ANTEMPSO- Enhanced Optimization based Energy Efficient Protocol in Mobile Ad hoc Network

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Abstract **-** The nodes in an ad hoc network are constrained by battery power for their operation. To route a packet from a source to a destination involves a sufficient number of intermediate nodes. Hence, battery power of a node is a precious resource that must be used efficiently in order to avoid early termination of a node or a network. Communication (transmission and reception) is one of the main sources of energy consumption in Mobile Ad Hoc Networks. Since the rate of battery performance improvement is rather slow and in the absence of breakthroughs in this field, other measures have to be taken to achieve the goal of getting more performance out of the currently available battery resources. So, In this work we propose a new enhanced ANTEMPSO protocol where ACO and PSO based Hybrid optimization is used to select the efficient path for data transmission. The performance of this protocol is compared with other existing protocols on the basis of different metrics.

Keywords **-** ACO, PSO, Energy, AOMDV, MANETs.

I. INTRODUCTION

A wireless network is any type of computer network that uses wireless data connections for connecting network nodes. Wireless networking is a method by which homes, telecommunications networks and enterprise (business) installations avoid the costly process of introducing cables into a building, or as a connection between various equipment locations. Wireless telecommunications networks are generally implemented and administered using radio communication. This implementation takes place at the physical level (layer) of the OSI model network structure. MANETs stand [1] for Mobile Ad hoc Networks. Mobile implies "mobility". Ad hoc is a Latin word and it means "for this only". MANET is an autonomous collection of mobile routers or nodes that communicate over wireless links. MANET is an Infra-structure-less wireless network. The routers or nodes moves randomly and organize themselves arbitrarily. The nodes directly communicate via wireless links within each other's radio range, while that are distant apart use other nodes as relay, in a multi-hop routing function. As the nodes are mobile, the structure of the network changes dynamically and unpredictably over time. Ad hoc networks are self-configuring and self-organizing, so to maintain communication between nodes in the network, each node behaves as a transmitter, a host and a router. Routing [3] is an act of moving information from a source to a destination in an internetwork. At least one intermediate node in the internetwork is encountered during the transfer of information. Basically two activities are involved in the concept of determining the optimal routing paths and transferring the packets through the internetwork. The transferring of the packets through the internetwork is called as packet switching which is straight forward, and the path determination could be very complex. Routing protocols use several metrics as standard measurement to calculate the best path for routing the packets to its destination that could be number of hops, which are used by the routing algorithm to determine the optimal path for the packet to its destination. The process of path determination is that, routing algorithms find out and maintains routing tables, which contain the total route information for the packet. The information of route varies from one routing algorithm to another. The routing tables are filled with entries in the routing table are ip-address prefix and the next hop. Destination/next hop optimally by sending the packet to a route representing the address prefix specifies a set of destinations for which the routing entry is valid. Routing is mainly classified into static and dynamic routing. Routing protocol [5] in MANET can be classified into several ways depending upon their network structure, communication model, routing strategy, and state information and so on but most of these are done depending on routing strategy and network structure. Based on the Routing strategy the routing protocols can be classified into two parts: 1. Table driven and 2. Source initiated (on demand) while depending on the network structure these are classified as flat routing, hierarchical routing and geographic position assisted routing. Flat routing covers both routing protocols based on routing strategy. Though multiple approaches provide energy efficient routing for MANETs, each one assumes different parameters to attain unique goals. At this situation the need for energy aware metrics to compare these techniques is a mandate. Thus, a set of energy aware metrics are constituted for the purpose of quantifying the performance of the protocols included in this work.

II. RELATED WORK

Robinson and Rajaram [2015] proposed an energy-aware multipath routing scheme based on particle swarm optimization (EMPSO) that uses continuous time recurrent neural network (CTRNN) to solve optimization problems. CTRNN finds the optimal loop-free paths to solve link disjoint paths in a MANET. The CTRNN is used as an optimum path selection technique that produces a set of optimal paths between source and destination. In CTRNN, particle swarm optimization (PSO) method is primly used

for training the RNN. The proposed scheme uses the reliability measures such as transmission cost, energy factor, and the optimal traffic ratio between source and destination to increase routing performance. In this scheme, optimal loop-free paths can be found using PSO to seek better link quality nodes in route discovery phase. PSO optimizes a problem by iteratively trying to get a better solution with regard to a measure of quality. The proposed scheme discovers multiple loop-free paths by using PSO technique.

B.Nancharaiah et.al [2014] In this work ,A hybrid optimization technique using Ant Colony optimization (ACO) AND CUCKOO Search(CS) is proposed for the optimization of MANETS routing .Ad hoc On-demand distance vector routing (AODV)Protocol enhanced using the proposed optimization algorithm. The proposed hybrid algorithm achieves improved performance in terms of average end to end delay. It is shown that the proposed hybrid algorithm (ACO with CS) Performs better in terms of throughput ,Average end to end delay ,total cached replies sent and route acquisition time in comparison to the existing algorithms.

Bhavna Sharma et.al [2014] This paper work is motivated by the idea of taking account of several factors in Mobile Ad hoc Networks (MANET) routing design in a unified way. The rational of our motivation is that most of the multipath routing protocols are designed only based on one criterion, e.g., shortest path considered with balance load or energy conservation. They propose a scheme which could consider energy conservation, shortest path and load balancing, In this routing scheme, They would consider both the shortest path and the energy conservation in multipath way with proposed energy based multipath routing (E-AOMDV). They define an energy factor as that we will use the products of the energy factors of all the nodes along different paths as the selection criteria. The energy factor informs about the status of energy then here they evaluate the performance of AOMDV and energy based AOMDV (E-AOMDV). The life times of proposed E-AOMDV are limited but the improved routing as compare to AOMDV without including the energy factor. The performance of proposed scheme is better in limited life time. The performance matrices are shown the better results in proposed scheme.

Tran The Sonet.al [2014]In this model, a node monitors the mobility, energy consumption and traffic congestion based on a multi-metric named AEC constructed by Average Encounter Rate, Energy Consumption Rate, and Congestion Factor) to choose the most stable, power rich and congestion-free path for routing. As a result, packet delivery ratio of the proposed model improves almost 20%compared to that of original AODV protocol while the number of dead nodes and routing overheads decreases significantly. This paper has proposed a routing model, MECAR, which helps a routing protocol choose the stable, power-rich and congestion-free path for routing based on a metric named AEC. Simulation results showed the remarkable enhancements of packet delivery ratio, i.e. 19.8% and 37.09%, of MECAR at high mobility and traffic load conditions while still remaining highest number of active nodes in the network compared to that of original AODV and AODV-PER. The MECAR also helps to reduce routing overhead and dropped packets by routing over stable and congestion-free paths.

Dr . Annapurna et.al [2014] The proposed work is 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. Performance evaluation with respect to network lifetime, throughput, packet delivery ratio, end-to-end delay is done using simulation tools like NS2/QualNet. In this work, it is observed that battery life of the nodes in IEE_AODV protocol has been efficiently utilized by choosing a path with maximum energy. It has also been analytically proved that, the amount of remaining energy helps to probabilistically determine an efficient path. Further to the proposed work, the algorithm has been implemented and is evaluated using performance metrics like throughput, network lifetime, packet delivery ratio and end to end delay. The results are statistically analyzed using network simulation tools such as NS2 by varying the node density from 10 to 50 in steps of 20, and pause time of 3s, 5s and 8s.

Hrishabha Raj Jain et.al [2014] This paper presents a new approach of energy efficient secure multipath AODV (EESM-AODV) routing protocol for MANET based on AODV protocol is modified and converted to work on multiple path .Differing types of routing protocols planned over the years with minimal management overhead and network resources. AODV is well-liked routing protocol among others. It is a loop free, no centralized authority, single path, On-demand routing protocol and its performance is superior than different routing protocols in MANET. However, single path plan is that the most vital drawbacks of AODV. Also, it is a heap of routing overhead at the time of route repair and route discovery method. The mobile nodes in MANET also have restricted resources like battery power, restricted information measure that solely single path protocols cannot handle efficiently. so routing is also a really vital issue inside the look of a MANET. Multipath routing permits the multiple methods between one source and single destination node and during this paper conjointly offer security by filtering route discovery process in AODV routing protocol.

Baolin sun et.al [2010] In this paper, they provide an energy entropy multipath routing optimization algorithm in manets based on GA (EMRGA).The key idea of the protocol is to find The minimal node residual energy of each route in the process of selecting path by descending Node residual energy .Experimental shows that the approach is efficient,

promising performance Advantage for multipath traffic engineering and evaluates the route stability in dynamic mobile networks. The performance evaluation of our proposed methods is accomplished via modelling and simulation.

III. PROPOSED WORK

The nodes in an ad hoc network are constrained by battery power for their operation. To route a packet from a source to a destination involves a sufficient number of intermediate nodes. Hence, battery power of a node is a precious resource that must be used efficiently in order to avoid early termination of a node or a network. Then we design a trust system for increasing reliability and disrupted un- security from the network. Thus, Energy awareness and security is an important issue in such networks as it increases the life of a node as well as network lifetime. The problem of node failure, which results in network partitioning, is serious in ad-hoc networks. In contrast, as pointed out in a single node failure in sensor networks is usually unimportant if it does not lead to a loss of sensing and communication coverage. Ad-hoc networks are oriented towards personal communications and the loss of connectivity to any node is significant. Real time applications need mechanisms that guarantee restricted delay and delay jitter. For instance, the most important delays that affect the end to end delay in packet delivery from one node to another node are: the queuing delay at the source and intermediate nodes, the processing time at the intermediate nodes, the transmission delay, and the propagation duration over multiple hops from the source node to the destination node. QoS in ad-hoc networks relates not only to the available resources in the network but also to the mobility speed of these resources. This is because mobility of nodes in ad-hoc networks may cause link failures and broken paths. In order to continue a communication therefore, it requires finding a new path.
Communication (transmission and reception) is one of the main sources of energy consumption. Since the rate of battery performance improvement is rather slow and in the absence of breakthroughs in this field, other measures have to be taken to achieve the goal of getting more performance out of the currently available battery resources. Within this study, we focus our efforts on method of energy awareness in communications between ad-hoc network nodes. The problem, of, energy constraints has been addressed in different protocols, which are based on existing protocol. Those nodes which are loss there energy they are not being a part of network, but nodes having a capability to take part in communication having a sufficient energy to do communication in the network. Due to suddenly loss of session following problems are occurring:

1. Maximize the loss of packets.
2. Maximize the routing load.
3. Minimize throughput.

In this work, three protocols AOMDV, EMPSO and ANTEMPSO are implemented using NS-2 simulator. EMPSO is energy aware multipath protocol where Particle Swarm optimization is used to select best path for data transmission. ANTEMPSO is proposed protocol where hybrid optimization is used i.e. ACO is used along with PSO.

Step 1- Initialize 'n' Number of Nodes: In this work, experimentation is done by different scenarios where firstly nodes are initialized. There are 50, 100,150 and 200 number of nodes is deployed in the area of 1000x1000 m^2.

Step 2-Route Discovery: In the route setup phase, each node acquires its metadata of the neighborhood. This metadata is used in the route discovery to find the best next-hop node towards the destination node. The route discovery is activated whenever a source wants to transmit data to destination in an on-demand fashion that prevents multiple interference between source and destination. The route maintenance phase handles path failures during data transmission.

In the route setup phase, source node initiates a data transmission for forwarding packets to the destination. Each node in a MANET obtains its metadata of the neighborhood, which also includes the transmission cost (tc) of its neighbors towards the destination node. The tc value of a link indicates the required number of transmissions for a successful packet reception at the receiver.

Whenever a source node wants to transmit data to destination, the route discovery phase is initiated to find multiple paths from the source to destination. The multipath routing protocol uses reliability measures such as transmission cost, optimal traffic ratio, and remaining energy. The source node starts the route discovery by transmitting a route request packet (RR) towards the destination node. Whenever an intermediate node receives a RR packet, it computes the transmission cost, optimal traffic ratio, and remaining energy for a path that is established between the source and the destination. Then, it also used a found path to forward the RR packet to the neighboring node with minimum cost. The reliability measures are stored in the routing table of a node in MANET. Overhead is less because in PSO mechanism, there is a limited exchange of routing control messages among the nodes for the route discovery phase.

Step 3-PSO based Selection: PSO is initialized with a group of particles and then searches for an optimal candidate solution by updating generations. Each particle is updated by two best values in the iterations. The first one is the best solution that has been achieved previously. The second best value is tracked by the particle swarm optimizer obtained currently by any particle in the population. The bound of the inertial range option is used for providing a satisfactory solution that eventually is discovered. This best value is a global best. The PSO algorithm significantly reduces the traffic overhead and computation complexity.

Step 4-Better Quality Path by ACO: In the natural world, ants (initially) wander randomly, and upon finding food return to their colony while laying down pheromone trails. If other ants find such a path, they are likely not to keep travelling at random, but to instead follow the trail, returning and reinforcing it if they eventually find food. Over time, however, the pheromone trail starts to evaporate, thus reducing its attractive strength. The more time it takes for an ant to travel down the path and back again, the more time the pheromones have to evaporate. A short path, by comparison, gets marched over more frequently, and thus the pheromone density becomes higher on shorter paths than longer ones. Pheromone evaporation also has the advantage of avoiding the convergence to a locally optimal solution. If there were no evaporation at all, the paths chosen by the first ants would tend to be excessively attractive to the following ones. In that case, the exploration of the solution space would be constrained. Thus, when one ant finds a good (i.e., short/ high residual energy) path from the colony to a food source, other ants are more likely to follow that path, and positive feedback eventually leads to all the ants' following a single path. The idea of the ant colony algorithm is to mimic this behavior with "simulated ants" walking around the graph representing the problem to solve.

IV. SIMULATION & RESULT ANALYSIS

To test the performance of the AOMDV, EMPSO and proposed ANTEMPSO protocol different performance metrics are used and to implement these protocols NS2 Simulator is used. These matrices are calculated after simulating these protocols on the defined scenario with all above defined protocols. The matrices are:

a. Packet Delivery Ratio

It is defined as the ratio of data packets actually received at the receiver end to those which were sent by sender. So, it can also be defined as:

$$PDR = {}^{R_i}/_{S_i}$$

.

Where S_i is the total number of data packets sent by the nodes in the network and whereas R_i is the total number of data packets received by the receivers.

b. Overhead

It 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 by the total number of data packets received.

c. Delay

This includes all possible delays caused by buffering during route discovery, latency, and retransmission by intermediate nodes, processing delay and propagation delay. It is calculated as

$$D_i = (Tr - Ts)$$

Where, T_r is receive time and T_s is sent time of the packet. Where average delay is computed as:

$$Avg_{Delay} = \frac{1}{n}\sum_{i=1}^{n} D_i$$

d. Throughput

It is the average at which data packet is delivered successfully from one node to another over a communication network. It is usually measured in bits per second.

$$Throughput = (no\ of\ delivered\ packets * packet\ size) / total\ duration\ of\ simulation$$

4.1 Simulation Setup

To test the performance of the protocols, scenario is generated by varying node mobility/speed is simulated in area 1000x1000 m^2 with CBR traffic. The other Simulation parameters are given in the next sections with the resultant parameters

Table 1: Simulation Setup

Simulation Parameters	Values
Area	1000x1000
No. of nodes	50
Speed	10,20,30,40,50 m/s
Traffic	CBR
Packet Size	1000 bytes
Packet Rate	250k/s
Pause Time	500s
Simulation Time	1000s
Max Connection	40

4.2 Results Analysis

To analyze the performance of these protocols, different metrics are used.

Packet Delivery Ratio: The PDR of three protocols AOMDV, EMPSO, and ANTEMPSO is as given in Fig 1. The results show that the performance of the proposed ANT based EMPSO (ANTEMPSO) is better than both AOMDV and EMPSO. The PDR of this proposed protocol is 79% improved if we compare with AOMDV and 7.7% improved from EMPSO.

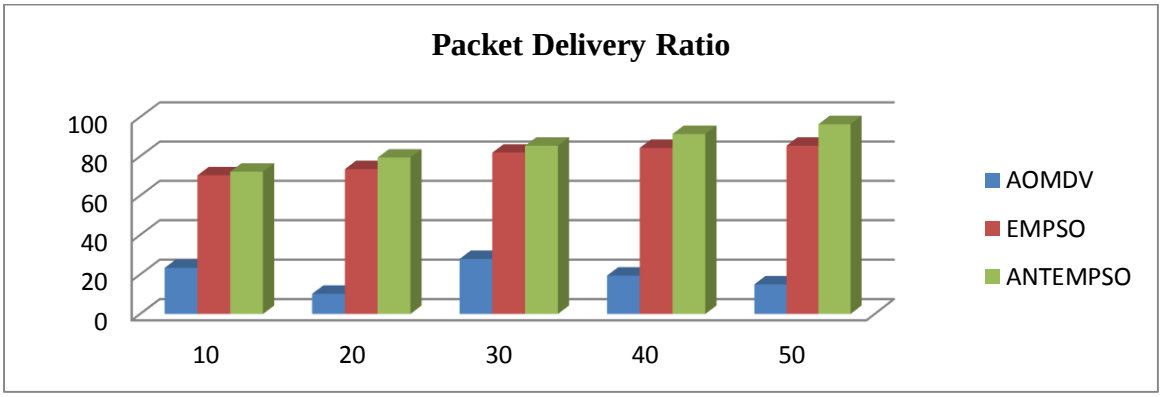

Fig 1: Performance Metrics (PDR)

Overhead: The Overhead of three protocols AOMDV, EMPSO, and ANTEMPSO is as given in fig 2. The results show that the performance of the proposed ANT based EMPSO (ANTEMPSO) is better than both AOMDV and EMPSO. The Overhead of this proposed protocol is 69% improved if we compare with AOMDV and 20% improved from EMPSO.

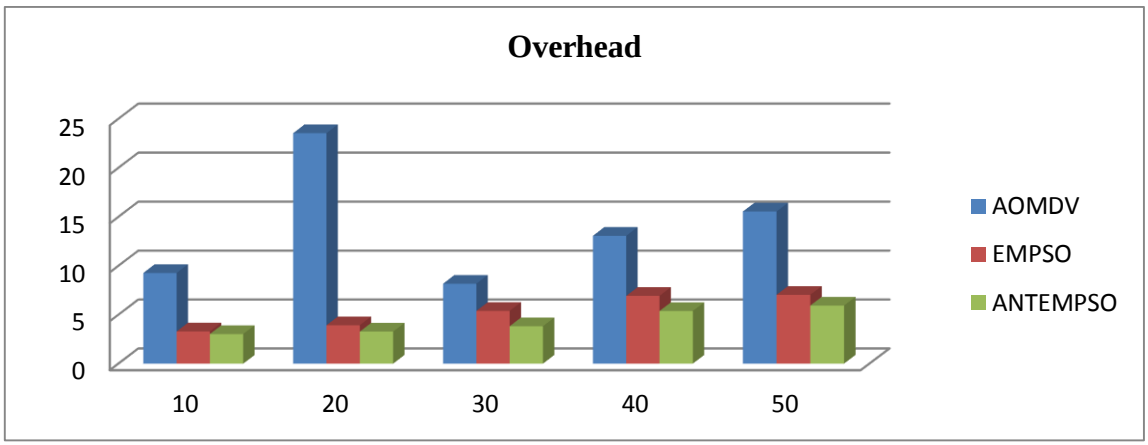

Fig 2: Performance Metrics (Overhead)

Delay: The Delay for three protocols AOMDV, EMPSO, and ANTEMPSO is as given in fig 3. The results show that the performance of the proposed ANT based EMPSO (ANTEMPSO) is better than both AOMDV and EMPSO. The PDR of this proposed protocol is 44% improved if we compare with AOMDV and 44% improved from EMPSO.

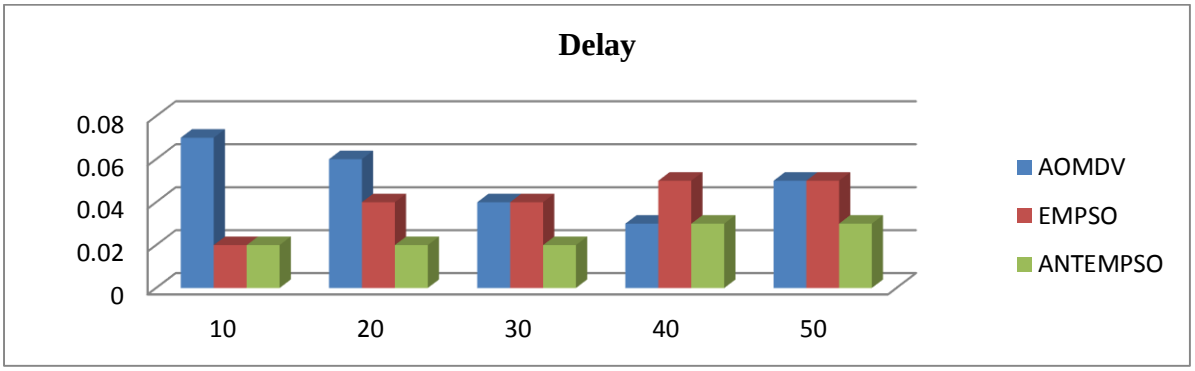

Fig 3: Performance Metrics (Delay)

Throughput: The Throughput for three protocols AOMDV, EMPSO, and ANTEMPSO is as given in fig 4. The results show that the performance of the proposed ANT based EMPSO (ANTEMPSO) is better than both AOMDV and EMPSO. The throughput of this proposed protocol is 38% improved if we compare with AOMDV and 6% improved from EMPSO.

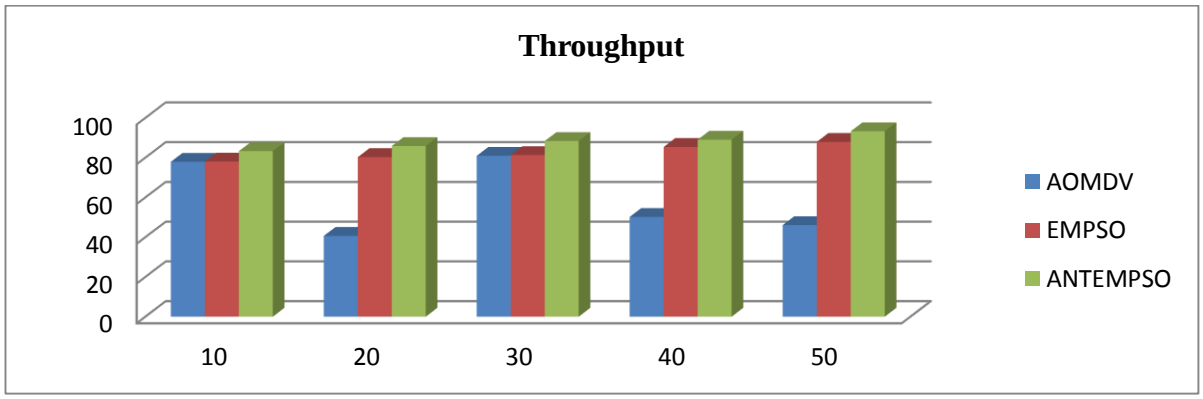

Fig 4: Performance Metrics (Throughput)

Total Energy: The total Energy consumption for three protocols AOMDV, EMPSO, and ANTEMPSO is as given in fig 5. The results show that the performance of the proposed ANT based EMPSO (ANTEMPSO) is better than both AOMDV and EMPSO. The throughput of this proposed protocol is 7% improved if we compare with AOMDV and 3% improved from EMPSO.

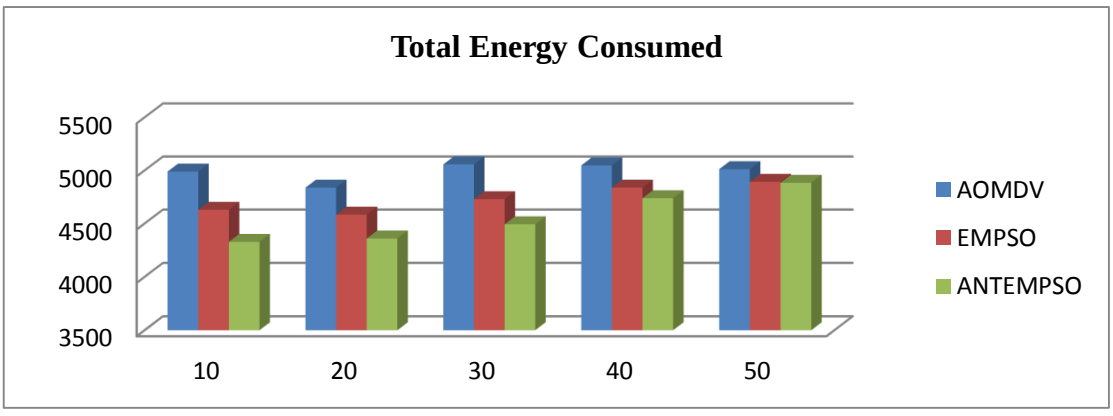

Fig 5: Performance Metrics (Total Energy Consumption)

V. CONCLUSION

In this work, ANTEMPSO- Enhanced Optimization based Energy Efficient Protocol is proposed and performance of this protocol is compared with other protocols named AOMDV and EMPSO on the basis of different performance metrics like PDR, Overhead, Delay, Throughput, and Total Energy Consumption. To Simulate these protocol a scenario is generated by varying nodes mobility. Results concludes that the performance of this proposed protocol is improved 7% in terms of PDR, 20% in terms of Overhead, 44% in terms of delay, 6% in terms of throughput and 7% in terms of energy consumption. So, we can say on an average this enhanced protocol gives 16% improvements in MANETs.

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