IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

ENERGY EFFICIENT WITH OPTIMIZING ROUTING IN MANET

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Abstract: In Wireless Networks, MANETs can dynamically create a network without relying on a central hub or infrastructure. These features will be helpful for scenarios such as disaster relief or military operations. However, the absence of a central authority presents challenges concerning security and routing, affecting the network's stability and capabilities. A proposed scheme incorporates the consideration of the power factor when selecting routes to handle the challenges efficiently. These are integrated with the widely used AODV routing protocol and simulated using the NS-2 simulator. We evaluate the simulated results to determine the impact of the proposed scheme on the network. The simulation outcomes demonstrate that the suggested approach significantly improves network performance concerning power consumption and stability. Including the power factor in route selection positively influences the network's capacity to maintain efficient communication and reduce the energy consumed. Review based Analysis.

Index terms **- Power factor, MANETs, AODV, Energy.**

I.INTRODUCTION

Wireless networks are rapidly advancing, enabling users to access information and services through electronic media. This technology provides fast and affordable internet connectivity to people worldwide without requiring a license. One variation of wireless networks in the third layer, the networklayer, is AdHoc networks. In such networks, nodes exhibit dynamicity and mobility, leading to rapid changes in network topology. In this network, every node will serve as both a host and a router; however, the dynamic nature of these nodes will result in frequent changes in the network's topology. Ad hoc networks have numerous potential applications and are particularly valuable in various fields. These networks are beneficial in battlefield operations, disaster recovery efforts (e.g., earthquake, flood, and fire), emergency missions, home networking, conferences, and conventions where information sharing is crucial. In military communications, data acquisition and virtual classroom applications in hostile environments are suitable for setting up contacts in exhibitions, facilitating information sharing. The Paper follows the structure below: The Literature review examines the previous work, while Section3elaboratesontheproposedalgorithm.Section4 conducts the performance evaluation using NS-2, and the concluding section presents the final remarks.

II.LITERATURE REVIEW

The AODV (Ad-hoc On-demand Distance Vector) routing protocol will be created explicitly for mobile ad-hoc networks (MANETs) to operate reactively, establishing the route between the nodes only if required. Recently, researchers have examined various aspects of the AODV protocol, including its performance, security, and robustness. Some investigations have focused on assessing the impact of different network conditions, such as node mobility and density, on AODV's performance. A new routing protocol inspired by AODV integrates machine learning algorithms to improve the PDR and minimize the E2E delay. The outcomes indicated that their innovative approach surpassed the performance of the traditional AODV protocol. Similarly, (Bhattacharyyaetal.,2018) [21],the novel AODV incorporates a direction-based routing mechanism, leveraging direction information to improve routing performance. The study highlighted the superior performance of the proposed protocol compared to AODV, considering metrics such as E2E delay, PDR, and control overhead. Regarding on-demand protocols, there are two main methods: Discovering and Maintaining the route. In the discovering phase, source nodes send messages to find the best and shortest path to the destination,which can use much energy. In basic on-demand protocols like AODV and DSR (Patil M et al., 2015) [19], both processesarenotcapableunderheavynetworkloadsduetoincreasednodemobilitycausedbypacket transmission delays concern MAC (Medium et al.) contention. Mobility disrupts established routes, and their repair further drains battery power. Additionally, flooding RREQ and RREP messages depletes the energy resources of participating nodes. Even base stations that receive these broadcast messages use very little energy. AODV and DSR are two routing protocols commonly employed in ad-hoc networks. Whenever there is a requirement, AODV establishes routes between nodes only when required. Whenever any node wants to transfer a packet to another node without a set route, it transmits the RREQ packet in all the outgoing paths. The RREQ propagates through the network, and upon reaching a node that has a possible or existing route tothe destination oris the destination itself, a routereply (RREP) packet is sent back to the source, thereby creating a route for packet transmission. Pushparaj R et al. (2014). Pushparaj R et al. (2014). Patil M et al. (2015) and Chawda K et al. (2015) [18, 19, 22] developed Energy2AODV, an energy-efficient AODV that incorporates the Expand Ring Search (ERS) technique for route discovery, effectively reducing energy consumption by avoiding duplicate rebroadcasting of RREQ packets. They carried out the research using AODV as the base protocol. (Krung M et al., 2002) [33] Enhances the capability of AODV by utilizing power-based path selection. When a link breaks in an AODV-enabled network, a RERR message is triggered. The node-detecting link break broadcasts the RERR message to its neighbors, who propagate it further until all nodes with a route through the broken link must get notified. After receiving the RERR message, the route discovery process initiates to check another possible route to the destination based on available neighboring nods. This protocol calculates the number of hops covered by the data packet and the number of remaining hops to be traveled. If the number of traveled hops exceeds the remaining hops, it enables an energy booster path; otherwise, it selects an alternate path. Under high network load, this protocol exhibits good performance. The authors (Tavosian et al., 2012) [4] applied network coding in the ANC scheme to improve AODV's energy consumption. The authors combined network coding with the AODV routing process, reducing energy consumption and data transmission. Additionally, they introduced a buffering mechanism in intermediate nodes to store incoming packets, combined them with the coding scheme, and forwarded the combination. The authors (Shibao et al., 2010) [10] presented HP-ERS-AODV, which predicts the latest location of the destination node by studying the patterns of wireless devices attached to humans. Utilizing time-to-live values reduces the re-transmission of request messages. The authors (Dargahi et al., 2008) [11] modified AODV and introduced SP-AODV, where they added a flag value to the RREQ packet. They also included two constants, MinTH and MaxTH, which control the value of a new field called the counter in the routing table. The counter value is incremented or decremented based on the constant values, indicating the estimated time for a node to reach the destination. Demir et al. (2007) [12] discuss an auction-based protocol for end-to-end routing to avoid wastage of the source's resources. Considering parameters like digital currency and current energy, implementing the Vickery auction increases the bid when the energy level decreases, and vice versa. However, selfish behavior does not guarantee favorable outcomes. (Sethi S et al., 2009) [13] IMAODV combines AODV and MAODV, which supports multicasting and reliability in a large network area. This protocol establishes bi-directional shared multicasting trees if the group members remain within the connected network. (Thanthry N et al.,2006) [7] proposed using the EM-AODV algorithm to increase the lifespan of networks. This algorithm considers the energy levels of nodes to optimize their usage.

III.PROPOSED APPROACH

The primary objective aims to ensure energy efficiency and stability in the route. By seamlessly integrating, it modifies the AODV protocol. It specifically focussesto different levels of data traffic and comprises two significant phases: the Route Request Phase (RREQ) and the RREP phase. In this modified version of AOD, every node updates its routing table with new power-relatedinformation. The node's battery status is categorized into various levels, with the critical battery status being the lowest or most precarious state, rendering the node ineligible for inclusion. On the other hand, the Active state indicates that the battery has a higher value than a specified threshold. When a route is required, the system assesses the node's status and establishes the route accordingly.Route Establishment: This algorithm facilitates the selection of an appropriate sequence of nodes via the path for the requesting party.

Session:

```
Initially, Pi=0
For each valid path Pi
For each node Nin Pi
IF current battery status = Active state
Then
Include node in the path and broadcast RREQ to the intermediate nodes Ni.
End IF
At the source node S, Scan all RREPs
RREP with the shortest active route and CURRENT Battery STATUS > MIN_BATTERY is selected
Forward data
Else
Exclude node from the path
Then
Sent RREQ to the selected node
Then
Forward the RREQ on the available active route
Destination node D sends back RREP on the reverse path
Source node S receives RREP
Route is established
The established route forwards data
End For
End For
```

IV.SIMULATION SCENARIO

We incorporated the above methodology into AODV by adding battery status to change its format. We conduct EDA simulation to study and analyze the operations of theM_AODV. The simulation used NS-2 (Dattana et al., 2019; Gouda et al., 2013) [15, 28]. During the simulation study, we considered the following metrics: E2E delay, throughput, PDR, and the sending and receiving of control packets.

Table1: Simulation Scenario with Parameter Value

Simulation Parameters	Parameter Value
Simulator	NS-2.32
Simulation Area	700mts×700mts
Mobile Nodes	25,50,75,100
Pause Time	100
Packet Size	512kb
Protocols used for routing	AODV & Modi_AODV
Traffic Sources	CBR(UDP)
Simulation Time	500Sec.
Performance Metrics	The proposed protocol was evaluated based on its impact on Packet Delivery Ratio, Throughput, Average End-to- End Delay, and Routing Load.

End-to-End Delay versus Number of Nodes: Primary performance measurement used to calculate the effectiveness of AODV are the E2E delay, representing the time required for a packet to transfer from source to destination. The network's size can significantly influence AODV's performance depending on the number of nodes. With an increased number of nodes, the required likelihood of congestion and collisions in the network rises, resulting in prolonged end-to-end delay. Furthermore, routing and control message overhead increase as the number of nodes increases, further contributing to delays. The growing network complexity due to increasing nodes impacts delays and path discovery time, potentially causing increased delays. However, more nodes in the network may present more communication options and enhance the probability of finding a viable path to the destination. Consequently, a trade off exists between the number of nodes and end-to-end delay for AODV. Figure 1 illustrates the efficiency of AODV and Modi_AODV concerning the end-to-end delay. When considering the existing AODV, the high end-to-end delay exhibits significant fluctuations. Conversely, Modi_AODV achieves a lower and more stable end-to-end delay ratio.

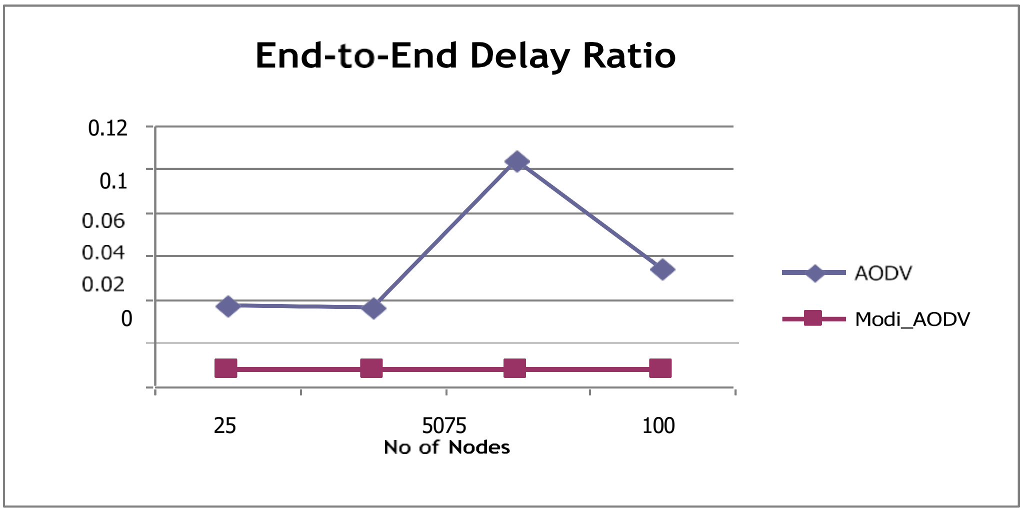

Fig.1: End-to-End Delay comparison for different no of Nodes [100]

Throughput versus Number of Nodes: Throughput is a quantifiable measure of the data volume transmitted across a network within a specific time frame, typically expressed in bits per second (bps). Within the AODV protocol, several factors can impact the throughput, including the number of nodes available in the network, the volume of traffic generated by these nodes, and their capabilities, such as their processing power and wireless interfaces. As the network's node count increases, so does the volume of generated traffic, potentially leading to congestion and reduced throughput. The number of nodes within the network will also directly influence the AODV protocol's efficiency.

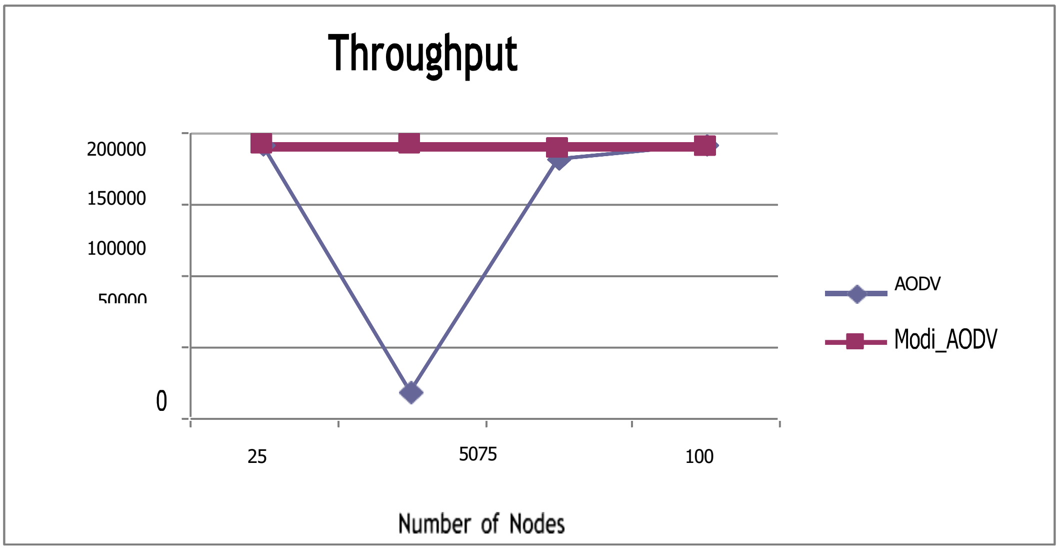

Fig.2: Throughput using various No of Nodes [100]

More nodes result in increased routing tables that must be maintained, causing heightened overhead and lengthier routing table lookup times. An elevated node count generally introduces overhead and complexity to the routing protocol, impacting overall network performance. It is vital to balance the desired level of throughput, overall performance, and the number of nodes present within the network to achieve optimal results. Figure 2 depicts the efficiency of AODV and Modi_AODV in terms of throughput. According to Krung M et al.'s study in 2002 [33], while the throughput remains relatively low at 50 nodes with AODV, it demonstrates better performance at 25, 75, and 100 nodes. In contrast, Modi_AODV exhibits superior and more stable performance. Packet delivery rate compared to the number of nodes: The packet delivery rate represents the percentage of packets reaching their intended destination. In contrast, the number of nodes denotes the total count of devices within the network. When the number of nodes changes, the network's complexity grows, potentially resulting in a lower packet delivery ratio. A higher node count increases the likelihood of packet collisions or interference, leading to lost or delayed packets. Additionally, more nodes lead to larger routing tables, causing increased overhead and delays. However, employing efficient routing protocols like AODV can reduce the influence of node quantity on the packet delivery rate, as they can swiftly and accurately find routes between nodes.The RREP packet contains essential details such as the destination, source addresses, and the destination's current sequence number. The RREQ/RREP packets can set a hop count as a constraint,avoiding loops and limiting the broadcast domain's size to ensure that the packets do not exceed as specific hop count. Additionally, the time-to-live (TTL) field in the RREQ/RREP packets prevents further forwarding when its TTL value reaches zero.

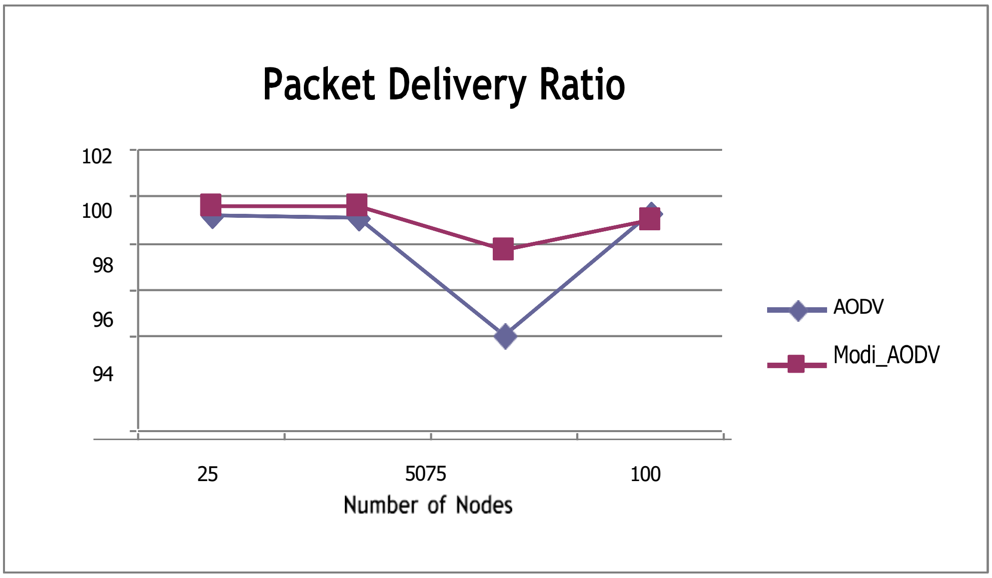

Fig.3: Packet Delivery using different No of Nodes[100]

Figure 3 illustrates the comparison between AODV and Modi_AODV regarding the Packet delivery Ratio metric. While AODV exhibits low and unstable packet delivery ratios, Modi_AODV demonstrates better and consistently stable performance .In MANET, the discovery and establishment of routes between nodes rely on Route Request (RREQ)and Route Reply (RREP) packets. When a source node lacks a route to a destination, it initiates the process by broadcasting an RREQ packet containing relevant information like source and destination addresses, a unique broadcast ID, and the source node's current sequence number. The receiving nodes forward the RREQ packet unless the end node or the nodes already forwarded the same RREQ basedon the broadcast ID and source address is reached. Once the end node or an intermediate node witha fresher route to the destination reaches, it sends back a Route Reply (RREP) packet to the sourcenode. The RREP packet contains essential details such as the destination, source addresses, and the destination's current sequence number. The RREQ/RREP packets can set a hop count as a constraint, avoiding loops and limiting the broadcast domain's size to ensure that the packets do not exceed a specific hop count. Additionally, the time-to-live (TTL) field in the RREQ/RREP packets prevents urther forwarding when its TTL value reaches zero.Delivery Ratiometric. While AODV exhibits low and unstable packet delivery ratios, Modi_AODV demonstrates better and consistently stable performance.In MANET, the discovery and establishment of routes between nodes rely on Route Request (RREQ)and Route Reply (RREP) packets. When a source node lacks a route to a destination, it initiates theprocess by broadcasting an RREQ packet containing relevant information like source and destination addresses, a unique broadcast ID, and the source node's current sequence number. The receiving nodes forward the RREQ packet unless the end node or the nodes already forwarded the same RREQ based on the broadcast ID and source address are reached. Once the end node or an intermediate node with a fresher route to the destination reaches, it sends back a Route Reply (RREP) packet to the source node. The RREP packet contains essential details such as the destination, source addresses, and the destination's current sequence number. The RREQ/RREP packets can set a hop count as a constraint, avoiding loops and limiting the broadcast domain's size to ensure that the packets do not exceed a specific hop count. Additionally, the time-to-live (TTL) field in the RREQ/RREP packets prevents further forwarding when its TTL value reaches zero.

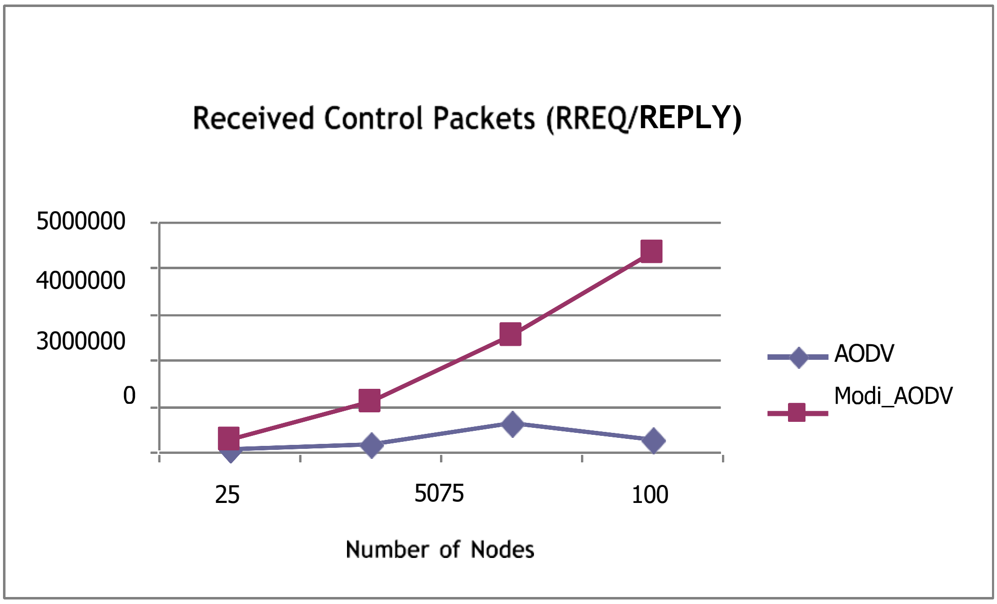

Fig.4: Received Control Packets (RREQ/REPLY) using various Numbers of Nodes[100]

Figure 4 presents the performance comparison between AODV and Modi_AODV regarding Received Control Packets. In the case of Modi_AODV, similar to Send Control packets, the count of Received Control packets is higher than AODV

V. CONCLUSION

Based on the evaluation of throughput, PDR, and E2E delay, it is evident that Modi_AODV outperforms AODV regarding network performance. The optimization techniques applied in Modi_AODV, which include utilizing node location information to reduce control overhead and enhance routing efficiency, have led to significant improvements. This enhanced protocol demonstrates lower E2E delay, higher throughput, and a superior PDR, showcasing its overall greater efficiency in mobile ad-hoc networks. The findings indicate that the modifications made in Modi_AODV compared to the original AODV algorithm have contributed to these performance enhancements. The route discovery process is streamlined by leveraging a path stability mechanism, leading to increased network efficiency. It is worth noting that the efficiency of a routing protocol is contingent upon the unique network conditions and attributes, which can differ based on the situation.

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