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Energy Efficient AODV Routing Protocol for Mobile Ad-hoc Networks

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Abstract: Mobile ad-hoc networks are infrastructure-less networks used for communication between two or more nodes without a common access point. It is a collection of nodes that is connected through a wireless medium forming changing topologies. In mobile ad-hoc networks all the nodes are mobile in nature and having limited battery charge. Continuous change in position of nodes in the network degrades the battery charge of the nodes therefore it is necessary to save the battery power of those nodes so that the network lifetime can be long lasting. Nodes in the network are working in the presence of limited energy then energy efficient routing is necessary for reducing energy consumption. In this paper we proposed energy efficient AODV routing protocol in which Dijkstra algorithm is enhanced to improve the overall performance of the network. Existing systems are not capable of finding the shortest and energy based path among the nodes in the network if multiple nodes fail simultaneously. Performance parameters are Packet delivery ratio, Throughput, Energy consumption and routing overhead. The simulation is done using network simulator NS-2.

Keywords: Energy efficiency, AODV, Manet, NS-2.

I. INTRODUCTION

A Mobile ad hoc network is a group of wireless mobile nodes in which nodes collaborate by forwarding packets for each other and allow them to communicate outside the direct wireless range. These networks are fully distributed, and can work at any place without the help of any infrastructure [9]. Ad-hoc network does not require any fixed network infrastructure such as base stations, and can be easily set up at low cost as needed. The routers, the participating nodes act as router, are free to move in network randomly and manage themselves arbitrarily; thus, the network's wireless topology may change rapidly and unpredictably. Each of the mobile nodes is operated by a limited energy battery and usually it is impossible to recharge or replace the batteries in a remote area. Since wireless communications consume significant amount of battery power [1], this limited battery lifetime imposes a severe constraint on the network performance. Routing is a process of detecting various routes from source to destination nodes. All the routes are calculated and then restored in network. . Routing tables are of two types Static Routing and Dynamic Routing. Static routing is a type of network routing technique. Dynamic routing is a networking technique that provides optimal data routing. The routing table is not affected by addition or deletions of router in case of static routing but it is affected in dynamic routing. Due changing of positions of nodes [3] and connections, the energy and lifetime of network degrades.

To overcome the problem, several solutions have been proposed. We have analysed that no solution have feasible solution. So in this paper we have implemented an energy efficient AODV Routing protocol that is able to enhance the energy and routing overhead of the network.

The rest of the paper is organized as follows. We begin with Section 2 of discussing related work. In Section 3, proposed work is described. Section 4 simulation setup and results. Section 5 we conclude.

II. RELATED WORK

Jhunu Debbarma et al [1] Presents an efficient energy management protocol E-power. It is proposed to reduce power consumption and reduce transmission latency on useless tasks. High node density significantly improves network performance with all three protocols. The reason for better performance is because when a link breaks, it becomes easier and faster to find a new link. E-power performance is better. It is also seen that the higher the node density, the better is the performance of the E-power algorithm.

Bhabani Sankar Gouda et al [2] presents an energy optimal AODV (EOAODV) routing protocol based on reactive routing protocol. In this proposed approach, source node does not send any RREQ; no enough energy (battery life time) and received RREP until the node density in its neighbouring exceeds a particular threshold. When applying routing discovery and needs to avoid the unnecessary information sending efficiently.

Dr. Annapurna P Patil et al [3] proposed a newer variation of the AODV routing protocol, which tackles major issues in MANETs like adaptability and energy efficiency. It is achieved by evaluating energy values of the nodes and forwarding packets along least drained nodes path, making the network adaptive in nature.

Chandan Kumar Behera et al [4] proposes a new optimal energy conserving reverse reactive routing protocol has been proposed that computes the shortest path in between any source-destination pair on demand. The approach,

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unlike other energy conserving reactive protocols, finds loop-free, increases in power consumption and optimal path between the end nodes.

Said Khelifa et al [5] presents a full performance analysis of an energy conserving routing protocol in mobile ad hoc network, named EM-AODV. This paper proposed a mechanism which tries multiple route replies. The second mechanism proposes a new adaptive approach which seeks to incorporate the metric "residual energy " in the process route selection, Indeed the residual energy of mobile nodes were considered when making routing decisions.

S. Preethi et al [6] proposed an energy efficient route discovery process for AODV based on ERS. This approach saves energy of the nodes by avoiding the redundant rebroadcasting of the route request packets. The relaying status of the node is decided based on the broadcasting of its RREQ packets by its neighbors. And it helps in reducing routing overhead incurred during the route discovery process.

Uma Rathore Bhatt et al [7] an energy efficient routing protocol viz. EERP is proposed for this purpose which is based on AODV. The protocol reduces the transmission power of a node which is part of an active route if next hop node is closer. The distance between two consecutive nodes is calculated based on RSS (received signal strength) from next hop during the route reply process. If the RSS is high, it implies that nodes are closer; as a result lesser transmission power will be required to send data. This in turn reduces battery consumption.It is compared with existing AODV routing protocol.

III.PROPOSED WORK

One of the greatest challenges in mobile ad-hoc network design is the limited availability of the energy resources. Energy efficient communication is critical for increasing the life of power limited wireless ad hoc networks. From previous discussions it is clear that weakness of AODV protocol is energy. In order to make this energy efficient, its enhanced version EE-AODV is proposed in which Dijkstra algorithm is enhanced with AODV to improve the overall performance of the network. Existing systems are not capable of finding the shortest and energy based path among the nodes in the network if multiple nodes fail simultaneously. EE-AODV checks the Energy/Distance ratio of each path available in the network. When source node wants to communicate with destination node to transfer the data it starts the route discovery process and broadcast the route request packets to their neighbor along with its energy after receiving the RREQ the neighbor node update their routing table and forward request to their own neighbor along with energy level. After receiving the route request (RREQ) the destination node checks the Energy/Distance ratio for each path in which path having maximum energy and minimum distance is selected in the E/D ratio and after calculating ratio destination replies back to source paths having maximum ratio and after getting the route reply (RREP) source node transmit data through path having maximum ratio. Simulation results of proposed algorithm shows that it improves the overall performance of the network in terms of throughput, packet delivery ratio, routing overhead and energy consumption.The flowchart for EE-AODV protocol is shown in Fig. 1.

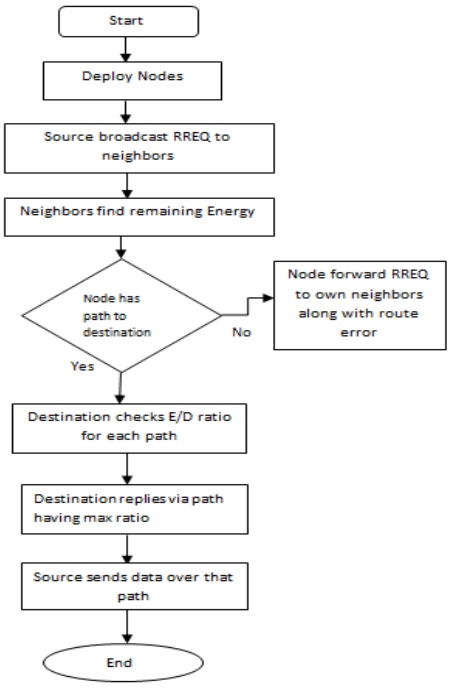

Fig 1: Flowchart of proposed methodology

The flowchart for EE-AODV protocol is shown in Fig. 1. It depicts the scenario when source node broadcast the route request to the neighbor nodes. If the neighbor node has path to destination, then the request is forwarded to the destination node otherwise the route error message is forwarded to the source node through neighbor nodes. After receiving the route request message, the destination check Energy/distance ratio for each path (Maximum energy and Minimum distance) and replies back paths having maximum ratio to source and after receiving RREP source transfer the data over that path having maximum ratio.

IV. RESULTS AND DISCUSSIONS

Simulations play a dynamic role in the development and testing of ad hoc networking protocols. The performance analysis was carried out using network simulator NS-2.35 (NS2) version to perform comparison between EE-AODV (energy efficient) and MM-AODV (maximum multipath). NS2 is a discrete event, object oriented, simulator developed by the VINT project research group at Carnegie Mellon University. NS2 is one of most popular network simulator tools worldwide. The NS2 was installed under Ubuntu 12.04 as a simulation platform. Network dimension used is 1100m x 1100m network and the channel type is wireless and the mobility model is random waypoint and the type of antenna is Omni-directional. The following table shows that the important parameters chosen for the NS2 simulation:

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Table1. Simulation Parameters

PARAMETERS	VALUES
Channel type	Wireless channel
Mobility model	Random way point
Type of antenna	Omni directional
Topology area	1100m × 1100m
Number of Nodes	50
MAC Protocol	MAC 802.11
Routing protocol	AODV
Traffic Type	CBR
Initial energy	100J
Transmission Power	0.14W
Interface queue type	Drop tail/PriQueue

4.1 Performance metrics

The performance analysis was carried out using network simulator 2 and we have compared our proposed work EE-AODV with MM-AODV and we focused on four performance metrics for evaluation which are Packet Delivery ratio (PDR), Energy consumption, Throughput and Routing overhead. Various performance parameters analyzed are as follows:

4.1.1Energy Consumption

It is measured as the total consumed energy divided by the total number of packets received. In case of EE-AODV, lesser transmission power is used to send data if the node is closer therefore remaining energy of EE-AODV is more as compared to MM-AODV.

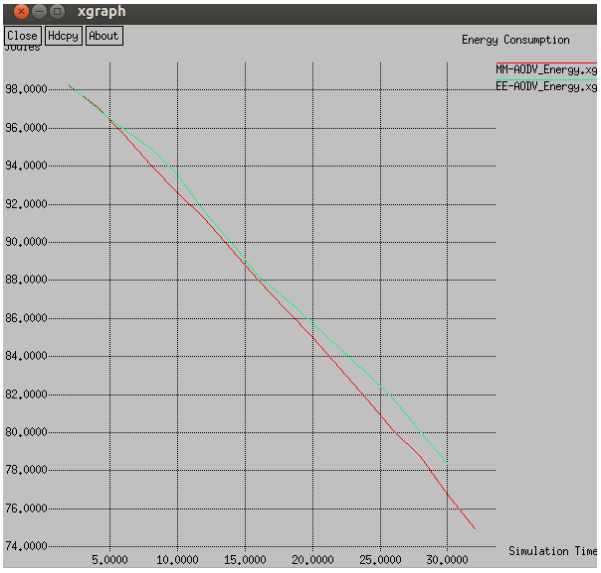

Fig2: Remaining energy vs. simulation time

4.1.2 Routing Overhead

This metric describes how many routing packets for route discovery and route maintenance need to be sent so as to propagate the data packets.The lower value of routing load are represents the better network performance.

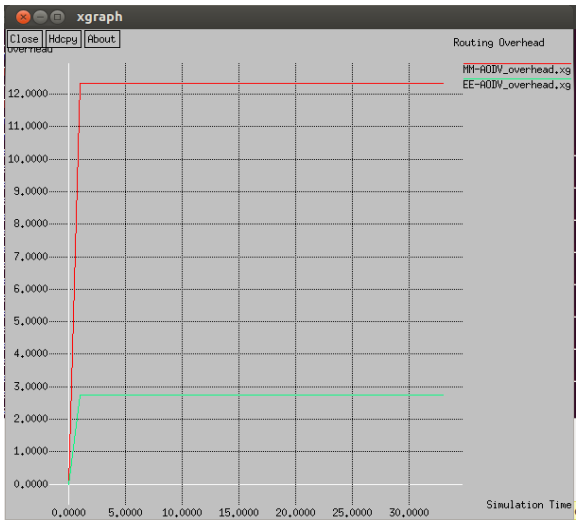

Fig3: Routing overhead vs. Simulation time

4.1.3 Packet Delivery Ratio

It can be defined as the ratio of number of packets successfully delivered to destination to thenumber of packets transmitted by source node.

$$PDR = \frac{\text{(Total number of packets successfully received)}}{\text{(Total number of packets sent)}}$$

Fig 4: Packet delivery ratio vs. Simulation time

4.1.4 Throughput

It is the average number of messages successfully delivered per unit time or it is the average number of bits delivered per second. This data may be sended over a physical or logical link, or pass through a confident network node. This is the measure of how rapidly an end user is able to receive data. It is determined as the ratio of the total data received to required promulgation time. A higher throughput will directly impact the user's observation of the quality of service. In figure 5 the throughput comparison is given and it is clear that the throughput of EE-AODV is greater than MM-AODV

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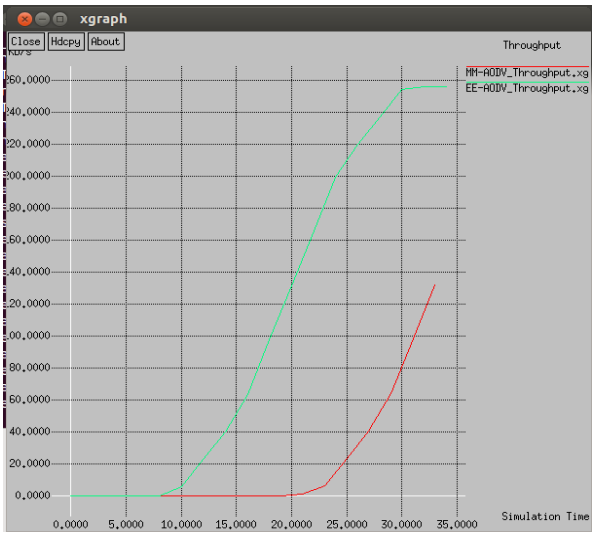

Fig 5: Throughput vs. Simulation time

V. CONCLUSION

In this paper we provided an overview of mobile ad-hoc networks and discuss how energy is the most important constraints in the Manet. All the nodes are mobile in nature and having limited battery charge therefore it is necessary to save the battery power of those nodes to increase the lifetime of the network. The Energy degradation is a serious problem. So we have implemented energy efficient AODV routing protocol which finds the optimal path between source and destination and reduces the energy consumption of the nodes in the network with better performance. The performance analysis was carried out using network simulator NS-2.35 (NS2) version and compared the performance of EE-AODV with MM-AODV. The result of comparison shows that EE-AODV performs better than MM-AODV in terms of throughput, energy consumption, routing overhead and Packet delivery ratio of the network.

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