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EPARGA: A Resourceful Power Aware Routing Protocol for MANETs

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Abstract— **A Mobile Ad-hoc Network (MANET) is a collection of wireless mobile hosts which cooperatively form a network, using no fixed infrastructure or centralized administration. Many problems are encountered in the network realization one major problem is the packet path selection based on energy efficiency. MANETs are usually characterized by mobile nodes with limited battery, so one of the major requirements is to limit energy consumption. This paper proposes a new energy efficient routing protocol called Efficient Power Aware Routing Protocol with Genetic Algorithm (EPARGA) which is a modification of DSR. It minimizes the overhead of source by distributing its load among the intermediate nodes and giving its control of finding the best route between source and destination node. It also balances the consumption of energy between utilized nodes and the underutilized nodes. Efficient Power Aware Routing Protocol (EPAR) is an on demand source routing protocol that uses battery lifetime prediction. Genetic algorithm is applied to find the maximum optimal routes using the process such as selection of individual paths, crossover and mutation technique for reproducing new path. The proposed EPARGA outperforms the existing protocols DSR and EPAR in terms of Routing load , Delay, Throughput and Network lifetime.**

Index Terms— **MANETs, DSR, EPAR, EPARGA, Genetic Algorithm, Battery lifetime.**

I. INTRODUCTION

A mobile ad hoc network (MANET) is a continuously self-configuring, infrastructure-less network of mobile devices connected without wires. Each node in a MANET is free to move independently as there is no centralized administration [1]. For this reason each devices change its links to other devices frequently. These mobile devices are battery operated so the extention of battery lifetime has become an important goal. Most of the researchers have started to consider power- aware development of efficient protocols for MANETs [6]. Though each node in a MANET performs routing function for selecting best paths in a network, a few nodes still die due to limited battery power. Limited transmission range due to mobility may also put an impact on network scalability.

A node consumes maximum battery power during transmission and reception of a data packet. The power consumption also increases during this process. Thus, there is a continuous effort on increasing network lifetime with minimum power consumption. In this research work we mainly focus to improve the energy efficiency and network lifetime. This research work also aim to select the node for routing that has sufficient residual energy which can deliver the data reliably with low power. Routing is a fundamental research issue in MANET for power management. On-demand routing is the most popular approach in the ad hoc networks. On- demand routing protocols build routes only when a node needs to send data packets to a destination.

We propose the Efficient Power Aware Routing protocol with Genetic Algorithm (EPARGA) to find the maximum optimal routes using the process such as selection of individual paths, crossover and mutation technique for reproducing new path.

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II. RELATED WORK

The designing of efficient routing protocol have been a fundamental issue in a MANET. Most of the previous work deals with the problem of finding and maintaining energy efficient paths in ad-hoc networks[12]. In [4], the authors proposed a shortest path algorithm that guaranteed strong connectivity assuming limited node range. But the route was not the minimum energy solution due to omission of optimal links at the time of network calculation. In [2], the authors proposed the generic algorithm of location- aided ticket based QoS routing that have lower overhead and finds high quality routes. In [1], the authors presented the impact of variable transmission range in MANET. The protocol developed have potential to increase the power savings and network lifetime in MANET. In [3], the authors developed routing mechanisms for MANET based on energy drain rate but the mechanism does not work for mobile nodes. In [5], the authors developed QoS based Power Aware Routing Protocol (Q-PAR) that selected an energy stable QoS constrained end to end path. The proposed protocol avoids packet loss and link failure in MANET. In [6], the authors performed performance comparison of stability oriented on demand MANET routing protocols and introduced the idea of Stability Delay Tradeoff (SDT) as a measure of the efficiency of a MANET routing protocols. In [10], the

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authors proposed new scheme called Efficient Power Routing DSR (EPRDSR) to improve existing on- demand routing protocols by introducing the power efficient algorithm in MANET. The proposed scheme also aimed to prolong the network lifetime of each connection. In [11], the authors proposed the Efficient Power and Life Aware Routing Protocol (EPLAR) to increase the life of the nodes and network by selecting the path with maximum lifetime and providing alternate paths in case of exhaustion of nodes in original paths. In [12], the authors proposed Efficient Power aware Routing (EPAR), a new power aware routing protocol that increases the network lifetime of MANET. EPAR was able to handle high mobility of the nodes that caused changes in network topology.

III. EXISTING PROTOCOLS AND THEIR LIMITATIONS

A. *DYNAMIC SOURCE ROUTING(DSR) PROTOCOL:*

The Dynamic Source Routing (DSR) protocol is an on-demand routing protocol. Mobile nodes are required to maintain route caches that contain unexpired routes and are continually updated as new routes are learned [10]. The protocol consists of two major phases: route discovery and route maintenance.

a. Route Discovery: It is done by the source if it doesn't found any path for the destination in its route cache. It is done by broadcasting a RREQ packet to all the neighbors initiated by source then by every node that receives the RREQ packet, till the destination is found. When destination receives a RREQ packet, it replies source with a RREP packet along the reverse of the route recorded in RREQ.

b. Route maintenance: Route maintenance is done by the use of route error packets and acknowledgments. RERR packet is send by a node to the source when the data link layer met a fatal transmission problem. When a RERR packet is received, the erroneous hop is removed from the node's route cache and all routes that contain that hop are truncated at that point.

Though the dynamic source routing have many advantages but it have some disadvantages as well. It does not reduce the overhead of source. It is not energy efficient. It does not reduce network failure by analyzing the energy level of the nodes. When faced with a choice of multiple routes, DSR does not have any mechanism for route entry invalidation or route prioritization.

B. *EFFICIENT POWER AWARE ROUTING (EPAR):*

EPAR is an on demand source routing protocol that uses battery lifetime prediction. To conserve energy, the amount of energy consumed by all packets transmitted from source node to destination node should be minimized [11]. Existing research proposed many protocols but its not efficient when compared to EPAR. The EPAR protocol finds the multiple path involved in intermediate routers. The EPAR mainly chooses the path based on energy. First, the lowest hop energy for each path is calculated, which is referred as the battery power for each path. Then the maximum lowest hop energy is selected. The selected path should have maximum life time. It increases the network lifetime of the MANET.

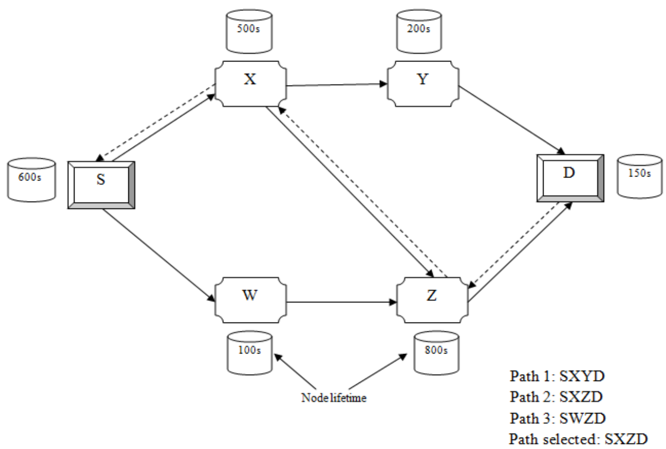

Figure 1. Technical Architecture of EPAR

The architecture shows the path selection for the data transmission using EPAR algorithm. The figure shows DSR selects the shortest path SXYD or SWZD. But EPAR selects SXZD only, since the selected path has the maximum network lifetime i.e. 800s. Thus it increases the network lifetime of the MANET. This protocol always selects the path with maximum lifetime using Min-Max formula [12] as given below:

$$\mathbf{Max\ T_k(t) = Min\ T_i(t)} \quad \textbf{(1)}$$

where, $T_k(t)$ =lifetime of path

$T_i(t)$ = predicted lifetime of node i in path k .

There are some drawbacks of EPAR protocol which includes that it does not consider the frequent movement of nodes and so the mobility is not determined and there is no alternate paths provided for the data transmission during depletion of nodes in the original path [11].

IV. PROPOSED WORK

During the route discovery phase, EPAR selects an optimal route by considering a set of parameters including energy and hop count. For EPARGA, genetic algorithm is applied to find the maximum optimal routes using the process such as selection of individual paths, crossover and mutation technique for reproducing new path.

A Genetic Algorithm maintains a population of candidate solutions (genetic string), where each candidate solution is called a chromosome. The chromosome consists of sequences of positive integers that represent the IDs of nodes through which a routing path passes. A set of chromosomes forms a population, which is evaluated and ranked by fitness function. The fitness function plays a

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critical role in GAs because it provides information how good is each candidate. The evolution from one generation to the next one involves mainly three steps: fitness evaluation, selection and reproduction. First, the current population is evaluated using the fitness evolution function and then ranked based on their fitness. A new generation is created with the goal of improving the fitness. Simple GA uses three operators with probabilistic rules: reproduction, crossover and mutation. First selective reproduction is applied to the current population so that the string makes a number of copies proportional to their own fitness. This results in an intermediate population. Second, GA select "parents" from the current population with a bias that better chromosome are likely to be selected. This is accomplished by the fitness value or ranking of a chromosome. Third, GA reproduces "children" (new strings) from selected parents using crossover and/or mutation operators.

Modules:

A. Shortest path identification
B. Energy based path identification
C. Genetic Algorithm
D. Data transmission over Genetic path
E. Performance evaluation

A. Shortest path identification

Input: Set of available path from source and destination
Output: Set of shortest path

Source node broadcasts routing request message to its neighbors in order to find a route to destination node. The neighbors of the source node forward the request to their neighbors and this process continues till reaches the destination. Destination node sends reply to the source node through all available paths. This process results in set of routes with hop count of each path. The source node selects preferred route, which it believes that it has less hop count and high energy node. Source node selects list of path with least hop count and high energy from all available paths.

B. Energy based path identification

Input: Energy of each router in set of shortest path
Output: Energy efficient shortest path

First, the lowest hop energy for each path is calculated, which is referred as the battery power for each path. Then the maximum lowest hop energy is selected. The selected path should have maximum life time. It increases the network lifetime of the MANET shown in equation 1.
The objective of this routing protocol is to extend the service lifetime of MANET with dynamic topology.

C. Genetic Algorithm:

Input: Number of paths
Output: Optimum path

Calculation of the probability of selection of newly generated path that are obtained by applying genetic algorithm for the given source-destination pair. The path will be selected with the higher probability. The path with the higher path preference probability will be considered as the best path and the data transmission can be started along that path.

D. Data transmission over Genetic path

Input: Energy efficient shortest path
Output: Data transmission

Data is transmitted over the selected energy efficient shortest path. Source node which sends the data packet must be attached with UDP agent. Destination node which receives the data packet must be attached with agent Null. Two agents must be connected with each other so that nodes will involve in communication through this agents. Data packets are generated by application. The generated packets in the sender are transported to the receiver through the transport agents. So transport agent and application must be connected. Application used here is CBR (Constant Bit Rate). In CBR packet will be generated at constant interval.

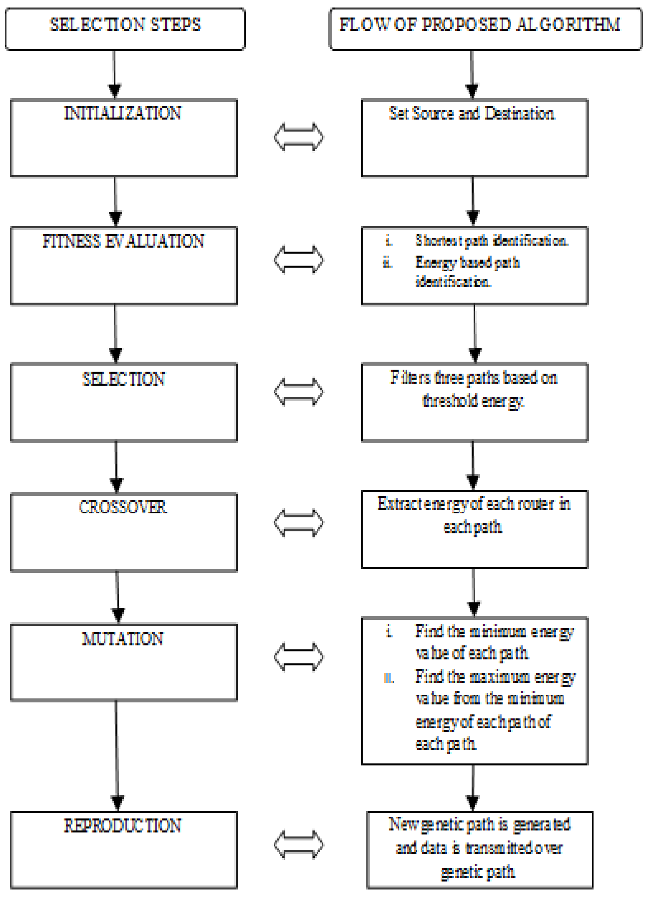

Figure 2. Flow of Proposed EPARGA

E. Performance Evaluation

Input: Data flow
Output: Delay, Network lifetime, Routing Load and Throughput

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NUMBER OF NODES	Random
TOPOLOGY	Random
MAC TYPE	802.11
QUEUE LENGTH	50 Packets
ANTENNA TYPE	Omni Antenna
ROUTING PROTOCOL	DSR, EPAR, EPARGA
TRANSPORT AGENT	UDP
APPLICATION AGENT	CBR
SIMULATION TIME	50seconds

TABLE 1. Simulation Parameters

a. Delay

The average time taken by a data packet to arrive in the destination is referred as delay. It also includes the delay caused by route discovery process and the queue in the data packet transmission. Only the data packets that successfully delivered to destination that countered.

b. Network Life Time

Network lifetime is the time at which the first network node runs out of energy to send a packet, because to lose a node could mean that the network could loss some functionality.

c. Routing Load

Normalized Routing Load (or Normalized Routing Overhead) is defined as the total number of routing packet transmitted per data packet. It is calculated by dividing the total number of routing packets sent (includes forwarded routing packets as well) by the total number of data packets received.

d. Throughput

It is rate of successful delivery of packets at the receiver. It is measured in bits/seconds.

V. SIMULATION SETUP AND RESULT DISCUSSION

The simulation was conducted in NS-2.34. The simulated network consists of variable nodes randomly scattered in random topology area area during the simulation. The simulation time was taken as 50 seconds. Table 1 shows the simulation parameters.

Fig.3 shows that Throughput of genetic is higher than DSR and EPAR. The genetic selects the nodes having high energy to deliver the packets to destination. But DSR protocol randomly selects the intermediate nodes.

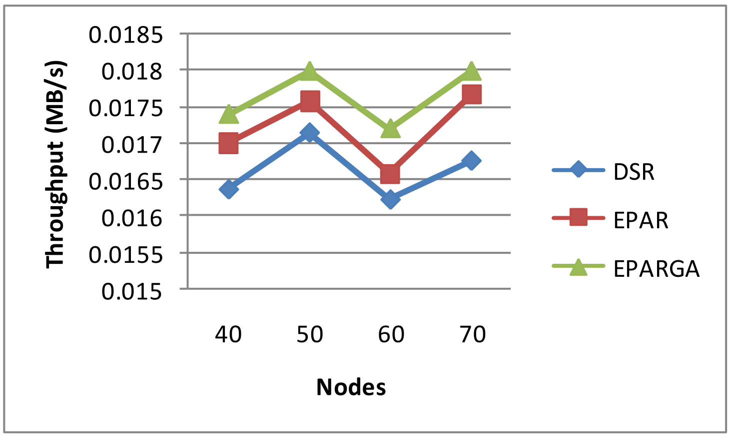

Figure 3.Node versus Throughput

Fig.4 shows that Network Lifetime of Genetic is higher than EPAR and DSR. The genetic protocol selects the high energy to deliver the packets to destination. So network life time is increased.

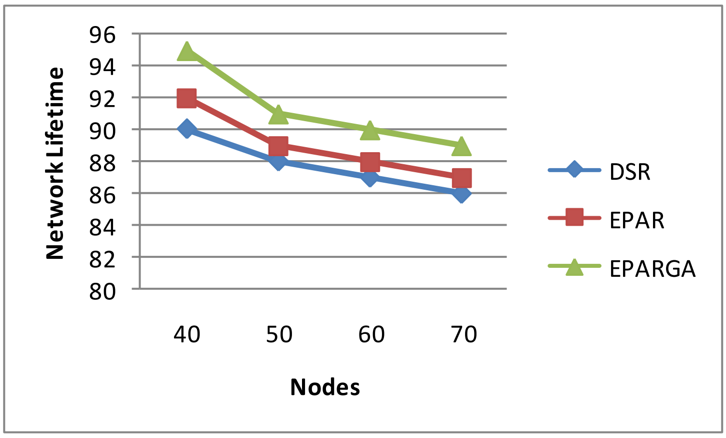

Figure 4 .Node versus Network Lifetime

Fig. 5 shows that Delay of proposed protocol (EPAR with genetic and threshold energy) is decreased when compared to DSR and EPAR.

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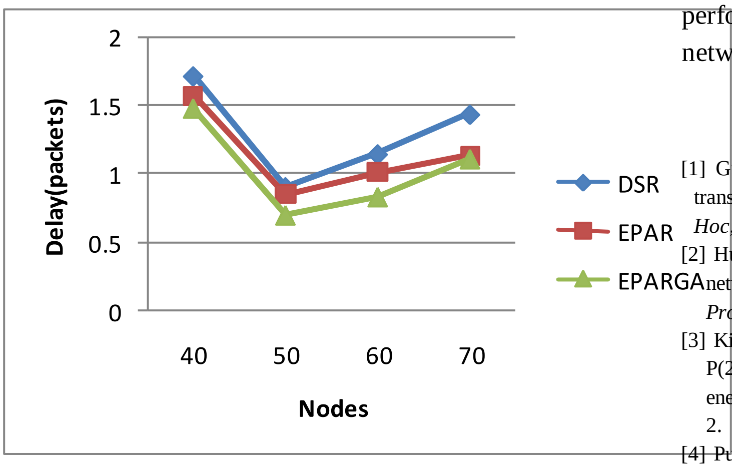

Figure 5.Node versus Delay

Fig. 6 shows that Number of Routing packet is decreased in proposed protocol when compared to DSR and EPAR.

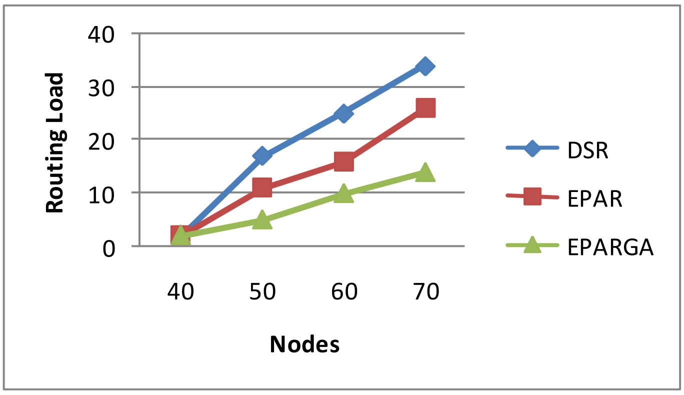

Figure 6. Node versus Routing Load

VI. CONCLUSION AND FUTURE SCOPE

This research work mainly deals with the problem of maximizing the network lifetime of MANET. We proposed a new energy efficient routing protocol called EAPRGA with genetic algorithm. EPARGA is a modification of DSR. This study evaluated three MANET protocols i.e., DSR, EPAR and EPARGA in terms of routing load, delay, throughput and network lifetime. The proposed EPARGA minimized the overhead of source. It also balanced the consumption of energy between utilized and underutilized nodes. EPARGA finds the maximum optimal routes using the process of traditional genetic algorithm. From various graphs, it was observed that EPARGA better than the existing protocols DSR and EPAR.

In future work the performance comparison of the routing protocols under different scenarios created by varying the pause time, speed of node movement and network size in the network could be done, that would impact the relative performance of routing protocols considered in different network scenarios.

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BIOGRAPHY

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