Cluster-Based Model for Predicting Energy Efficiency in MANETs through Parameter Evaluation

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Abstract - *Mobile ad hoc due to autonomous node direction, networks are selfconfiguring, structure-less systems for sending data from one connection to another. One of the key difficulties in a network during information transmission is maintaining intermediate node information for efficient transmission. Additionally, the intermediary party can be hacking the data using wormhole and black hole assaults. As a result, this research suggests an efficient clustering methodology based on neighboring relationships. The transmitted node information protocols' surrounding relationships are analyzed by the protocol. Information from each similar node is gathered into a cluster. The configuration of the cl-head and nearby nodes is now being modified regularly to prevent middleman operation like wormhole and black hole. Additionally, the Fireflies algorithm-based Energy efficient routing protocol is used to efficiently regulate the energy consumption. The observational data, such as the packet delivery ratio, energy usage factor, and proportion of attack-free routing efficiency, are then used to examine the system's efficiency.*

Key Words: obility, throughput, loadbalance, scalability, fireflies, cluster head (cl-head).

1.INTRODUCTION

Mobile ad hoc networks have experienced a fundamental increase in demand. In fact, this kind of network has been used in a variety of utilizes, including those in the industrial, economic, cultural, and environmental fields, as well as in help desks, sensor networks, and communicative cars. Ad hoc networks' volatile communication is expected given how frequently the topology changes in these networks. Additionally, the mobility and energy limitations of mobile devices are a major source of issues. As a result, a multi-cluster network design for wireless systems needs to be able to adapt to changing network configurations on the go [1].

Ad hoc network partitioning, or clustering, is used to address the inefficient use of power and bandwidth for direct communication between each node. In clustered communication, network nodes can be divided into compact groups known as clusters, via which information transfer can be carried out. Each cluster often has a cl-head who coordinates the gathering and aggregation of data inside that cluster[2]. Any node of the particular cluster typically transfers the data packets to the cl-head. Clustering in WSN ensures that fundamental performance goals are met with a greater number of sensor nodes. Because clustering raises the requirement for central structure and encourages local decisions, it also increases the scalability of WSN.

It is possible to separate the MANET structure into distributed and cluster networks. In a distributed network structure, all nodes play an equal role, and mesh topographic anatomy can be freely changed in response to node quality. The selection of the cluster head node is a crucial issue in clustering networks [3]. The performance of cluster-head nodes is superior to that of regular nodes, necessitating more powerful processing and more energy. So choosing the cluster-head nodes is crucial in a clustering network. Clustering can solve issues with routing protocols, enhance the calibre of data transmission, and increase network scalability. In MANET, clusters offer a reliable means of tying together mobile nodes and efficiently allocating resources. They also offer a network layered environment through cluster to assure the stability of MANET structure. Clustering involves the cl-head, cluster members, and gateway, with the cl-head and gateway acting as the backbone nodes in a hierarchical ad hoc network. Cluster- Member (CM) is a regular node, and Cluster-Head (CH) is a cluster's local coordinator. The node in question is not a CH or a gateway.

Fig-1: MANET Architecture

Clustering involves the cl-head, cluster members, and gateway, with the cl-head and gateway acting as the backbone nodes in a hierarchical ad hoc network. Cluster-Member (CM) is a regular node, and Cluster-Head (CH) is a cluster's local coordinator. The node in question is not a CH or a gateway.

A cluster gateway is a shared node that connects two or more clusters and offers nodes to transmit information between clusters. The cl-head set is referred to as the dominant set [5].All services are provided by the cl-head to the other nodes. Ordinary nodes or cluster members are terms for other nodes. Ordinary nodes cannot directly connect with other cluster members, but every member node has direct access to the cl-head.During communication, the CH frequently experiences load balancing problems, which causes the MANET nodes to lose energy more quickly. This is the primary cause of link failure .The unique clustering and optimised approaches based routing protocol is then used to address the problems with the network protocols. The approach uses the adjacent relationship idea to analyse the network's nodes, and related nodes are grouped together to form clusters. Since it is impossible for attackers to predict both the data flow and content, the created cl-head has been updated continuously to stop attacks.The Energy efficient routing protocol, which is based on the Fireflies algorithm, is used to reduce energy consumption during transmission.

1. GENERAL ARCHITECTURE OF cl-head SELECTION FOR MANETS USING WEIGHTED CLUSTERING ALGORITHM

In this section fig 1 shows the general architecture of cl-head selection for manets using weighted clustering algorithm. There are five phases in this architecture. The below paragraph tells briefly about those five phases.

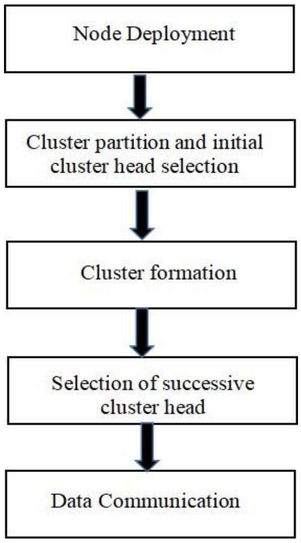

Fig.2: General Architecture of cl-head selection for manets using weighted clustering algorithm.

Here, first phase node deployment, after this phase initialization of cl-head takes place and it is the intermediate phase. And the one-third phase is cluster formation. In the forth phase selection of successive cl-head takes place and finally in the fifth phase data communication takes and data transmitted.

2. Literature Survey

In this section, many writers discuss the approaches used in various types of routing algorithms.

cl-head Selection Methods

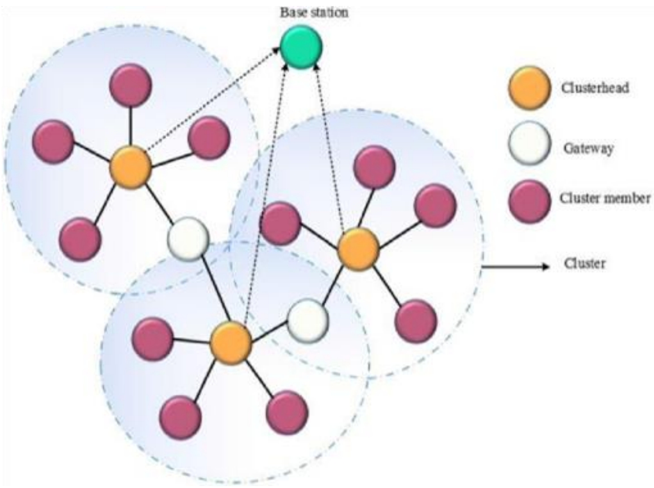

Fig.3-Clustering Formation (Courtesy: D.Pramodh Krishna et al…)

2.1 Entropy-based Weighted Clustering Algorithm

Kulkarni et al. (2017) [6] developed a high node mobility in WCA causes frequent re-affiliations, which raises network overhead. Higher re-affiliation frequency causes the cluster assignment to be recalculated more frequently, increasing communication overhead. Entropy-based clustering, which produces a more stable network, fixes the flaw in WCA. It uses an entropy-based methodology to evaluate the route stability in ad hoc networks and select the cluster leader. Entropy is a gauge of how chaotic and uncertain a system is. As a result, it gives a more accurate signal of the mobility and stability of the ad hoc network.

2.2 Load Balancing Clustering Algorithm

Chia-Cheng Hu et al. (2012) [7] proposed a load balancing algorithm offer the elected cl-heads with a close-by load balance. Once a node has been chosen as the cl-head, it is preferred for it to remain in that position for the designated maximum period of time or program. The algorithm's budget is a user-defined restriction that can be adjusted to take into account the particulars of the system, such as the battery life of one-on-one nodes. Each mobile node in this method has a variable called a virtual ID (VID), and the value of this variable is initially set as the node's ID number. The cl-head job is initially awarded to the mobile nodes with the highest IDs in their immediate vicinity. When a cl-head node uses up all of its duration budget, it resets its VID to 0 and ceases to be a cl-head node because LBC places a cap on the longest continuous period of time that a node can serve as a cl-head. When two cl-heads are within reach of one another, the one with the greatest VID becomes the new cl-head. The non-cl-head in the neighbourhood with the greatest VID score may succeed a departing cl-head. The newly selected mobile node has the shortest overall cl-head service time in its neighbourhood, which should ensure a great force for the new clhead position. The disadvantage is that a mobile node's energy consumption may not always be accurately predicted by the cl-head serving time alone.

2.3 Stable Clustering Algorithm

A. H. Hussein et al. (2008) [8] suggested an algorithm's core concept centred on rapid topology changes adaption and minimized cl-head re-election. To choose the most advantageous combination of criteria for choosing a cl-head, on the other hand. With this approach, we favour gathering metrics that influence the cluster's stability. Two steps make up the suggested algorithm. The election of the cl-head takes place in the first step, and the cluster's members are formed in the second. Each node must broadcast its ID to all of its other nodes within the same transmission range in order to determine the position of the nodes at this first stage. Each neighbour who heard the radio message can determine how far away it is. From the signal's strength that was received. Another option is the Global Positioning System (GPS), however it has the drawback of using more energy. In the second phase construction of cl-head members takes place.

2.4 3-hop between adjacent cl-heads

X. Yang et al. (2013) [9] developed a 3-hop between adjacent cl-heads (3hBAC) technique produces a 1-hop non-overlapping clusters structure with three hops between neighbouring cl-heads and introduces a new node status called cluster guest. A mobile node known as a cluster guest node can connect to some clusters via a cluster member but is unable to connect to any CH directly. The mobile nodes with the highest node degree are chosen as the initial CH. If a mobile node has the highest node degree in its neighbourhood and is not disqualified as a CH, it declares as a new CH. A mobile node enters the appropriate cluster as a cluster guest when it learns that it cannot act as a CH or join a cluster as a clmember but that one of its individual is a cluster member of another cluster. For node maintenance, this method keeps the neighbouring CHs at least two hops away. Using this algorithm, fewer small unnecessary clusters and CHs are created.

2.5 Energy Efficient and Secured Clustering Techniques.

Keerthipriya N et al. (2015) [10] proposes a system in order due to the multihop scenario and impulsive topographic anatomy changes via a wireless medium, mobile ad hoc networks struggle with network mobility and safety solutions. Some of these issues are addressed by the cluster-based approach. To enhance the operation of the mobile ad hoc network, the projected protocol employing fuzzy logic for cl-head selection under competence level, Goodness Function, and Mobility is employed. To execute routing and authentication over a network and ease network congestion, MANET is separated into clusters. This logic creates a cl-head that is completely secure, reliable, and has minimal network overhead. The cl-head is more effective thanks to the competence level, and the cluster is more stable thanks to the mobility factor.

2.6 Fuzzy Score Based (FSB) Cl-head Algorithm

Reddy A. P et al. (2017) [11] proposed a system to maintain stable clustering construction, A DWCA is projected, which picks locally optimum cl-heads and incorporates power establishment at the cl-heads, to lengthen the life of the system's mobile nodes, reduce the burden associated with cluster setup and maintenance, and achieve good end-to-end performance. A weighted clustering approach based on node degree, received power level, stationary factor, and left over time batteries is proposed for MANETS in order to create stable cluster architecture and maintain the topology of the MANET as stable as feasible. The chunk with the full fitness is chosen as the clhead after the performance is evaluated through simulation.

3. Route based Clustering Techniques

3.1 Firm cl-head transmission design

S. Muruganandam et al. (2021) [12] used four clustering techniques to know the secure and time reliable cl-head in the network.

3.1.1 Region centric geographic clustering

The suggested method groups network nodes based on their locations and power characteristics. The procedure begins by reading the network exposure and locating a group of mobile nodes that are instant in the network. Next, the network is divided into chunks. A set of nodes located are recognized for each region, and more nodes found are detected from neighbouring regions or a snapshot. The approach calculates the average distance between each of them. The nodes in the region are clustered into a cluster if the avg distinct between them are smaller than a certain threshold. Every region node is recognized and grouped similarly.

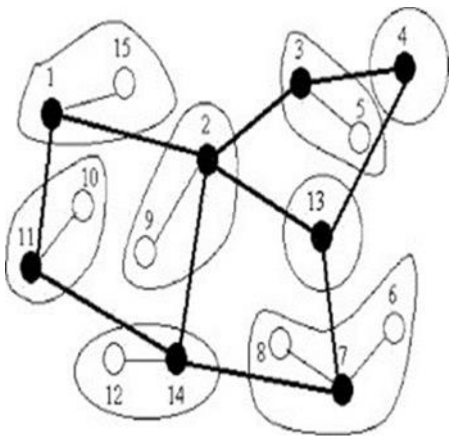

Fig-4: Optimal path selection(Courtesy: Mainak Chatterjee)

3.1.2 Power centric reliable CH selection

When choosing a cl-head, the power-centric CH selection strategy takes into account various factors, including the quality available, the no.of transmissions made, the number of re transmissions made, and the no.of neighbors. The projected a single node uses to find out the value of reliable delivery is chosen as the cl-head, using all of these variables.

3.1.3 Dependable transmission support estimate using many factors

Any cluster's nodes use a variety of paths to get to the cl-head and destination node. However, there are a no.of chunks in the network which has a unique security problem. Any malicious nodes on the route would disrupt the transmission by engaging in various improper actions if they were there. To achieve transmission efficiency, a secure route must be used. In order to achieve this, the approach calculates dependable transmission support estimate using many factors based on various variables, including force, quality, position, the no.of transmissions, success rate, and re-transmission values. The procedure calculates the value of MFRTS based on each of these variables. Based on the time value of MFRTS, the path is chosen.

3.1.4 Secure Transmission

The suggested approach uses a variety of security techniques to carry out data transmission in an encrypted manner. The approach determines the list of path in accordance with the topographic anatomy of clusters to do this. The approach calculates multi-factor dependable transmission support for each of the accessible routes. According to the parameters of mobility, transmission volume, re-transmission frequency, and success rate of the route's point, the value of dependable transmission support is computed. The approach calculates the value of MFRTS based on the measurements taken for each hop along the path. The technique chooses the route with the highest value based on MFRTS value. Data transmission has been done using the chosen route.

3.2 Mobile-Based Cl-Measure

For the cluster formation procedure, P. Basu et al. (2001) [13] introduced a local mobility metric such that moving nodes with slower speeds than their neighbours have a chance to become cl-heads. The aggregate local speed of a mobile chunk is calculated by computing the moment of the link speed in relation to all of its neighbours. If this mobile node's variance value is low, it might not be as mobile as nodes close by. Therefore, mobile nodes with low values for neighbour variation are selected as the cl-head. By limiting re-clustering for accidental interactions between two passing clheads, timer is employed for cluster maintenance to lower the rate of cl-head change.

A cl-head is not always bonded to have a low movement features in comparison to its associates during the supporting phase because the quality behaviour of mobile chunks is not always taken into account in cluster maintenance. The mobility criterion is becoming less and less important over time. This method works well for MANETs with group mobility behaviour, in which a collection of mobile nodes travels in a coordinated manner, much like highway traffic. As a result, a chosen cl-head may often guarantee low mobility in relation to its member connections. Therefore, performance may suffer if mobile nodes move erratically.

3.3 Optimal path selection Algorithm

A. Johnson Santhosh et al. (2022) [14] proposed an algorithm to calculate the reliability factor. This method involves computing the dependability pair factor and the node's maximum energy to produce the cl-head. A node is recognized as the cl-head when it has the most energy, with the nodes below it serving as the alternate cl-head. The alternative cl-heads are used in two situations. When the cl-head's energy level drops, the backup cl-head takes over automatically. The route between the sources and the destination is discovered using the optimal way selection technique. This algorithm provides a strategy based on a node's highest energy and a minimum number of hops between nodes. This algorithm may allow us to find multiple paths with the same high energy. The alternate route must be picked if there are any crashes along the route. Thus, computation time can be shortened.

3.4 Calculating trust energy using distance vector Algorithm

D. Singh et al. (2018) [15] proposed an approach to adjust the AODV routing algorithm's route retention mechanism and pay special attention to choose an ideal path that only has the nodes that are the most appropriate between the source and the destination at any given time. The method changed the originator node's packet header by inserting a new field with the default value of 0 called HC (Hop Count) (zero). A packet's hop count to the finish chunk is often reserve in HC. The value of HC has raised by 1 with each hop that has passed. The suggested method is to evaluate the packet HC value at the destination node to determine or update the active path.

3.5 Location based routing Algorithm

S. Hadjiefthymiades et al. (2019) [16] developed an algorithm to perform clustering on basics of location information. The suggested method divided into four action stages, including cluster creation, data packet routing, location information, and location recovery maintenance, to carry out routing. The first is Cluster Formation. To avoid early establishment overheads associated with cluster organization, CLBR chooses and maintain the cl-head using "regional minimum" rather than "global minimum, "it determines the smallest heavy quantity for each node in the network. The second is Location Recovery Processing, where the source node of a data collection keeps the data message in the frame and broadcasts an LREQ packet if it wants to transfer the packet which contains the data to the destination without using the routing table. The third is data packet routing, in which the source node, destination node, and neighbour node are used to determine the actual routing of data packets. The position of packets that do not use source routing, determines where they go from source to destination. Location Information is the final. The established route continues to change as a result of the characteristics of wireless sensor networks.

3.6 Real-Time traffic multicasting in Manets using Routing Algorithms.

Sapna B Kulkarni et al. (2015) [17] proposed a link for design nodes. The cl-head nodes are those with the highest levels of connectivity, bandwidth availability, and residual energy. A shortest path multicast tree is created using members as leaf nodes and the cl-head as group leaders. This facilitates the transmission of multimedia data to various recipients. The Top-N rule selection method algorithm is used after the cl-head has been chosen to partition multimedia traffic quickly and effectively. The data is divided in this method based on the hit rate. To distribute multimedia data to various recipients, the shortest path multicast tree is created using the Top-N rule selection method technique. The Node connectivity, Energy and Bandwidth Aware Clustering Routing Algorithm for Mobile Ad Hoc Network is used to route data. After the shortest path multicast tree has been constructed. For each receiver, several distinct pathways are constructed when multicasting multimedia packets.

3.7 Cognitive Packet Network CPN Algorithms

K. Sindhanaiselvan et al. (2019) [18] developed a hybrid dynamic topology to choose the cl-head based on energy measurements. They conducted the experiment apply two variables power usage and the choice of cl-heads. Every cluster needs a leader, or clhead (CH), who acts as bridge to faster communication between and within clusters by considering elements like node weightiness, level, compactness, quality, separately or in collection. The main aim is to send the content to every region in the cluster, but it should also make it simpler to communicate with nodes in other clusters via the cl-head or intermediary nodes.

3.8 Avoiding Black Hole Attack in MANETs using Protocols.

Tarek et al.(2015)[19] proposed the transparency based mobility communication networks. One of the most significant attacks that tracks all the data during information transit is the black hole attack. In order to prevent intermediary access to the information, the author uses the networks is based on vector protocol in conjunction with an intrusion avoidance system. This plan of action is constructed using the NS2 machine tools, and its effectiveness is assessed by comparing it to the conventional ad hoc demand distance vector in terms of throughput, packet arrival ratio, and normalize routing load.

3.9 Mobility Ad Hoc Networks

Black-Hole Assault Mohammad et al.(2020) [20] minimizing black hole attacks on the MANET communication network in order to establish an effective communication system. The author analyses the answers in two different approaches. First, ad-hoc networks must be used to choose an efficient source and destination. After determining the most efficient path, it is necessary to choose the packet header and sequence in an efficient manner. The implemented method is compared to the traditional and existing systems, and the publisher proposed a structure which is valid above 75% and below 98%, ensuring the best and safest path with the least amount of time and money spent.

3.10 Using Secure Message Digest, AODV for MANETs

Dharman, et al.(2016) [21] using the privacy network for the digit message approach with ad hoc networks to prevent the network's existing gray hole attack. The technique scans the end-to-end nodes in the network as well as the network topology in different directions. By carrying out the intermediary activity, the gray hole attack affected the network and dropped the packet. In order to make it harder to guess the real connection path, the root and end are identified and encrypted using the message digit approach. An ad hoc routing protocol effectively transmits the information from the estimated path. The group of effectiveness is then evaluated in terms of the message transmission scale using the NS2 simulation tool.

In their comprehensive study [40], Sri Lakshmi et al. conducted a detailed study of this algorithms in this type of networks, focusing on their impact on performance. They compared two existing methods, EA-DRP and EE-OHRA, and their results led them to recommend the Secure Optimization Routing (SOR) technique. SOR, a secure optimization algorithm for Mobile Ad Hoc Networks , was proposed in the paper. Initially, SOR identifies the shortest path between source and destination nodes. It then optimizes this path using a genetic algorithm to enhance its security features. The authors evaluated SOR's performance through simulation studies. Their experiments demonstrated that SOR significantly improves MANET security by reducing some parameters. This study contributes to the understanding of MANET routing security in several ways. Firstly, it introduces a novel, dynamically adaptable secure optimization routing technique. Secondly, it provides a comprehensive performance analysis of the proposed method using simulation studies, enriching the existing knowledge on MANET routing security.

Duc M. Hoang et al.[41] introduced a novel algorithm named the AODV for Mobile Communication. They introduced the algorithm that selects optimal routes based on higher energy and performance compared to existing techniques like FF-AOMDV and EE-LB-AOMDV. Through simulated studies, the authors evaluated FT-AORP's performance, demonstrating its ability to enhance MANETs' fault tolerance in some parameters. This study's about Fault-Tolerant utilizes MANET nodes' characteristics to identify reliable pathways for data transmission. Similarly, research by Nishit Shah et al. [42] introduced the Genetic Algorithm-based Adaptable Routing Protocol (GARP) in Mobile Networks. GARP selects optimal routes based on the highest fitness value, considering factors like the number of hops, link reliability, and traffic load on each link. Through simulated studies, the authors demonstrated GARP's ability to enhance MANET performance, particularly in some parameters. This adaptive protocol tailors its routing paths to meet the network's requirements, ensuring efficient.

In their paper [43], Sabri et al. introduced two critical processes for enhancing Efficient Route Discovery and Link Failure Detection in Source Routing Protocols for Mobile Ad-Hoc Networks .In this type of networks they improving the efficiency of route discovery is crucial, and one method involves reducing the number of nodes handling RREQ packets. In this source protocols, the Link Failure Prediction Mechanism (LFPM) plays a vital role in enhancing link failure detection effectiveness. LFPM predicts the probability of a link failure between two nodes based on their mobility and position data. When a link failure occurs, this information is utilized to determine whether to transmit a Route Error (RERR) packet. This approach can significantly reduce the volume of RERR packets sent, thereby improving the overall effectiveness of link failure detection.

In a study by Pattnaik et al. [44], a distinctive mobility and obstacle-aware algorithm for MANETs is introduced. The authors critically assess previous efforts and propose a strategy that considers both mobility in real environments and obstacles. They develop a method employing Bezier curves and unique node lists to navigate around obstacles and select optimal paths based on mobility indicators and link reliability. This methodology results in the creation of the "Mobility and Obstacle-Aware Routing Algorithm.

"Additionally, another literature review in paper [45] provides an overview of existing routing techniques and their limitations. It discusses the shortcomings of the simple flooding mechanism, particularly the adverse effects of excessive duplicated traffic. Fatemeh Safari et al. specifically highlight the On-demand protocol as an sample of straightforward flooding, a process notorious for causing broadcast storms and weak in the performance of network. To overcome this problem, their proposed approach employs a Fuzzy Inference System (FIS) to make broadcast decisions. This algorithm utilizes the Mamdani fuzzy inference system, known for its simplicity and low computational demands, and consists of a monitoring and fuzzy analysis module, along with a broadcast decision-maker module.

Saleh Ahmed Alghamdi et al.,well-versed in business process modeling, information systems, and smart city development, constitute a significant research group [46]. Another notable researcher, Neenavath Veeraiah, specializes in SE.Additionally, Uppalapati Srilakshmi has contributed several articles on her research in secure multipath routing methods for Manets. The literature underscores the challenges faced by MANETs, including dynamic topology, wireless technology, and bandwidth limitations, rendering them vulnerable to hostile attacks. Consequently, finding secure protocols has become a research priority. To address this, hybrid optimization algorithms have been developed, combining techniques like the Genetic Algorithm (GA) and the Hill Climbing Algorithm (HCA). Moreover, hybrid routing protocols, integrating static and dynamic routing strategies, have been formulated. One such protocol is the Secure Optimization Routing (SOR) protocol, which combines (AODV) and Secure Routing Protocol (SRP) into an innovative hybrid protocol.

In their work, Neenavath et al. [47] delve into the challenges of mobile ad hoc networks, particularly focusing on limited energy resources and the necessity for energy efficient protocols. They highlight the crucial need for information pledge technology to secure MANETs and mitigate their security risks. The researchers propose a hybrid algorithm called the cat slap single-player method for MANETs, which ensures both trust-based security and energy efficiency .

This protocol employs multi-hop routing based on a hybrid approach to select optimal routes considering factors like delay, throughput, and connectivity. Fuzzy clustering is utilized to designate cluster heads (CHs) based on trust levels. The novel technology is rigorously evaluated and compared with existing methods, showcasing its potential for significant energy savings. The utilization of the existing Minimum Cost Spanning Tree (MCST) posed challenges in terms of data transmission efficiency, particularly in providing an all-nodes-to-all shortest route in broadcast networks, as discussed in paper [48].

Collaborating with other researchers, Milan Kumar Dholey et al. developed a broadcast network based on Kruskal's MCST broadcast network, serving as a foundational solution to enhance control message broadcast and data transmission efficiency. Ditipriya Sinha and Ayan Kumar Das proposed augmenting high-frequency links to the base network using the Dijkstra algorithm. The resulting High Frequency link-based broadcast network, analyzed through Omnet++, displayed a minor increase in control overhead compared to current methods. Despite the less-than-ideal routes, this approach significantly enhanced data efficiency while reducing link costs, especially as broadcast volume increased. Meanwhile, according to Hang Zhan et al. [49], Swarm Intelligence-based algorithms show promise in finding optimal solutions for complex challenges. These algorithms, grounded in Swarm Intelligence (SI), offer notable benefits such as high robustness and low cost. Xi Wang and Dieter Hogrefe highlighted Ant Colony Optimization (ACO) as an effective illustration of Swarm Intelligence. The proposed meta-heuristic Ant Colony Optimization technique successfully balanced the routing requirements of Mobile Ad hoc networks, addressing aspects like Packet Delay and Packet Delivery Rate.

In the research conducted by Jinbin Tu et al. in their paper "An Active-Routing Authentication Scheme in MANET" [50], the authors highlight potential security issues arising from open channels and rapidly changing network topologies as solution tailored to active routing protocol characteristics. Their suggested Active Authentication Scheme (AAS) proves resilient against selective forwarding attacks and route spoofing attacks, making it compatible with numerous active routing protocols. This Active Authentication Scheme, as deduced from their study, is expected to enhance packet delivery, reduce collision rates, and maintain network performance. Additionally, in the paper titled "An Adaptive On-Demand Multipath Routing Protocol with QoS Support for High-Speed MANET," authors Wenli Zhou et al. [51] argue that the impact of node mobility on link stability poses a challenge in develops a protocol which provides quality . In this context of Mobile Ad-Hoc Networks, Zheng Chen emphasizes this necessity for adaptability in network architecture to ensure Quality of Service (QoS). To address the problems posed by high-speed node movement, the research proposes the utilization of the Topological change Adaptive Ad hoc On-demand Multipath Distance Vector Protocol. Through its implementation, the study concludes that this protocol significantly improves QoS metrics, some parameters. Additionally, it demonstrates strong potential in supporting QoS requirements for high-speed MANETs.

In the research conducted by Kamlesh et al. [52], the effectiveness of the MMEE routing protocol introduces an innovative approach that has the potential to significantly enhance MANET performance. Unlike its counterparts, MMEE considers nodes' energy levels, bandwidth, and queue length when selecting routes. Additionally, it incorporates a multipath multichannel strategy to improve routing accuracy and efficiency. In comparison to EA-DRP and EE-OHRA, as outlined in [1], the MMEE routing protocol outperforms both in terms of packet delivery (99.9%), delay (0.36 MS), and throughput (0.85 Mbps). This highlights the MMEE protocol's superior reliability, efficiency, and capability in contrast to EA-DRP and EE-OHRA.

Study [53] delves and focusing on the Branch and Bound algorithm. Addressing complex are essential in solving the energy efficiency optimization problem in MANETs. Researchers led by Wen kuang kuo proposed a tailored branch and bound (BB) method, leveraging the unique model structure. This approach proved highly effective for globally optimizing energy efficiency issues in MANETs. The Energy Efficiency (EE) over One-Hop Routing (OHRA) percentage, denoted as EE-OHRA, demonstrated a remarkable increase, up to 7.87 times when compared to one-hop routing protocols. This implies the suggested algorithm significantly enhances MANETs' energy efficiency. The final results affirm the algorithm's efficacy in finding effective solutions for the EE Optimization problem in MANETs, all while ensuring computational efficiency and guaranteeing optimal solutions.

In their study, Shahenda et al. utilized the Elephant Herding Optimization (EHO) method and conducted tests using an NS-3 simulator to evaluate its effectiveness. They introduced a promising energy-efficient MANET routing protocol known as EHAODMV. According to [54], the EHO algorithm categorizes nodes into fit and unfit clans based on their energy levels, where nodes with ample energy are considered fit while those lacking energy are deemed unfit. This approach led to the development of the EHO-AOMDV routing protocol, employing the EHO algorithm to select optimal paths with suitable nodes before using these paths to transmit packets. Notably, this protocol offers more energy-efficient routing for MANETs compared to current routing protocols.

A ground-breaking contribution from Aqeel Taha et al. [55] introduced the Fitness Function-based Ad hoc On-Demand Multipath Distance Vector Algorithm, delving into the challenges of developing energy-efficient routing protocols in Mobile Ad-Hoc Networks (MANETs) [4]. Described as a novel, energy-efficient multipath routing algorithm, FF-AOMDV selects routes based on fitness criteria. Notably, it surpasses the existing AOMR-LM and AOMDV protocols in terms of some parameters.

The FF-AOMDV outperforms AOMR-LM and AOMDV with an impressive EEOHRA percentage of 75%, surpassing AOMR-LM's 65% and AOMDV's 55%. Additionally, FF-AOMDV exhibits superior performance metrics, including some parameters ,outclassing both AOMR-LM and AOMDV. This study meticulously considers energy consumption, distance, and bandwidth of the links when selecting routes.

In their paper [56], Y. Harold Robinson et al. introduce a novel approach for managing network traffic overload in this type of Networks (MANETs) through a fresh link-joint multipath routing strategy. This proposed method guarantees both reliability and load balancing, streamlining the selection of optimal paths for individual data packets. The LDM algorithm, detailed in [1], calculates the path cost using a specific factor. When compared to other alternatives, the LDM algorithm outperforms in terms of some parameters. Through simulations, the LDM Algorithm was rigorously tested, revealing remarkable results: achieving up to 99% packet delivery, a mere 100ms endto-end delay, and a substantial network throughput of 200ms. It stands out for its ability to enhance network performance in crucial aspects ensuring both reliability and the load balancing. Tong Guang et al. introduced three innovative algorithms outlined in their paper [57]: "Multi-path Routing and MPTCP-Based Data Delivery Over MANETs." These algorithms include the QOE-Driven Packet Scheduling Algorithm, and the Improved Multi-Hop Algorithm.

Their emphasis lies to improves the Quality of Service (QoS) for phone devices within Mobile Ad Hoc Networks , all without relying on a fixed infrastructure. As stated in reference [2], the research demonstrates that the proposed algorithms and techniques significantly enhance the efficiency of utilizing multiple routing, Multi-Path TCP (MPTCP), and Quality of Experience (QOE). The study underscores the practicality and effectiveness of their proposed model while acknowledging the necessity for additional development and real-world testing.

The AOMDV-GA protocol uses a genetic algorithm to create new routes that are more likely to be efficient, according to a check done by Antra et al. [58].The distance to the destination, the level of congestion on the routes, and the energy level of the nodes along the route are just a few of the variables that affect how suitable a route is. In [3], the output is taken on the basis of delay, energy. The AOMDV-GA protocol uses a congestion control technique to avoid congested paths and maintains pathways to destinations, making it more resilient to connection failures and congestion. Though it is still in development, the AOMDV protocol has the capacity to be a useful tool. Evaluating a route's efficiency through a fitness function proves to be a promising strategy. In their paper titled "Neighbor-Based Dynamic Connectivity Factor Routing Protocol for this type of Networks" [59], ALI M.Ejmaa et al. highlighted the drawbacks of routing protocols relying solely on predetermined variables. The latter approach increases undesirable routing overhead and compromises system performance. To mitigate these issues, a novel routing protocol was introduced by Shamala Subramaniam et al. This protocol employs a unique connectivity factor, aiming to reduce RREQ overhead while enabling dynamic probing of the network's status. Their innovative solution was designed to enhance various aspects of performance, including some parameters. In their paper titled "Trust Routing Protocol Based on Cloud-Based Fuzzy Petri Net and Trust Entropy for this type of Network" [60], Xiao Liang et al. tackled the challenge dealing with performance metrics that are inherently fuzzy and difficult to quantify. These ambiguities often lead to errors in estimating nodes' trust values.

To address this issue, the researchers employed an issue of trust approach depending on the cloud model and Fuzzy Petri Net (FPN). Their research focused on overcoming these challenges using innovative methods. In a bid to provide the best quality in this type of Networks and surpass existing trust-based Optimized Link State Routing (OLSR) protocols, PENG ZHANG and Mei Qi proposed a novel routing algorithm. This algorithm, named Trust Entropy Routing Algorithm and Optimized Link State Routing , was designed to optimize link state routing and leverage trust entropy. Their approach aimed to elevate the performance of MANETs in terms of trust-based routing protocols.

TABLE-1: SUMMARY OF ROUTING ALGORITHM

SNO	BFOA	AODV	GA	HA	FP AODV
1.	▯	×	×	×	×
2.	×	▯	×	×	×
3.	×	×	▯	×	×
4.	×	▯	×	×	×
6.	×	▯	×	×	▯
7.	×	×	▯	×	×

BFOA: Bacteria for Aging Optimization

AODV: Ad Hoc On-Demand Distance Vector

GA: Genetic Algorithm

HA: Hybrid Algorithm

FP AODV: Fixed Probability Ad Hoc On-Demand Distance Vector Algorithm.

4. Result analysis

We learned that various algorithms were proposed with various parameters after reviewing a number of papers. According to our expertise, we compared many parameters.

TABLE-2: PERFORMANCE EVALUATION WITH DIFFERENT PARAMETERS

S.No	Algorithm	PDR	Delay	Energy
1.	BFAO	-	-	0.10mj
2.	AODV	85%	1.5s	0.08mj
3.	FP-AODV	18%	10S	-
4.	GA & HCA	89%	0.004ms	0.10mj
5.	HA	0.99%	0.005s	0.11mj
6.	AOMDV-TA AOMDV-FF EHO-AOMDV	4.4% 10.2% 15%	- - -	10.75% 61.96% 32.32%
7.	MOAR	-	1.34ms	19.27%
8.	AOMDV-TA	10.7%	53.05%	-
9.	MMAC AOMDV TA-AOMDV MMEE	- 90.4% 94.8% 95.1%	0.54ms 0.36ms 0.3ms 0.21ms	0.27j 0.19j 0.08j 10j

1. **PDR**

The proportion of data packets effectively transmitted from the start terminal to the end terminal within the network is determined as the packet delivery ratio (PDR). This can be represented by the following formula:

$$PDR = \frac{(No.of\ packets\ received)}{(No.of\ packets\ sent)} * 100 \quad (1)$$

2. **Delay**

The duration it takes for a data packet to traverse multiple routers and network segments from the beginning terminal to the ending terminal is known as delay. This can be mathematically expressed as :

$$Delay = \frac{\sum_{i=1}^{n}(Ri - Si)}{n} \quad (2)$$

Where (2) denotes the total discrepancies between the transmission time (Si) & reception time (Ri) of n packets.

3. **Energy**

When discussing routing, the term "energy consumption" refers to the amount of electricity required by network equipment, such as switches, routers, and other networking devices, during the transmission and reception of data packets inside a computer network.

$$Energy = \sum_{i=1}^{n}(ini(i) - ene(i))_n \quad (3)$$

In equation (3), the dissimilarity between the starting energy (ini(i)) and the left energy (ene(i)) of ith component or device within the network is expressed as the summation of the nth power of these variances.

TABLE-3: COMPARISON TABLE FOR VARIOUS PROTOCOLS

Protocols	Accuracy	Delay	Through put	Energy
AODV [19,21]	Intermediate	Low	Intermediate	Intermediate
PSOGA [1]	Intermediate	Low	Intermediate	Intermediate
P2P [12]	Variable	Change	Variable	Variable
GKCA	Variable	Change	Variable	Variable
CHSA [2,18,31]	Intermediate	Low	Intermediate	Intermediate
AODV [19,21]	Variable	Change	Variable	Variable

5.Challenges and gaps:

5.1 Adaptive Topology

Routing protocols must adjust to these modifications and create effective routes in real-time

5.2 Threats to Security

Various security risks, such as rogue nodes, eavesdropping, and denial-of-service attacks, can affect MANETs. Security safeguards must be built into routing protocols to counter these dangers.

5.3Requirements for service quality

From straightforward data interchange to real-time multimedia streaming, MANETs are utilized for a variety of applications with different quality of service needs. QoS-sensitive traffic should be given priority via routing protocols.

6.Future research direction

6.1 Privacy-Preserving Routing:

Possibility Address user data privacy issues in MA-

NETs by building routing protocols

6.2 Energy-Efficient Protocols:

Research on energy-efficient routing protocols should be continued in order to meet the rising demand for MANETs with limited energy resources .

6.3 Security and Trust Mechanisms:

To combat growing threats, there is a chance to improve security and trust mechanisms in MANET routing protocols.

7. CONCLUSION

The literature review in my research sheds light on the authors' background and interests, focusing on the challenges related to energy conservation and security. It emphasizes the secure protocols based on trust. Several studies conducted by scientists have consistently shown that AODV outperforms other algorithms. AODV is highly regarded in mobile due to its on-demand routing approach, proactive route management, and effective adaptation to changing network conditions. AODV, emerging prominently from academic research, has demonstrated superior performance in comparison to alternative routing algorithms in various studies. Its key strength lies in its on-demand routing strategy, ensuring efficient resource utilization. Additionally, proactive route management techniques contribute to network stability even in dynamic scenarios, making it a reliable choice for addressing the unique challenges of mobile ad hoc networks. In summary, AODV's attributes make it a preferred choice in MANETs, where energy efficiency and security are critical concerns.

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