A Node Monitoring Agent based Handover Mechanism for Effective Communication in Cloud-Assisted MANETs in 5G

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Abstract—As nodes often join or leave the network, the communication between the cloud and the MANET remains unreliable in Cloud-Assisted MANET. The event of connection failure in MANET presents several challenges to the network, in particular, the handover issue and high energy consumption during route re-establishment if a connection fails in D2D (device-to-device) communication networks. To address this problem of D2D mobile communication in 5G, we propose a Node Monitoring Agent Based Handover Mechanism (NMABHM). To improve the network's efficiency, we use the K-means algorithm for clustering and cluster head selection in Hybrid MANET and maintain a backup routing table based on a Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) to quickly recover the route. Additionally, a Node Monitoring Agent (NMA) is introduced to handle the handover issue if a node comes out of range during the communication phase. The NMABHM-based handover mechanism is proposed with group mobility over a cluster-based architecture involving agents. The results of the simulation indicate that, in terms of lower energy consumption and higher throughput, our proposed mechanism is more effective than the current routing mechanisms.

Keywords—MANET; clustering; cloud computing; 5G Wireless networks; cloud-assisted MANET

I. INTRODUCTION

Wireless technology, the most important communication medium for information between different devices, has witnessed rapid growth over the subsequent years. The future wireless technology, i.e. 5G, which is a new global standard of communication, is especially designed for the purpose of forward compatibility and to flexibly support services like mission-critical communication, mobile broadband, IOT, cloud-based services, and D2D communication [1]. With the increasing demand for QoS and the data transfer speed for mobile networks, there is still a requirement for new communication technologies [2,3]. Due to the compatibility features, Cloud Assisted MANET, which is the combination of Cloud and Mobile Ad-Hoc Network, has received a lot of interest from researchers today.

A. MANET

MANET is one of the most widely used Ad-Hoc wireless networks [4]. Routing in MANET is multi-hop and each node in the network is a transceiver with bidirectional links. MANET's distinguishing feature, in addition to its unique features and advantages like dynamic topology, mobility, multi-hop, and decentralised administration, is its ease of connection with other networks. With this superiority in communication, MANET has made significant contributions to the growth of the Internet industry [3].

B. Cloud Computing

Cloud Computing has been observed exponential growth in recent developments and the potential has been developed to limit energy consumption and to enhance the usefulness of mobile nodes in MANET [5]. Cloud storage platforms are used by the three administrative models, like IaaS (Infrastructure as a Service), SaaS (Software as a Service), and PaaS (Platform as a Service), which are delivered to users through Internet-connected systems [6]. In addition to the benefits of Cloud Computing like scalability, affordability, and security, the 5G and D2D connectivity specifications require the use of CA-MANETs, resulting in various research gaps in this area.

C. CA-MANET

The convergence of MANET and Cloud Computing has become more popular in recent years. MANETs are widely used in emergency situations because they don't adhere to a predetermined topology. When disasters like earthquakes or other natural calamities strike, smart devices in MANET will need to access the data on health care services and other essentials stored on site maps via the Cloud. The requirement for mobile devices in MANET to access cloud services, as well as D2D communication and 5G wireless networks, necessitated the CA-MANET architecture, where multiple devices may be simply connected. CA-MANET unquestionably constructs robust 5G networks [7]. An overlay of peers, i.e. mobile devices and cloud data servers, is formed in CA-MANET, as shown in Fig. 1, when the cloud server joins the MANET [8,9]. The overlay in CA-MANET is self-organizing, i.e. any Peer can join or leave the network anytime. In CA-MANET, Super Peers are the cloud data servers interconnected logically to the Peers. In order to route, search, and send messages, each Peer keeps the information necessary to do so and may be linked to the Super Peer either directly or indirectly. If a Peer and a Super Peer have an indirect link, intermediate Peers operate as routers and help forward the requested services.
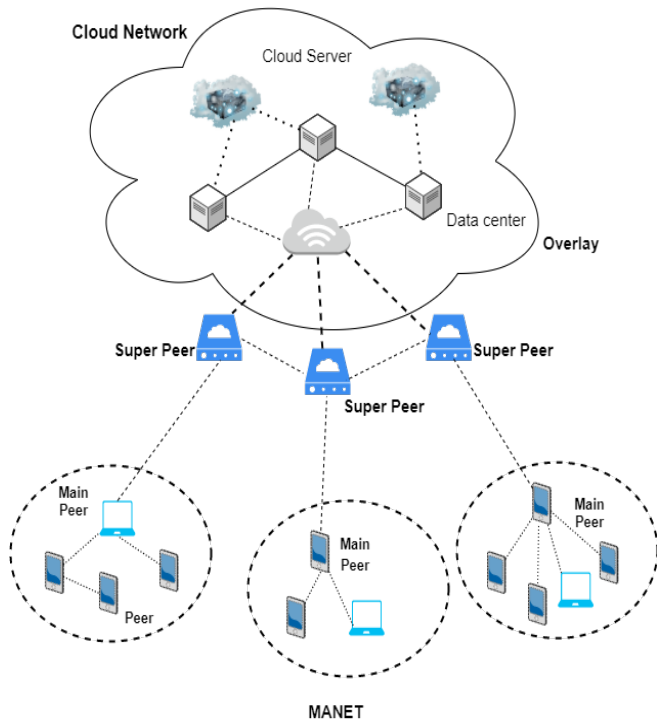
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Fig. 1.   An Overlay of Data Centers and Cloud Servers with D2D Communication.

The role of cloud servers in the overlay is to provide the required data and services for MANET communication. When MANET requests a particular cloud service, the cloud server performs operations like searching, routing, and updating its database in order to provide future service requests [10]. Due to frequent link breakages in MANET, there is a chance for communication loss between the cloud and MANET. This creates several of the issues like handover, link failures, an increase in overhead and energy consumption in route re-discovery, which indeed effects the cloud servers' service delivery efficiency [11,12]. The cost of processing power and energy consumption grows as network resources are depleted, affecting D2D network performance in 5G networks, which is the main challenge. In addition to that, link failures, effective handover, bandwidth utilization, and route selection are also other challenges to consider. Analyzing the above concerns in detail indicates that energy consumption is the key concern, which is dependent on MANET routing protocols [31]. If energy degradation is handled by selecting the most robust and optimal MANET routing approach, most CA-MANET problems will be solved. For this, we propose a Node Monitoring Agent-Based Handover Mechanism (NMABHM) that focuses on the minimization of energy consumption by effectively handling link failure and service handover.

The significant contributions of the proposed work include:

- Organizing the MANET into Clusters and electing the Cluster Head (CH) based on the K-means algorithm that benefit in bandwidth reusability.

- Introducing a Node Monitoring Agent (NMA) that can perform the ease of handover process without failure by supervising the link failures and node movement.

- Effective Route establishment and maintenance by introducing TOPSIS [13,14] procedure in the AODV algorithm that benefits in maintaining backup route table for selecting optimal alternate paths during link failure.

The rest of the paper is structured in the following manner: Section 2 describes existing works related to minimizing energy consumption in CA-MANET. Section 3 describes the problem description and scenario. Section 4 describes our proposed NMABHM. Section 5 provides performance evaluation and results, followed by Section 6 of Conclusion and Future Work.

II. LITERATURE SURVEY

Due to the growing popularity and increasing demand of mobile devices in wireless communication, 5G networks have evolved. Because of the limited resources available, 5G network components must be able to efficiently use energy and power [15]. To increase overall network performance, it is necessary to study the energy consumption of network nodes [16]. This can be accomplished by the deployment of intelligent approaches to make optimal routing decisions in communication.

In [17,18] the authors suggested a new protocol with a sophisticated costing function that uses residual battery capacity and hop count as parameters to determine high throughput, low energy and long-lasting data transmission routes on the basis of mobile agent technology. In [19] the authors proposed a new strategy called SBR-Stable Backup Routing, which includes techniques for the design and management of backup routes. The SBR greatly reduces packet loss and increases delivery ratio by overhearing MAC signals and the bit error rate of networks. In order to improve the efficiency of the OLSR routing protocol, the authors in [20] developed a method, termed AIS-OLSR, that uses an artificial immune system. Negative selection and ClonalG algorithms are used to calculate hop count, residual energy in relay nodes, and distance between nodes.

In [21] the authors presented ELBRP, which focuses on the problem of energy-awareness by analysing the nodes' amounts of energy and various forwarding strategies that decrease the energy utilization, optimize the delay, and enhance the network usage. In the survey on mobile device energy usage [22], the authors concentrated on various offloading mechanisms that are responsible for the low battery life of mobile phones due to their unique components. In [23] the authors conducted a detailed assessment of the MANET network challenges and discussed the prospect of resolving them using neural network-based clustering by using a multi-criteria decision of network characteristics, specific cluster algorithm implementations for routing applications. To optimize energy consumption of wireless sensor networks, the authors in [24] suggested an effective cluster head selection approach utilising the K-means algorithm. In this method, the cluster head is identified by

reducing the sum of Euclidean distances amongst the head and its members.

In [8] the authors proposed a novel collaboration paradigm between cloudlets and MANETs, in which the objective is to conserve energy and benefit from green computing by developing DCRM. In [9,18] the authors proposed an overlay architecture, in which a viable energy saving strategy is used to reduce searching and routing activities in cloud data servers.

Due to the high degree of node mobility in MANET, handover happens when a node in communication moves out of the coverage ratio. The functionality of the handover requires a time delay. The difficult part is to identify the appropriate handover and execute it well. In [29] the authors proposed a Vertical handover using MIH/SDN to optimise handover in the future generation of mobile networks. In [25] the authors proposed the IMMH mobility handover strategy for IPv6-based MANETs. In IMMH, a user always communicates with a node via its home address, and both the node's mobility handover and care-of address updating processes eliminate the cost and latency associated with duplicate address detection. In [26] the authors address the handover problem for a fixed path by introducing a cloud-assisted ant colony-based solution termed CAFP. This solution leverages Cloud Computing to significantly reduce the time required for handover, notably during handover judgment.

The energy issue is among the most difficult issues to deal with when using cloud networks and MANETs together. When there is a disconnect between a MANET and the cloud, it might result in a cost issue. Many studies have offered routing options for MANETs that save energy and increase performance. EERR is an energy-efficient and effective routing method that has been developed by the authors in [27] for mobility prediction-based MANET systems. EERR uses location information to determine the best transmission power for delivering packets successfully. In [10,18] the authors

proposed CEPRM method, in which service requests can be directed directly to the destination cloud server by preserving a content map on the Super Peer nodes. It decreases the cost of searching time and so minimises the amount of energy consumed by the cloud server's search operation. To help CA-MANETs recover quickly when a connection fails, the authors in [28] developed an EECRM -Energy Efficient Cloud-Assisted Routing Mechanism. In this mechanism, the Bellman-Ford algorithm is altered with parameters such as residual and total energy of the nodes in the network. Backup nodes discovered via nearby nodes during the route maintenance stage aid quick route restoration by presenting alternate paths that are discovered, which reduces energy exhaustion. According to existing research, it is clear that high energy consumption and connection handover issues in CA-MANET's are still unsolved [30]. Also, most of the currently available techniques, such as CEPRM and EEPRM, are proposed for optimal route recovery and maintenance in the event of a link failure between the Main Peer and the Super Peer. However, none of these approaches took into account the scenario of establishing and maintaining an effective route for the Indirect Peer when it moves out of range during the on-going communication process. This contributes to the motivation for the proposed NMABHM, which successfully establishes a path between the Indirect Peer and the Main Peer, by utilising residual energy and handover procedures effectively.

III. PROBLEM DESCRIPTION

Fig. 2 describes the problem scenario in CA-MANET that has been considered for the proposed work. Here, Peer A is the Main Peer as it connects directly to the Super Peer S1. The services provided by Super Peer S1 can be accessed by the Indirect Peers via Main Peer A. Now the Indirect Peer C requests service from S1 through A. If the service requested by Peer C is in the cache of S1, then S1 can respond to the service through Main Peer A.
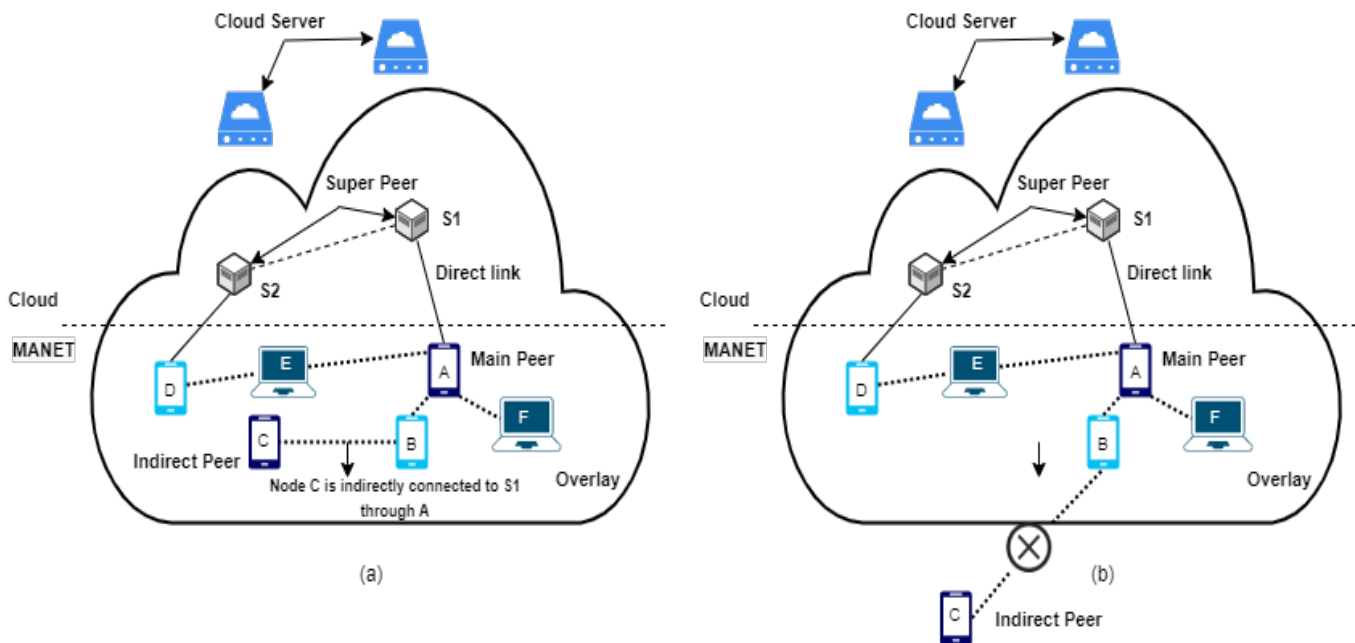

Fig. 2. Link Failure in CA-MANET during Ongoing Communication Process.

Assume that the requested service is in the cache of S1 and the communication is initiated between the Super Peer S1 and the Indirect Peer C through Main Peer A, as shown in Fig. 2(a). During the ongoing communication process between Super Peer S1 and indirect Peer C through Main Peer A and relay Peer B, imagine that Indirect Peer C begins to move away from Main Peer A. As shown in Fig. 2(b), when the indirect Peer C comes out of range from Main Peer A, a link failure occurs, resulting in communication loss between Super Peer S1 and the indirect Peer C. This interrupts the ongoing service communication between Super Peer S1 and Indirect Peer C, as the Indirect Peer C is now out of range from the Main Peer A to access the service. This is due to loss of connectivity and it results in a problem of incomplete service requests. This problem can be resolved by the effective handover of the requested service when the Indirect Peer moves out of range of its service resource.

A. Approach

To address this problem, we propose a Node Monitoring Agent-Based Handover Mechanism (NMABHM), in which the main idea is to implement a mechanism that allows the Indirect Peer to have access to the requested service from the cloud, in the case when it moves out of range from the Super Peer. For the proposed work, we follow an approach based on the following assumptions in CA-MANET:

- A Hybrid MANET scenario is implemented using a cluster-based architecture and the Cluster Head (CH) is considered the Main Peer.

- CH maintains a direct link to the Super Peer to communicate with the cloud services.

- CHs are all static in nature.

- Using the CEPRM algorithm, the Super Peers can share service information with one another and with additional Super Peers when they enter an overlay [10].

IV. PROPOSED MECHANISM

A. NMABHM Algorithm

Fig. 3 represents the CA-MANET considered for the proposed work, in which the NAMBHM operates in three phases as follows:

1) Step 1: Using a K-means algorithm to group the mobile nodes for reliable and successful data transmission and Optimal Cluster Head Selection by following K-means algorithm based on the Euclidean distance and residual energy.

2) Step 2: Implementing a Node Monitoring Agent (NMA) to perform effective handover in the event of a link failure.

3) Step 3: Introducing the TOPSIS technique into the AODV algorithm for Effective Route establishment and Maintenance.
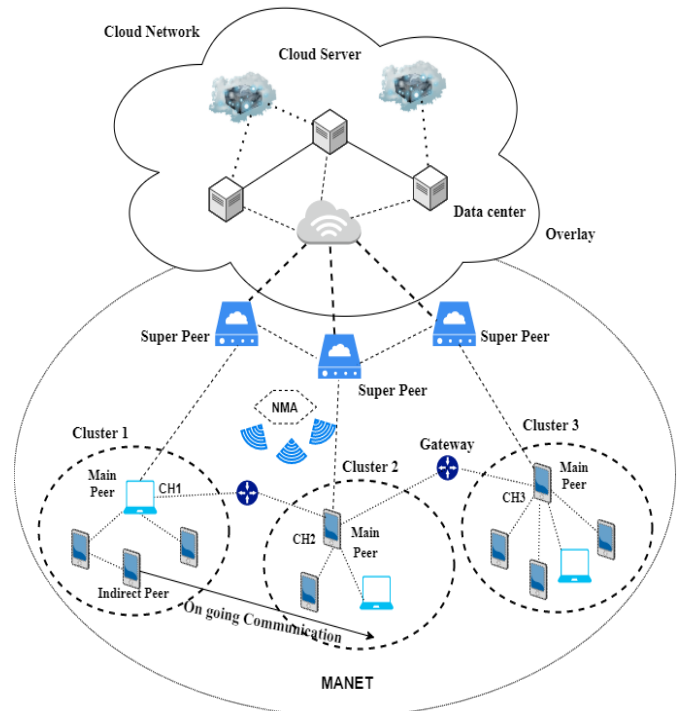

Fig. 3. Indirect Peer Movement from Cluster 1 to Cluster 2 during Ongoing Communication Process.

B. Clustering and CH Selection using K-Means Algorithm

1) Clustering: Clustering is still the most extensively utilised performance optimization technique for MANETs, enabling them to expand to a large number of mobile nodes. In order to perform the clustering in the network, a K-means algorithm is applied to group the mobile nodes, which creates clusters of nodes based on their Euclidean distances from one another [28]. This technique is used to generate clusters, so that the distance between nodes and the CH is as short as possible. For this, we suppose that most nodes have understood their particular location information by using either a GPS unit or a network localization technique.

2) Cluster head selection: The CH selection procedure is divided into three steps, which are as follows:

a) Step1: The First step is initial clustering.

The K-means technique is used to form clusters among the nodes within the network [24]. Assume that the n-node network is partitioned into k-clusters. Then, k nodes out of n are chosen at random to be the CHs. Based on the Euclidean distance, each of the available node chooses the CH nearest to it.

b) Step 2: The next step is to re-cluster.

The centroid of each cluster with an "s" number of nodes is computed after assigning each node to one of the network's k-clusters.

$$\text{Centroid}(X, Y) = \left(\frac{1}{s} \ \sum_{i=1}^{s} xi \ , \frac{1}{s} \ \sum_{i=1}^{s} yi \right) \tag{1}$$

c) Step 3: The third step is to choose a Cluster Head.

After generating the clusters, each node is assigned an ID number in the cluster based on its centroid distance, such that the closer nodes receive smallest ID number. A node's ID number determines the sequence in which it shall be elected as the Cluster Head. As a result, the ID number is critical in determining which node is designated as CH.

In each round, the CHs residual energy is verified to maintain the networks connectivity link. If the energy of the CH is less than the predefined threshold, the next order node is chosen as the new CH. The newly elected CH communicates the change in the CH to other nodes. This approach employs a routing mechanism that enables CHs to communicate directly with the Super Peer through a single-hop connection. The Super Peer then processes the collected information.

C. Node Monitoring Agent based Handover Mechanism

Once the Cluster Heads (CHs) are selected, Node Monitoring Agent Based Handover Mechanism (NMABHM) is incorporated with group mobility over cluster-based architecture involving agents in the CA-MANET for effective handover of service during the link breakage. This mechanism comprises all the correspondent properties for making handover decision. The various properties considered by the NMA are described as follows:

1) Capacity of cluster: This property ensures that the number of nodes available in a cluster is always lower than the original capacity of nodes that could be serviced by the CH in the corresponding cluster. Failure of this property results in handover.

2) Cloud Services: If the cloud service demanded by the mobile host is the same as that supplied by CH, the Peer must be present in the cluster, otherwise, according to the application specifications, it must scan for another network.

3) Received signal strength indication (RSSI): If the mobile host has same RSSI values from two different CHs it is then important to search the next near-hop and decide which cluster it will have to communicate with.

4) NMA: NMA is a handover issue detection agent that supervises various network events and updates the collection of CHs and is ultimately responsible for property-based handover decisions. It is responsible for interacting with CHs and Super Peers with various parameter-based decisions to choose the appropriate policy and providing CHs with suggestions. If anyone of the following properties fails, then handover occurs.

5) Property 1: Capacity of cluster

If the nodes count in a cluster is greater than the capacity, then

Set value for the parameter as:

pr_{var1}: No. of nodes to make handover

pr_{var2}: D is distance in terms of hop count to new cluster head.

pr_{var3}: Handover latency (H_{lay})

6) Property 2: Cloud Services

When looking for specified services on mobile hosts, the parameter values are

pr_{var1}: Offered Service list

pr_{var2}: Offered service plans

pr_{var3}: Security features provided

7) Property 3: Next Hop Specification

If two mobile hosts receive same RSSI from two or more different cluster heads, then

Set parameter Value as:

pr_{var1}: Min $P_{Consumed}$ (MN)

pr_{var2}: RSSI value

pr_{var3}: Weight variable value

To perform these steps, dynamic packets are created. Those packets are known as Request Packets of Handover (RPH). Then handoff is predicted via Handoff Label Packet (HLP) as shown in Table I.

TABLE I.   PACKET INFORMATION

Request Packet of Handover (RPH)		
pr_{var1}	pr_{var2}	pr_{var3}
Handoff Label Packet (HLP)		
RSSI value	H_{lay}	Min $P_{Consumed}$ (MN)

D. Optimal Route Selection using TOPSIS Algorithm

In the proposed work, nodes can communicate with each other by using the AODV routing protocol and a backup routing table is maintained based on two parameters such as the hop count and the available energy. In case of an ongoing communication process, when the communicating Indirect Peer moves out of range from the Main Peer (CH), communication loss occurs between the Main Peer and the communicating Indirect Peer which results in a connectivity issue between the Super Peer and the communicating Indirect Peer. Now, to utilize the requested service, the Indirect Peer must be connected to the Main Peer (CH) of that particular region in which the Indirect Peer is present i.e. a route must be established between the Cluster Head and the Indirect Peer.

1) Route establishment and maintenance:

- The node movement information is shared by the NMA with all the Cluster Heads in the CA-MANET.

- On receiving the node movement information, the CH broadcasts the HELLO messages to all of the neighbouring nodes in the cluster.

- The Indirect Peer broadcasts RREQ and route establishment is done between the CH (Main Peer) and the Indirect Peer as shown in Fig. 4.
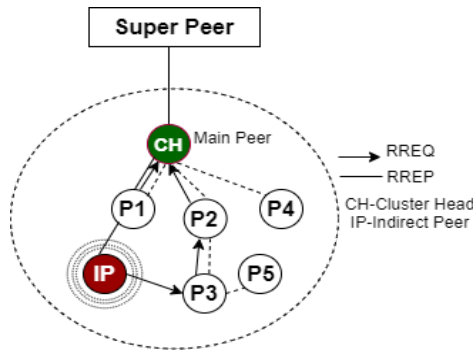
Fig. 4. Route Establishment and Maintenance when Indirect Peer Enters into Another Cluster.

2) TOPSIS process:

The following measures include the TOPSIS process:

a) Step 1: To define the Decision Matrix (DM)

$$T_1 \quad T_2 \dots \quad T_n$$

$$DM = \begin{matrix} AP_1 \\ AP_2 \\ \vdots \\ AP_m \end{matrix} \begin{bmatrix} t_{11} & t_{12} \dots & t_{1n} \\ t_{21} & t_{22} \dots & t_{2n} \\ \vdots & \vdots & \vdots \\ t_{m1} & t_{m2} \dots & t_{mn} \end{bmatrix} \tag{2}$$

In this case, i = 1...m represents the criterion index, m represents the number of possible connections, and j = 1...n represents the alternative index [13,14]. The criteria are T_1, T_2 ..., T_n, and the alternate positions are AP_1, AP_2..., AP_m. The matrix components in alternative j are linked to the set of parameters i.

b) Step 2: Create a Normalized Decision Matrix (NDM) that accurately represents the output of design alternatives.

$$NDM = R_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \tag{3}$$

c) Step 3: Evaluate the weight decision Matrix by considering the random weight as W_j.

$$V = V_{ij} = W_j \times R_{ij} \tag{4}$$

d) Step 4: Using the weighted decision matrix the Ideal solutions are generated.

$$I^+ = \{v_1^+, v_2^+, v_{3,}^+, \dots, v_n^+\} \tag{5}$$

in which $V_j^+ = \{(max_i(v_{ij}) \text{ if } j \in J); (min_i v_{ij} \text{ if } j \in J')\}$

$$I^- = \{v_1^-, v_2^-, v_{3,}^-, \dots, v_n^-\} \tag{6}$$

in which $V_j^- = \{(min_i(v_{ij}) \text{ if } j \in J); (max_i v_{ij} \text{ if } j \in J')\}$

where, I^+ is the Positive Ideal Solution and I^- is the Negative Ideal Solution [14]. The beneficial attributes are given with J and non-beneficial attributes with J'.

e) Step 5: Using the above Ideal solution i.e., I^+ and I^-, compute each competitive alternative's separation distance (SD) with the criteria index 'i' and the alternative index 'j'.

$$SD^+ = \sqrt{\sum_{j=1}^{n}(V_j^+ - V_{ij})^2} \text{ for } i = 1, \dots, m \tag{7}$$

$$SD^- = \sqrt{\sum_{j=1}^{n}(V_j^- - V_{ij})^2} \text{ for } i = 1, \dots, m \tag{8}$$

f) Step 6: Calculate the optimal solution for all the locations depending on their proximity.

The relative closeness (RC) of each possible position within the optimal solution is determined for each competitive alternative.

$$RC_i = {SD_i^-}\Big/{(SD_i^+ + SD_i^-)}, 0 \leq RC_i \leq 1 \tag{9}$$

g) Step 7: Prioritize the alternatives in order of preference.

The greater the value for relative proximity, the better the order of rating, and thus, dependent on the value of C_i, the greater the alternative output. In descending order, the rating of preference thus makes it possible to equate comparatively better results.

V. PERFORMANCE EVALUATION

A. Simulation Setup

To evaluate the simulation findings with other research work, the standard simulation environment for the NS2 simulator has been implemented using this mechanism. Table II presents the simulation parameters considered for the network.

B. Result and Analysis

By assuring effective handover, the proposed NMABHM addresses the issue of energy consumption in CA-MANETs. For this purpose, the execution process period and energy consumption are chosen as the parameters for performance evaluation. Energy consumption is calculated based on execution time, and a comparison is made between our Node Monitoring Agent-based Handover Mechanism-(NMABHM) and the existing Energy-Efficient Cloud-Assisted Routing Mechanism-(EECRM).

TABLE II. SIMULATION PARAMETERS:NS2 SIMULATOR

Parameter	Value
Area	1000*500
No of nodes	40
Queue Length	50
Protocol	NMABHM (modifying AODV)
Model	Energy Model
Initial Energy	100 J
Topology	Flat Grid
Simulation time	400 sec

The other parameters considered are:

1) Distance between node measurements in NS2: A Dynamic topology (coordinates x and y) is created. The distance between the nodes is calculated by applying the coordinates of the node (x, y) in the Pythagorean theorem.

2) Available energy in NS2: The level of energy in the network is described by utilizing the energy model. In this energy model, the initial value, called "initial energy," is the energy level that the node has at the starting point of simulation. At any given time, the variable "energy" indicates the amount of energy in a node. The original energy value is passed on as an input argument. For each packet transmission, a node loses a particular amount of energy. As a result, the value of a node's initial energy is reduced and is known as the "Residual Energy". This residual energy is evaluated at different times by accessing the built-in variable "energy" in the find Energy method.

By considering the above parameters, we simulated 40 nodes with a total simulation time of 400 sec with the EECRM and our proposed NMABHM. The results obtained for the metrics are as follows:

a) Average End-to-End delay: Fig. 5 depicts the average end-to-end delay in milliseconds (m/s) experienced while transmitting data from mobile nodes to the Main Peer within 400 units of time. For simulation times up to 200 seconds, the EECRM and the NMABHM both produce outputs that are delayed by a similar amount. The delay in EECRM begins to increase after 200 units of time, but our NMABHM achieves respectable results in terms of delay.
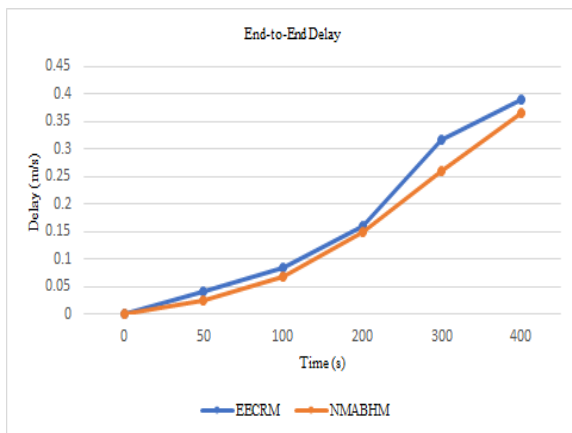

Fig. 5. Average End-to-End Delay in 400 Units of Time.

b) Throughput: It is defined as the number of successfully received packets in a unit time and is shown in Fig. 6. While the results of both approaches are identical at the beginning of the simulation, our proposed NMABHM strategy achieves a maximum throughput of 180 kbps (approximately) towards the end of the simulation.

c) Average Energy consumption in NMABHM: Fig. 7 depicts the average amount of energy spent by the MANET nodes during the communication process during a period of 400 units of time. This energy consumption is measured based

on the Optimal Route Selection using the TOPSIS Algorithm and the shortest Euclidean distance from the Super Peer to the Main Peer. During the simulation, it can be observed that the energy requirements of the existing EECRM approach is high than our suggested NMABHM approach. The energy consumption is reasonable in the midst of the execution, but at the end of the process, NMABHM has demonstrated reasonable energy usage.
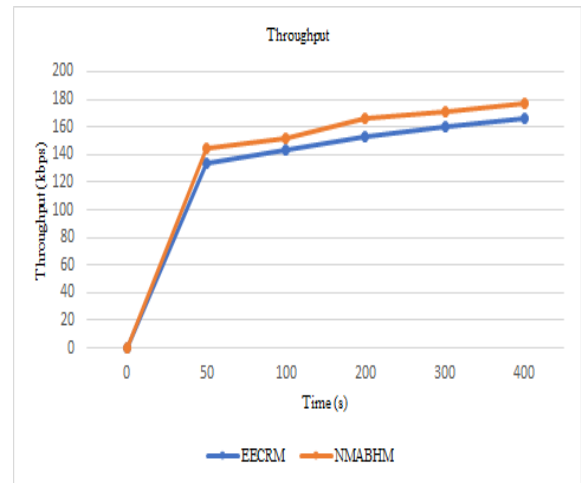

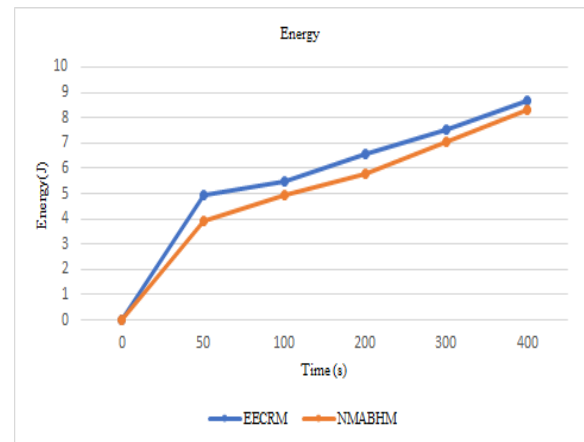Fig. 6. Throughput in 400 Units of Time.

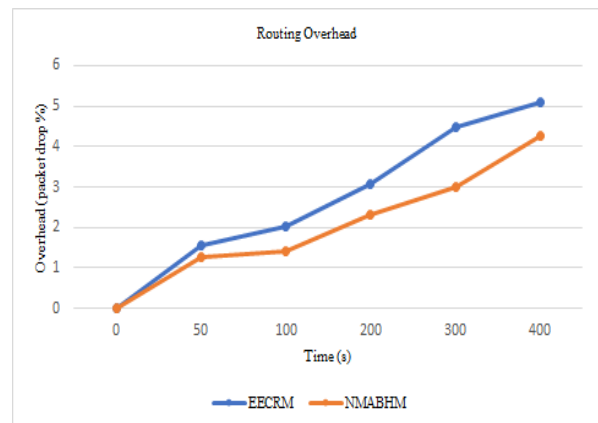Fig. 7. Average Energy Consumption in 400 Units of Time.

Fig. 8. Routing Overhead (RO) in 400 Units of Time.

d) Routing Overhead: The total number of routing packets needed for network communication is "Routing Overhead". Fig. 8 represents the routing overhead caused due to the route failure and route establishment of nodes in MANET. It is clear from the graph that there is a significant variation in the routing overhead results. The packet dropping rate is identical at the beginning of the simulation, but as the simulation progresses, the EECRM causes considerably more packet losses when compared to the NMABHM, resulting in a higher routing overhead when compared to our proposed work.

The experimental results show that the End-to-End delay in our proposed work has shown approximately 25% improvement than the compared EECRM. Also, there is 25-30% of energy gains, the Overhead is improved by approximately 10-15% and the throughput is achieved almost by 80-90%. The experimental results indicate that our suggested work can significantly minimize energy consumption in the event of a network link failure.

VI. CONCLUSION AND FUTURE WORK

In this work, we proposed a Node Monitoring Agent-based Handover Mechanism (NMABHM) in CA-MANET that helps in reducing the high energy consumption which occurs due to connectivity loss between the Super Peer and Indirect Peer. A Cluster-based CA-MANET architecture is suggested for effective use of bandwidth and energy in the network. We employ a Node Monitoring Agent (NMA) that acts as a Supervising node in the network to indicate the handover issue which can be effectively solved by adapting a multi-attribute decision-making technique called TOPSIS for Optimal route selection in MANET. The Simulation is done using an NS-2 simulator and the experimental results prove that the NMABHM mechanism helps in handling the Handover situation and lowering the energy consumption in the CA-MANET efficiently when compared to the existing EECRM mechanism. Simulations of our proposed work have been done with fewer nodes and with the assumption that cluster heads are static. By considering the cluster head's dynamic nature and scaling the simulation to include a larger number of nodes, we may expect our suggested technique to find many more practical applications in future work.

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