Liu, Ye Danxia [6] had done research on the multicast routing in Mobile ad-hoc network. The techniques like flooding the packets to all the nodes are also explained in the research. The paper throws light on Tree, Mesh and hybrid routing protocols used for multicast in MANET. Evaluating capacity, architecture and location for multicast routing protocols have been explained briefly. The proactive and reactive routing protocols have been explained and the quality of service of these protocols has been discussed thoroughly. The performance criteria used in the measurement of quality of services is based on the user parameters and configurations like control overhead, average delay and throughput, the second parameter used is comparing all the multicast routing protocols.

In 2010, Ajit Singh, Harshit Tiwari, Alok Vajpayee, Shiva Parkash [7], studied the challenges in the Mobile adhoc Networks and the routing protocols used in MANETs. In their research they discussed the energy efficient routing protocols used in MANET. The proactive and reactive has been thoroughly discussed. Hybrid and location based routing is also explained in their research. Signal stability based adaptive routing protocol is also explained in it in which the power is the main metric. They concluded in the study that the power is the main concern in the MANET and the performance of the network depends on various factors like average delay, routing overhead and control information.

Jinhua Zhu and Xin Wang [8], the members of IEEE had researched on the models and protocols for energy efficient routing in MANET. The minimum energy routing protocols have discussed and there types i.e. MTTP, MTTCP and MTRTP have also been thoroughly explained. They explained a new energy consumption model in the research for wireless networks. The four frame exchange model for energy efficient routing protocols have been explained and its working is also provided. The parameters like cost of link and mechanism for route maintenance is briefly explained in the paper. The performances of the routing protocols have been measure on the factors like number of nodes, packet size, connection arrival rate and connection duration and max/min speed.

Dr. R.B. Patel [9], a researcher in mobile ad-hoc network, has thoroughly described the Destination Sequenced Distance Vector (DSDV) Routing Protocol in MANET. In his research he described the properties of DSDV. In this he explained the link state routing and distance vector routing and the problems associated with them. He also explained that how the loops are formed in the network and the problems thus arises. He also compared the old loop formation with newer loop formation mechanism. The research gives the knowledge hoe the routing information in the form of routing tables is maintained. The example how a node updates its routing table is given which shows the complete mechanism how a change in topology results in change of routing table.

In the same era the Curt Schurgers and Mani B. Srivastava [10] of University of California at Los Angeles had laid down their research in wireless networks in which they discussed about the various routing protocols used in these types of networks. Their main emphasis is on energy efficient routing strategy for which they have discussed energy optimal routing scheme in which he explained how the optimal traffic scheduling can be helpful in the networks where the energy is main metric. In their research they also discussed the network traffic spreading in which the techniques like Stochastic Scheme, Energy-Based Scheme and Stream-Based Schemes are discussed thoroughly.

Min Chen and Yong Yuan [14] of University of British Columbia have researched in reliable and efficient routing protocols in wireless networks. In their research they had shown how the routing protocols in wireless packets find their route to route the packet to the destination. They discussed the dead end problem in their research in which the node does not have any connection to any other node and the packet transfer can't takes palace. Thus they have measures the performance of the routing protocols used in wireless networks on the basis of end to end delay, average packet fraction and control overhead parameters.

In early 2012, Tanupreet Singh, Shiavni Dua and Vikrant Das [13] have done research regarding the energy efficient routing protocols in MANET. In the paper they briefly discussed the flat routing protocols. The properties of proactive and reactive routing protocols are given and their difference is also explained. In their research they took three protocols whose performance they are measuring on the parameters like average delay, control overhead, packet delivery fraction. They briefly showed how the three protocols i.e. Destination Sequenced Distance Vector (DSDV), Dynamic Source Routing (DSR) and Ad-hoc On Demand Distance Vector (AODV) routing protocols works. The brief knowledge is given how these protocols maintain their routing information so as to interact with other nodes on the network.

The Comparison between DSR, DSDV and AODV has been analized by Shrikant Upadhyay, Pankaj Joshi, Neha Gandotra and Aditi Kumari [11] of Dehradun institute of technology. In their research they used the network simulator tool to analyze the performance of the above mentioned protocols and then they deduced differences between them from the outcomes.

In mid 2012 Pinki nayak, Rekha Aggarwal and Seema Verma [5] have done a research in energy efficient routing in Mobile Ad-hoc Network. As in earlier studies the main

consideration in energy efficient routing is the power metrics. They worked to reduce the energy consumption of the node during transferring a packet. They also explained the transmission control approach which uses power Aware Localized Routing, Smallest Common Power Routing and flow Augmentation Routing. The methods that can save energy of the nodes are discussed in the research which leads to increase the life of the network.

3. ROUTING PROTOCOLS IN MANET

Ad Hoc on Demand Distance Vector (AODV): The Ad hoc On Demand Distance Vector (AODV) routing algorithm is a routing protocol designed for ad hoc mobile networks. AODV is capable of both unicast and multicast routing. AODV is an on demand algorithm which means that it creates routes between nodes only when the source nodes has to transfer the data to other node. These routes are maintained as long as they are required by the sources. AODV also forms trees which are used to connect members of a multicast group. The tree consists of the members of the group and the nodes that are required to connect the members. There is use of sequence numbers in AODV so that freshness of routes can be maintained. In AODV the route is built using a route request / route reply query cycle. Whenever a node requires a route to a destination for which it does not have a route already, it broadcasts a route request (RREQ) packet across the network. The Nodes that receives this packet updates the information for the source node and sets backwards pointers to the source node in the routing tables. Apart from the source node IP address, current sequence number, and broadcast ID, the RREQ also consists of the most recent sequence number for the destination is also maintained. The node that receives the RREQ may send a route reply (RREP) if it is either the destination or if it has a route to the destination with corresponding sequence number greater than or equal to that of existing in the RREQ. In this case, it unicast a RREP back to the source node else it rebroadcasts the RREQ. The Nodes keeps track of the RREQ's source IP address and its broadcast ID, if they receives a RREQ which they already had processed, they discard the RREQ and will not forward it. As a result of this RREP propagates back to the source and nodes set up forward pointers to the destination node. On receiving the RREP by the source node it begins to forward data packets to the destination. When the source receives a RREP containing a greater sequence number it updates its routing information for that destination and start using better route. AODV only maintains the routes as long as the route remains active.

Dynamic Source Routing (DSR): The Dynamic Source Routing protocol (DSR) is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks. The DSR allows the network to be a self-organizing and self-configuring network, without the need for any existing network infrastructure or administration. DSR is being implemented by different groups, and deployed on several tests. Dynamic Source Routing can operate with Mobile IP, and nodes using Mobile IP and DSR have seamlessly migrated between WLANs, cellular data services, and DSR mobile ad hoc networks. The DSR protocol uses the two main mechanisms of "Route Discovery" and "Route Maintenance", which together works so as to allow nodes to discover and maintain routes to destinations in the ad hoc network. The DSR protocol allows more than one routes to any destination and allows each sender to select and control the routes used during routing the packets. The main advantage of DSR protocol is that it easily guarantees loop-free routing. It also has support for use in networks having unidirectional links and very rapid recovery when there is change in routes in the network.

Destination-Sequenced Distance-Vector Routing (DSDV): The DSDV is also known as Distributed Bellman-Ford or RIP (Routing Information Protocol). In it every node maintains a routing table for all available destinations. It also maintains the information about the next node to reach the destination in its routing table. One another thing that is present in its routing table is the number of hops that encores during reaching the destination. It periodically sends its routing table to all neighbors to maintain the topology. As in MANET the topology changes dynamically so it has to exchange the routing table to its nodes whenever there is change in the topology. The issue with DSDV is that all routing decisions in distributed manner are made. Every node use local information available for routing the messages. The local information could be old and invalid. Local information may not be updated. This gives rise to loops. A message may loop around a cycle for a long time.

4. RELATED WORK

The proposed work is aimed at developing energy efficient AODV routing protocol. This section documents some of the many energy efficient schemes based on AODV developed by researchers in the field.

Various Algorithms

1. Local routing: This on-demand ad hoc algorithms states that all nodes participate in the phase of path searching but the final decision is made in source or destination node. The algorithm has granted every node in network the permission to decide whether to participate in route searching or not. The Local Energy-Aware Routing (LEAR) algorithm has as a main criterion the energy profile of the nodes. The residual energy defines the reluctance of intermediate nodes to respond to route requests and forward data traffic. When energy Ei in a node i is lower than a predefined threshold level (Th):

$$E_i < Th,$$

The node does not forward the route request control message, but simply drops it. Thus does not participate in the selection and forwarding phase

2. Expected energy consumption:
This is proposed to maximize the lifetime of the nodes. It uses energy as a metric but the route is chosen on the minimum transmission energy basis until the residual energy of the constituent nodes in a network is above a predefined threshold. If there are any nodes on the discovered routes whose energy is below the threshold the route request is dropped

3. Battery-sensitive routing:
The approach is presented to make use of the available battery capacity by means of battery-sensitive routing. The

algorithms are based on two processes, namely, recovery and discharging loss. These processes are experienced when either no traffic or new traffic is transmitted. This line of study led to the design of a cost function that penalizes the discharging loss event and prioritizes routes with "well recovered" nodes. Thus, battery recovery can take place and a node's maximum battery capacity can be attained. The selection function in is a minimum function over the cost functions of all routes.

4. Energy drain rate:

The energy drain rate metric, which represents the speed of energy consumption. It estimates the lifetime of a node and if the estimated value is below a threshold, the traffic passing through it can be diverted in order to avoid node failure due to battery outage. The cost functions of a node i is defined as the ratio between the Residual Battery Power (RBC) and the Drain Rate (DR).

5. PROPOSED WORK:

In this paper the approach is based on AODV routing protocol in which it uses a load balancing technique. The technique comprises of a Thresh hold value (Th) which is fixed for each node on the network. When the energy (Ei) of the node goes beyond the threshold value (Th) that node is not further used for transfer of data through it. In AODV if in route reply message contains the node whose value is less than the Th value than the AODV will not follow the route and finds the other route which is optimal than the path in route reply message. By this method node with less energy will not be used unless higher Th value nodes are available hence saves the node from getting down and out of the network. When energy Ei in a node i is lower than a predefined threshold level (Th):

$$E_i < Th$$

The node does not forward the route request control message, but simply drops it thus saves energy and saves the lifetime of the network.

6. SIMULATIONS

The Simulation has to be performed using Network Simulator-2. The simulation will be using 50 wireless nodes which together form an ad-hoc network. The various parameters that is the part of the study are:

1. Routing Overhead which defines the ration between total control packets and delivered ones.

2. Throughput which is the measure of the total packets successfully delivered to the destination.

3. Average end to end delay which is the average time from the beginning of a packet transmission at a source node until packet delivery to a destination. This includes delays which are caused by buffering of data packets which incurs during discovery of routes, queuing that occurs at the interface queue, retransmission delays, and propagation and transfer times. To measure average end to end delay we can calculate the sending (S) time (t) and receiving(R) time (T) and then we have to average it. The size of the packet to calculate Packet Delivery Fraction and Average End to End Delay is to be taken of large size but should be kept constant throughout. Using this information the graph is to be plotted between average end to end delivery and the pause time by varying the number of nodes.

4. Energy Efficiency which is a critical issue during routing is to conserve as much power as we can so as to achieve high throughput.

5. Packet Delivery Fraction which is the ratio of the number of data packets successfully delivered to the destinations to those generated by CBR sources. Packet delivery fraction = (Received packets/Sent packets)*100.

7. CONCLUSION

When we talk about the comparison of the above stated routing protocols AODV performs better than DSR and DSDV. With the larger number of nodes the efficiency of the DSR and DSDV becomes less but AODV performs better than these. AODV is better option when there is CBR data. The energy is still a big issue in these protocols and this approach will lead to save energy or we can say manage energy in a efficient way with helps in longer lifetime of the network.

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