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# Energy Efficient Routing in Group and Disaster Mobility: Comparative Analysis

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**Abstract—**The energy consumption of battery-powered mobile devices is very important issue due to high traffic demands. As a result of this trend, energy efficiency has become a critical component of ad hoc networks. The lifespan of such a network is an important consideration in this area of research. As a result, energy consumption is an important metric to consider. In addition, due to a lack of energy, there is a problem with broken links, which causes chaos in the network system. This problem arises as a result of mobile neighbor node energy unawareness. As a result, one of the most critical issues in MANET is the introduction of an energy-aware routing protocol. This paper provides a brief overview and analysis of some energy-conscious routing protocols.

***Keywords—**MANET, DSR, DSDV, Energy, AODV, AOMDV*

## Introduction

A wireless network uses wireless connections to connect devices for the purpose of exchanging data and eliminates the costly method of installing cables between devices in different locations. Wireless networks include radio networks and Wi-Fi local networks, to name a few. Wireless networks are divided into two categories: infrastructure and infrastructure-less wireless networks.

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Ad-hoc networks are flexible, with bandwidth and energy constraints. As a result, routing in such a network has been difficult. Mobility causes rapid changes in network topology. The breakage of routing paths, according to various researchers, is the cause of these changes in network performance. This disconnect is caused by two major factors: Node in the routing path has run out of battery power; or a link between two nodes has been lost.Because of the highly dynamic nature, topology changes are frequent and unpredictable, making routing between mobile nodes more challenging and complex.

Various protocols are used to simulate various aspects such as packet drop rate, energy efficiency, packet end-to-end delay, network throughput, and routing protocol overhead. Proactive and reactive routing protocols are the two most popular forms of MANET routing protocols. Proactive protocols constantly monitor the topology of the network and collect data from it through data flow between nodes. This implies that a quick route can be found whenever one needs to go from one place to another. Table-driven routing protocols, such as DSDV (Destination Sequenced Distance Vector), are proactive protocols that merely store routing data in one or more tables.

On-demand protocols, often known as reactive routing techniques, are intended to reduce network traffic overhead. It's based on the "question reply" conversation. It is not continuous, but it establishes a mechanism for determining a single route from the source to the destination when necessary. Reactive routing systems include Ad Hoc On Demand Distance Vector, Dynamic Source Routing and Ad Hoc On Demand Multipath Distance Vector.

**Energy Aware Routing: Literature Survey**

Here the nodes are powered by batteries. Each node has a finite amount of energy, communication, and computational capacity. When a node loses all of its energy, it is unable to recharge its batteries and is consequently disconnected from the network. Energy consumption management is necessary for the following reasons:

-Limited energy storage: the nodes' battery power is limited.

-Battery replacement issues: recharging or battery replacement is extremely difficult in scenarios such as floods, earthquakes, and battlefields.

-lack of central coordination: here certain nodes operate as relaying nodes, which can burn a lot of energy if the traffic load is high.

-choosing the best transmission power: as the transmission power is increased, so is the amount of battery consumption. Optimal transmission power lowers inter-node interference, allowing for more simultaneous transmissions. The capacity of the node's battery can be increased to provide the nodes a longer lifespan. Battery or power management can be used to increase the node's battery capacity.

Every node in the MANET uses energy in four different states: send, receive, ideal, and sleep. The energy-aware criteria that affect energy-aware routing are as follows [4]. .

- Cutting down on typical energy use: By taking this action, the average energy usage per packet is decreased.

-Extending the life of a network by optimising its partitioning time: This strategy aims to maximise network lifetime.

-Reducing the variation in node power levels: This criterion guarantees the survival and cooperation of all nodes.

-Decreasing the packet delivery cost overall

-Minimising the maximum cost of the node: This statistic lowers the maximum cost of the node.

For lowering energy use, two different ways are used. Transmission power is increased in the Transmission Power Control Approach, resulting in an improvement in transmission range. There is a large end to end delay if the transmission is weak. As a result, having a good transmission range between any nodes is desirable for less power use. Instead of taking the fastest route, the second load distribution strategy uses under utilized nodes. The energy utilization of all nodes is well balanced due to proper load distribution among the nodes.

The relevance of energy-aware routing in MANET cannot be overstated. Energy efficient routing methods have the primary goal of decreasing energy consumption in packet transmission, avoiding routing packets through low-energy nodes, optimizing routing information in the network, and extending network lifetime. In ad hoc networks, energy efficient routing can be accomplished in a variety of methods. Some methods attempt to reduce energy usage during route discovery, response, and maintenance. This section discusses some energy-aware routing protocols for MANETs.

One of the most widely used protocols in MANETs is the DSR Mechanism, which is a dynamic source routing protocol. This approach, however, is inefficient in terms of energy use. Many researchers have made changes to the protocol phases and added energy metrics to the protocol to improve its performance in terms of energy consumption.

NCE- DSR is a new energy-saving method applied to DSR. For elongating the period of network lifetime, NCE-DSR calculates the cost function which is used to pick the route. If a node's remaining battery power is greater than a specific threshold, it will participate in route discovery [8,10], which is based on DSR. Otherwise, the node drops the RREQ packet and sends a new message DRREQ to notify the other nodes. Consequently, only after passing through nodes with more energy than the specified threshold will the RREQ packet arrive at its destination. Out of all the paths with sufficient energy, the one found in the RREP packets is the shortest. After withdrawing an RREQ message or receiving a DRREQ packet, every node lowers its battery threshold by a specific adjustment value. It then broadcasts the RREQ packet only if its remaining energy exceeds the new threshold.

Each node in the DSR-based energy efficient routing protocol (EDDSR) [7] assesses its willingness for participation basedd on its current level of battery power. The EDDSR mechanism attempts to prevent low-lived nodes from engaging in route discovery, hence increasing node and network longevity. Every node in the network regularly calculates its remaining battery power (RBP) and engages in network operations if it has sufficient battery power.

MEADSR [6] is a DSR-based energy conscious multi-path source routing mechanism. Two paths are found and saved in the routing table in this protocol. In the MEA-DSR protocol, the primary route is chosen based on the energy of nodes along the path and the overall transmission power necessary to send data. When it comes to choosing a second route, the path with the highest dis-jointness ratio from the first path takes precedence. The route table and RREQ packets now have a new field called min_bat_lev that stores the minimum energy of nodes on the path.

The path $\pi$ at time t is selected in the PSR [12] route discovery process in order to minimise the cost function. Using its remaining energy and the higher tier's traffic requirements as a guide, each node in the Energy Aware and Reliable Routing Protocol (EARR) [13] determines whether or not to send RREQ packets. Only when the remaining energy exceeds the required energy will RREQ packets be transmitted. In this protocol, the destination will only receive the RREQ packet when the intermediate nodes of the route have sufficient energy. Because of this, only valid paths are selected as candidate paths, prolonging the life of the network by preventing path rebuilding brought on by low battery power.

The major goal of the SEA-DSR [11] is to increase the dependability of the discovered path by considering both signal strength and node remaining energy. By dispersing traffic load, this protocol decreases connection failure and extends network longevity. Path failure, packet loss, route discovery, and routing management overhead are all reduced using this protocol.

The AODV routing protocol in which the routing table only contains the next hop for each destination. Energy conservation is a crucial application in the realm of emergency and military operations that require energy efficient solutions, according to Dr. Annapurna P Patil et al.[14]. AODV has a number of significant issues, including energy efficiency and adaptability. The least drained node path is used to evaluate forwarding data packets and node energy values in the proposed AODV.

Ashok Kumar et al [15] proposed using several routing algorithms to communicate amongst ad-hoc networks. The routing aim is defined by a set of nodes or actions that make up a routing protocol. Energy efficiency, network congestion, and mobility are three of MANET's main issues. The route failure problem happens when data packets are transported due to the mobility in the AODV.The technique proposed an extension of the AODV protocol called POAODV which aids in the identification of the most efficient network path.

Pushpendra Kumar et al. [16] proposed MRAODV which is entirely dependent on path stability. It calculates the energy to ensure that the found path is both stable and low in energy. The main goal is to compute energy in MRAODV without breaking any links in the path. This increases the network's maximum node stability and hop count.

The energy efficient routing protocol (EEAODR) determines the optimal path through an optimisation function based on time, node energy, and hop count parameters [17]. This protocol's optimizer function won't select a path that contains one node with a low energy level. If time is limited, the trip will be shorter and require less energy. Conversely, some nodes might pass away before their time.

DEEAR [8] is a distributed energy efficient routing protocol that only needs the network's battery power level and uses RREQ packets to gather the data needed for energy aware routing. In DEEAR, nodes with a lot of battery power broadcast the RREQ packets first, and intermediate nodes regulate the rebroadcast time of the RREQ packets.

Upon receiving the RREP packet, each intermediate node's remaining battery power is ascertained by the integrated energy aware routing protocol (EA AODV) [13]. To achieve this, it first calculates the energy needed at the node to transmit a packet, adds that energy to the node's energy supply, and then appends the result to the RREP packet. Each path node checks its battery level; if it is below the amount indicated in the RREP packet, it only replaces it. When multiple paths lead to the source, the path with the highest minimum battery energy is chosen. When routing, the available power and energy are taken into account. In order to balance the battery depletion in this protocol, the source node applies gearbox power and chooses the path based on the load balancing technique.

Routing decisions are based on the least amount of residual energy according to the Energy Aware Routing Protocol (AODVEA) [12]. The node with the lowest residual energy is highlighted, and the path with the highest minimum residual energy is chosen. RREQ and RREP control packets now include a new field called residual energy (Min-RE) as a result. Dynamic energy-aware routing technology EA-DYMO [8] is based on the DYMO protocol. The DYMO protocol has superseded the AODV protocol. The DYMO energy and load-aware routing protocol aims to provide a way to select the best path according to the remaining energy and traffic load of each node. The route selection factor is determined by this protocol as the average energy divided by the average traffic load. The path with the highest PS value is chosen for data transmission.

In the local energy aware routing protocol (LEAR-AODV) [5,10], A RREQ packet is transmitted if the battery level exceeds a specific threshold; otherwise, the message is dropped. The RREQ packet will reach its destination if all nodes on the path have sufficient energy. If the battery falls below a certain threshold during route maintenance, an RERR packet is sent to the sender node, which is done locally in the node delivering the RERR packet.

The path with the longest lifetime is chosen in the Lifetime prediction routing protocol (LPR-AODV) [8,10]. Battery lifetime prediction is used in this protocol. Based on previous activity, each node forecasts its battery lifetime. Except for the destination and source, all nodes calculate their expected lifetime during the route discovery phase. Each route request packet has an additional field called Min-lifetime that shows the minimal lifetime. The source node selects the path with the longest lifetime during the route selection phase. The Load Aware Routing Protocol (ELB-MRP) [8,9] calculates load at the node and its single hop surrounding nodes by using collision window size and queue size.

Qu Lei et al. [18] suggested an energy-efficient approach that is based on network node energy management. The energy metric is used to select the routing path in this approach. The selection of a path based on the energy measure aids in achieving a long path life by placing the path on nodes with high energy resources, hence extending the network lifetime. However, this algorithm has a flaw in that it selects routing paths solely on the basis of the node's energy. Because the connection can be severed if the high energy node is shifted from its position, node mobility should be regarded as a routing path selection parameter.

**Analysis With Experimental Results**

The necessary work is simulated using Network Simulator 2.34 [19,20,21]. Using OTcl, NS2 is a C++ discrete event simulator. Constant bit rate (CBR) traffic sources are used by MANET nodes in the appropriate simulation environment to send data to the Internet domain. The disaster area, which is 285 x 260 sq. m, is where all relief and medical aid efforts are conducted. To generate traffic, use the cbrgen utility. The interval ranges from 0.5 to 0.1 seconds. The current routing protocol is compared with the Disaster Area Mobility Model and the Reference Group Mobility Model. Simulation is created both for DM model and GM model with 111 nodes and 300 seconds of simulation time. Topology size of 285 m X 260 m is considered. Initial energy is 100 Joules/node is taken. Interval and Packet size these two parameters are considered against the residual energy of node. Six catastrophic areas are considered for DM model which includes one Incident Location, two Patient waiting treatment area, one Technical operation commands, one Ambulance Paring point, one Casualty Clearing Station.

MANET nodes have limited energy since they rely on a limited battery source. The nodes with low energy levels will not be able to finish the routing. Figure 1 depicts a graph of residual energy over time. The residual energy values for various intervals are listed in Table 1.

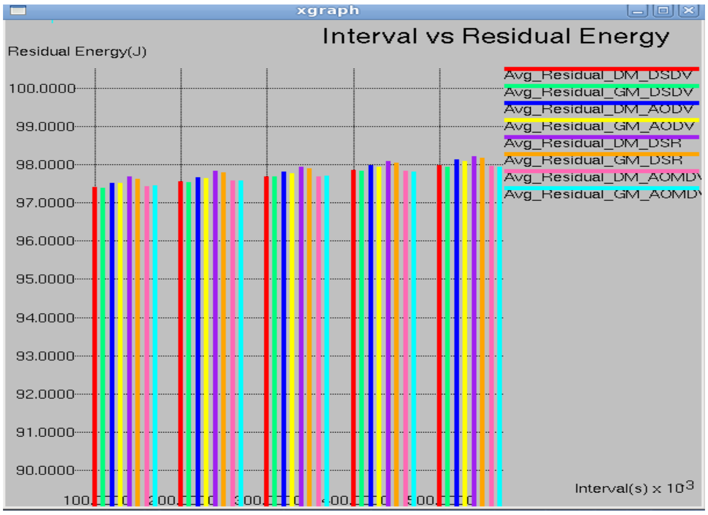


**Fig 1:** Interval vs. Residual Energy

**Table 1:** Interval vs. Residual Energy (J)

| **Interval** | **0.1** | **0.2** | **0.3** | **0.4** | **0.5** |
|---|---|---|---|---|---|
| AODV-DM | 97.51 | 97.66 | 97.80 | 97.96 | 98.12 |
| AODV-GM | 97.51 | 97.63 | 97.77 | 97.92 | 98.08 |
| AOMDV-DM | 97.43 | 97.56 | 97.69 | 97.82 | 97.94 |
| AOMDV-GM | 97.44 | 97.58 | 97.69 | 97.81 | 97.93 |
| DSDV-DM | 97.39 | 97.54 | 97.68 | 97.84 | 97.97 |
| DSDV-GM | 97.39 | 97.54 | 97.68 | 97.82 | 97.94 |
| DSR-DM | 97.68 | 97.83 | 97.94 | 98.08 | 98.22 |
| DSR-GM | 97.62 | 97.79 | 97.88 | 98.04 | 98.16 |

Here DM stands for Disaster mobility model and GM stands for reference point group mobility model.DM model is capable handling obstacles while GM model has limitation in handling obstacles. From table 1, AODV-DM is having better energy conservation that AODV-GM.DSR routing protocol in DM model has highest energy efficiency in given simulation setup.

Figure 2 illustrates a graph of residual energy as a function of packet size. Table 2 shows the residual energy levels for various packet sizes.

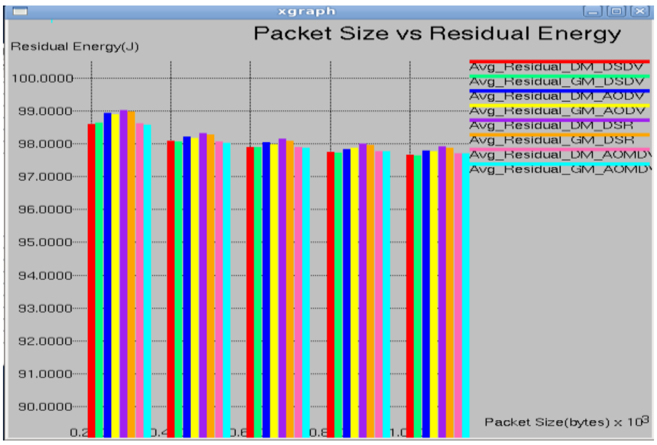


**Fig 2:** Packet Size vs. Residual Energy (J)

**Table 2:** packet size vs. residual energy (j)

| **Size of Packet** | **200** | **400** | **600** | **800** | **1000** |
|---|---|---|---|---|---|
| AODV-DM | 98.93 | 98.21 | 98.04 | 97.83 | 97.79 |
| AODV-GM | 98.88 | 98.15 | 97.97 | 97.86 | 97.76 |
| AOMDV-DM | 98.62 | 98.07 | 97.89 | 97.76 | 97.69 |
| AOMDV-GM | 98.58 | 98.03 | 97.87 | 97.75 | 97.69 |
| DSDV-DM | 98.58 | 98.09 | 97.89 | 97.74 | 97.66 |
| DSDV-GM | 98.63 | 98.05 | 97.88 | 97.73 | 97.64 |
| DSR-DM | 99.01 | 98.31 | 98.14 | 98.00 | 97.91 |
| DSR-GM | 98.97 | 98.26 | 98.07 | 97.96 | 97.87 |

From table 2, DSR performance is best for packet size varies from 200 to 1000.This will lead to increased life time of network.

**Conlusion**

An overview of recently suggested routing protocols that took nodes' energy metrics into account to enhance routing performance is presented in this paper. A network's performance is dependent on its parameters and state, and no routing protocol can offer optimal performance in every scenario. The most crucial elements in ad hoc networks are parameters like node mobility and QoS features. In this paper, we reviewed protocols that used energy measure as the primary parameter and concentrated on the energy characteristics of the nodes. One of the primary issues with a MANET is energy efficiency, particularly when it comes to routing protocol design. This study demonstrates that, in order to extend the lifespan of a network—which is crucial for military operations and disaster relief situations—energy-related problems in MANETs still need to be resolved. Additionally, the analysis of residual energy is performed by varying the packet size and rate. The DM model has the best DSR performance, which is followed by AODV.

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