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# A Novel Approach to AODV for Energy Efficient Routing Mechanism to Control Power Consumption in MANET

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***Abstract** - Network technologies have evolved into advanced and sophisticated channels for transmitting a huge amount of information in the digital world. The driving force for the performance of networks is a routing protocol. A routing protocol ensures the data is transmitted from the sender to the receiver through different nodes. MANETs are dynamic and decentralized networks that require additional care due to the mobile nodes. AODV is the standard reactive routing protocol used in MANETs. The performance of the standard protocol needs extensive analysis to find an optimized solution. This research study considers throughput, message rate, communication range, power consumption, and data rate and proposes an enhanced version of the AODV routing protocol. The new algorithm was designed and simulated on a software tool, and the results are plotted. The results reveal that the enhanced version determines the ways in which the optimized solution for throughput, communication range, message rates, and power consumption can be optimized. The results are compared with the published material, and it was found that the number of parameters used in the algorithm is higher and helps design an optimized solution depending on the requirements of the application.*

**Keywords:** *MANETs, Routing Protocols, AODV, Network Simulation, Throughput, Power Consumption*

## I. INTRODUCTION

Networking technologies are the basis of all digital communication today. The preliminary stages of networking were a wired channel with a sender and receiver. Networking devices and technologies have evolved to use wireless mediums and transmission between mobile nodes. Wireless ad hoc networks are a popular type of wireless network with a decentralized architecture [1, 2]. The infrastructure of a traditional networking system is not used in this type. Each node is considered as both receiver and sender because the nodes forward the data packets to the next node during the routing process. The decentralized nature does not allow the nodes to be strictly used as sender or receiver because they participate in both operations. The architecture requires multicast routing instead of broadcast or unicast because the node is mobile in this network.

The nodes in a Mobile Ad-hoc Network are free to move in various directions, due to which the data transmission and connection between nodes is changing rapidly. The node is required to forward the data packet to the next node irrespective of the direction as required by the routing table and the design [3, 4]. The primary challenge, in this case, is to maintain the information in the network and between the nodes without loss of data packets and moving towards the destination node. The other challenge is the increase in the number of data packets and nodes, which makes it difficult for the network to route the data packets. The data nodes should be aware of the input and output and forward the data packets in the same route without compromising the performance or efficiency of the network [5].

The nodes in Mobile Ad Hoc Network (MANET) do not have a fixed type of configuration, and each node requires the discovery of the topology for effective data transmission and communication. If a new node enters the network, all the other nodes should be aware of the new node [6, 7]. An announcement is usually made, and all the nodes are updated with the entry of the new node so that the routing can be efficient by forwarding the data packets across the network using new nodes if necessary [8-10].

A Routing protocol is an approach used to send the data from sender to receiver using a strategy. The components used in the routing protocol are nodes for transmission of data and the routing table or other approaches to direct the nodes towards the destination. Routing protocols have different strategies to perform this activity [11, 12]. The first strategy is a proactive type routing protocol. This strategy requires the use of routing protocols, and every node should maintain a list of entries in the table which direct the data packets from source to destination. The details of the routes, including the data nodes that forward the package to the next stage, are listed in the table. This approach is straightforward and does not require the use of other components because the details are available in the routing table. This approach is proactive in nature, and the routing tables are checked for the values only when there is a request from the sender node. Destination Sequenced Distance Vector Routing Protocol (DSDV) is the best example of a proactive protocol [3].

The second approach is a reactive routing protocol in which the details are not available in the routing table, but the data packet is required to discover the route when a packet is to be forwarded. Route discovery is initiated when there is a request for the transmission, and an announcement is made throughout the network about the request. Ad-Hoc On-Demand Vector Routing (AODV) belongs to the reactive type of routing protocol, the focus of this paper. Given the disadvantages of the standard AODV protocol in terms of performance, a new enhanced version of the protocol is designed and simulated.

## II. LITERATURE REVIEW

Literature in the field of routing protocols and AODV is extensive, discussing various possibilities of enhancing the performance of the standard protocol. New approaches are used to improve the effectiveness by addressing different phases of the routing protocol operation. The common methods used to measure the performance of a routing protocol and the network operations are packet delivery ratio, throughput, and delay [13, 14]. This section of the paper reviews the latest literature in this area, where the studies focus on improving performance using these metrics.

Research studies have simulated the performance of the AODV routing protocol because it is essential to have a thorough understanding of the existing methodology and then implemented it in real-world situations [15]. The flexibility of AODV offers an advantage to the researchers because it ensures the configuration can directly impact the performance. Open up the major points to be noted in this category is related to the non-availability of literature studies that compare the same values directly and measure the outcome. Instead, the performance is usually measured using one parameter, retaining the other parameters to standard values. For example, the throughput value of the enhanced routing protocol can be checked by improving the throughput algorithm by retaining the packet delivery ratio and delay [16].

Mathematical frameworks and simulations are used in this field to compare the values of the routing protocols and their performances. The overhead value of the routing protocols AODV and DSR when compared, and it was found that the parameters used for comparison were reviewed, and the result proved the importance of scalability and flexibility. These parameters can be compared by using the delay factor with packet delivery ratio and a load of the routing protocol [17, 18]. Mobility and density of the routing protocol are also considered in other studies with additional parameters such as load. A common trend in the studies from the literature is that the common protocols are compared for slightly better performances [6]. The fundamental operation of the protocols remained the same with additions to the approach or algorithm.

The loophole from these literature studies is that the four important factors are not essentially considered together to improve the algorithm in general. This loophole is addressed by considering the parameters and enhancing them using a new algorithm.

## III. PROPOSED CONCEPT ONTOLOGY FOR CAR MANUFACTURING INDUSTRIES (COCMI)

The design of the new routing algorithm is described using the following steps. The first step is to send the data and receive the route reply (RREP) signal. This reply ensures the algorithm is ready to send the data packets throughout the network through different nodes. The important factor and the enhancement of the proposed system is the calculation of the communication range, alternate route, and throughput value. Each of these values is enhanced using an iterative process to improve the standard algorithm. The communication range and alternative routes are checked iteratively before the data packets are sent. The advantage of this approach is the changes to be made for the ranges before finalizing the data packet transmission. The flow chart represents all the details and the steps involved in the enhanced algorithm given in Fig.1.

The first step is to check if the routes are available in the table. If the routes are readily available in the routing table, the node path is checked for reachability. If the route details are not available in the table, the route discovery process is initiated iteratively. This process keeps checking if the routing table is full of values or the route discovery process is initiated until the routes are found in the table. If the node path is reachable and the route details are available in the table, the alternative route is checked.

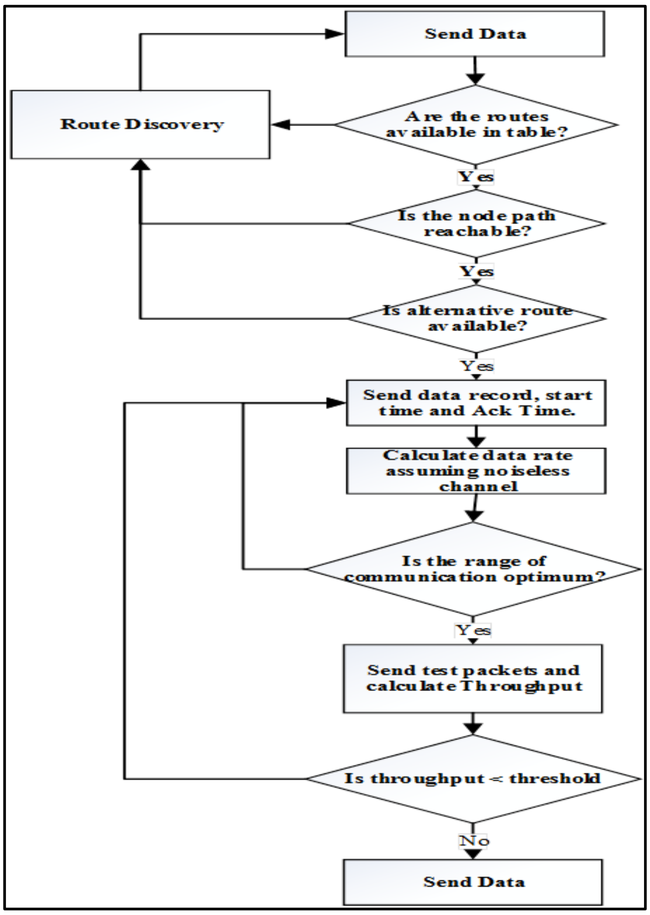


**Fig. 1. Flowchart of the Proposed Algorithm**

The next step in the process is to send the data and start the timing. The proposed algorithm assumes the channel is noiseless and the data rate is calculated. At this point, the communication range and optimization come into the picture. The range of communication is checked for optimization, and if the range is optimum only, then the test packets are sent to calculate the throughput. The next step is to calculate the throughput and compare it to the threshold value [19, 20]. A new value in this algorithm is the minimum bandwidth value required for the communication to be successful. 10 kbps value is assumed as it represents the minimum bandwidth for most of the applications. Calculation of the data rate and the communication range is the iterative step used in this algorithm.

The enhanced algorithm is also designed for the Power consumption aspect of the routing protocol. In this method, the data is sent after the Request message is received, and the sender node Power consumption is calculated. There are three aspects of power consumption considered in this enhanced algorithm. The power consumption range is the first parameter, and if the value is not within the given range, the adjustment of the communication range using increasing and decreasing options is included. The next step is to check if the power consumption is within the range specified by the designer and connected to the data rate and message rate. The three parameters - communication range, data rate, and message rate are used to minimize the power consumption. This enhanced version of the AODV algorithm is unique because there are three steps and parameters used in this algorithm to minimize the power consumption using an optimized value. Fig.2 represents the adjustments in the parameters which is necessary for the enhanced performance. The power consumption range considered in the design is a maximum of 2mW per node. The enhanced algorithm is summarized in Fig. 2.

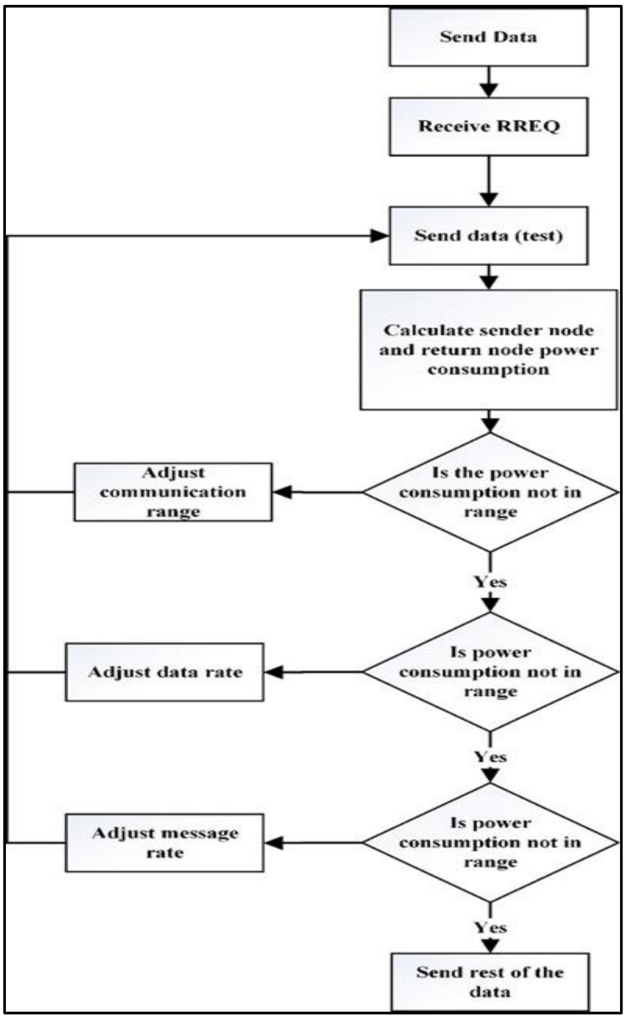


**Fig. 2. Flowchart of the Proposed Algorithm for Power Consumption**

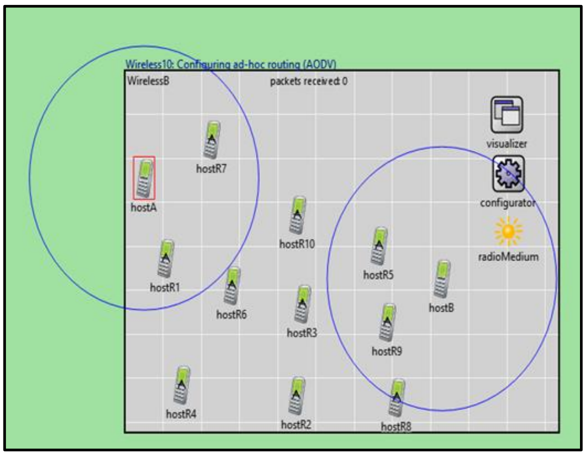


**Fig. 3. Default Network**

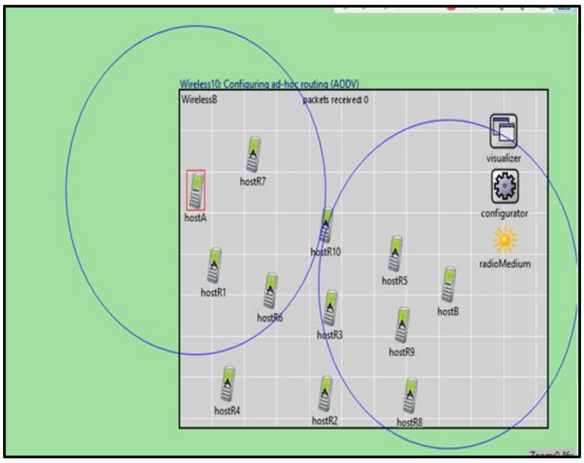


**Fig. 4. Enhanced Network**

Fig. 3 shows the default network designed for simulation. Fig. 4 is the enhanced network. Fig. 5 represents the comparison of throughput for different intermediate nodes. The number of intermediate nodes is found to be inversely proportional to the packets received because there are many nodes that the packet needs to traverse through, and the loss is higher. There are some exceptions for the values due to change in other network parameters. The value of data packets received is found to be 1332 for 25 intermediate nodes, whereas it is 852 for 100 intermediate nodes, as shown in Fig. 5.

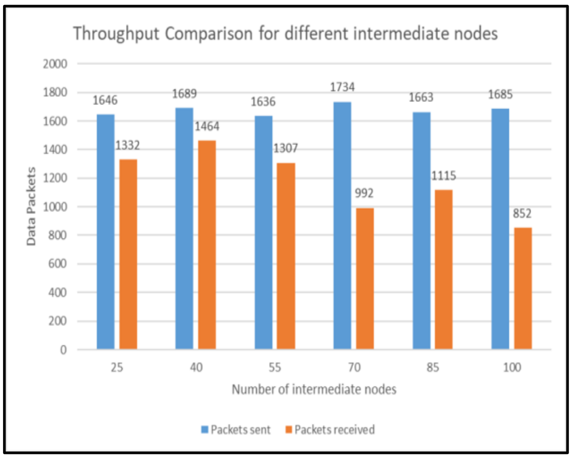


**Fig. 5. Throughput Comparison for Different Nodes**

Fig. 6 and Fig. 7 represent the power consumption for communication range and message size, respectively. The power consumption value is calculated and compared for the 10 m communication range and 1 Mbps data rate in four different message sizes. It is found that the message size should be smaller for the receiver node to receive more data packets, as shown in Fig. 6.

The same simulation was carried out for 10 m to 500 m communication range and constant data rate at 5 Mbps and message size of 1000B. The results revealed that for fixed message size and data rate, the communication range should be smaller for more number data packets to be received with lesser power consumption. A graph was plotted to analyze the communication range and throughput rates for 1000B, as shown in Fig. 7.

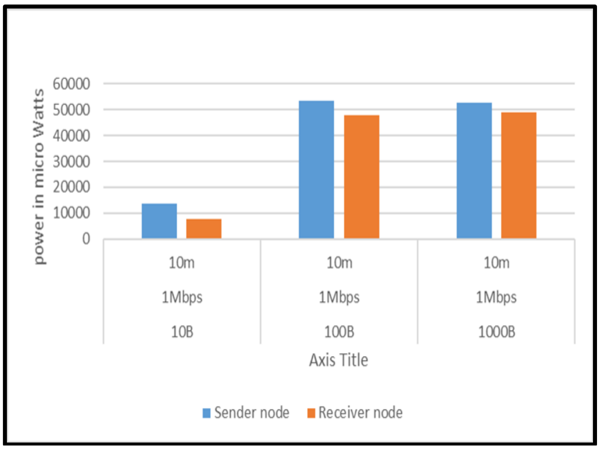


**Fig. 6. Power Consumption for 10m Communication Range, 1Mbps Data Rate, and Different Message Sizes**

The comparison of throughput between different algorithms such as AODV, TORA, DSR, DSDV, AND OLSR was analyzed in [19]. It is evident that the metrics used to compare the performance of different algorithms or the comparison between standard and the enhanced version of the algorithm remains the same. The authors in [19] and [3] have analyzed average throughput, average delay, and average packet delivery ratio for the standard algorithms used in different applications. The results revealed that AODV performs well in the throughput area, whereas DSDV performs well in average packet delivery ratio and OLSR in average delay.

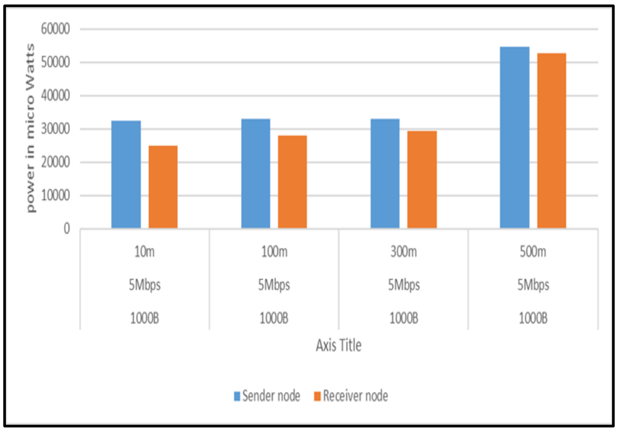


**Fig. 7. Power Consumption for 1000B Message Size, 5Mbps Data Rate, and Different Communication Ranges**

## IV. CONCLUSION

AODV is a reactive protocol used as a standard in many applications of MANETs. This research study proposes an enhanced version of the standard protocol. The proposed enhancement was designed, and different parameters were considered to compare the results. Throughput, message rate, packet delivery ratio, delay, communication range, and data rate are the parameters considered. A new algorithm is an iterative approach that adjusts the value of the parameters to maximize the throughput value and minimize the power consumption. The algorithm is explained with throughput, communication range, and message rate in combination with power consumption. The enhanced algorithm is unique in its nature because the literature in this field reveals that the comparisons are mostly between different algorithms and, in some cases, within the parameters of the AODV algorithm. The proposed algorithm was simulated in the OMNET tool, and the results are discussed. The algorithm performs better than the compared works especially discussing the numerous data rates and message sizes. The direct comparison between this algorithm and the work from the literature is challenging because different parameters are considered. An enhanced version with more empirical data and an optimized result for higher throughput and lower power consumption is considered the future scope of this study.

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