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RESEARCH ARTICLE

Secure Multi-Path Routing Using Splitting and Merging Based Clustering for Reducing Power Usage in MANET

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Abstract – On the Mobile Ad hoc Network (MANET), mobile devices often powered by batteries. These devices communicate with each other and broadcast information from a sender device to a receiver device. Suppose there are two devices between long distances due to the signal transmission limit. In such a case, they cannot directly communicate because they have to use more communication power. Routing technique needed to deal with this problem. Nowadays, a lot of routing techniques used in MANET. These have some significant drawbacks, such as a higher end-to-end delay and higher routing cost with higher power expenditure. To overcome this issue, Secure Multipath Routing (SMR) based on splitting and Merging-based Clustering (SMC) algorithm proposed for Secure Packets Transfer and Reduces Power Usage in MANET. This algorithm applies the splitting and merging network-based clustering and detects cluster-based minimum power usage routes for each mobile device. Experimental outcomes demonstrate that the SMR based on the SMC algorithm takes the smallest routing cost compared with existing algorithms and takes less end-to-end delay. Furthermore, it presents multipath routing to increase MANET security and reduces power usage efficiently.

Index Terms – Packet Transmission, Signal Transmission Range Limitation, Routing, Clustering and Energy Consumption.

1. INTRODUCTION

MANET indicates Mobile Ad Hoc Network, alias Wireless Ad-Hoc Network, which generally contain the routable networked-environment above the link-layer ad-hoc network [1]. They are a group of mobile devices linked wirelessly to a self-configured, self-healing network in the absence of immutable infrastructure. MANET devices are free to move approximately when network topology alters regularly. Each device acts as a router when sending traffic to a specific tool in the network. MANETs can function as a whole, or they can be part of a more extensive web. They create a more energy independent topography because there are various transceivers between the devices [2]. It could prevent road users from being killed or seriously injured, Environmental sensors, housing, health, disaster relief operation, aircraft/land / naval security, weapon, Robotics, and so on.

The portability of mobile nodes MANET topography generally changes as they move in, out, or exit the network. MANET is strong enough to create a self-maintenance system and self-regulation in the absence of the assist of centralised infrastructure, which is frequently inaccessible in necessary mission applications such as military conflict or crisis recovery [3]. MANET typically consists of battery-powered mobile devices that contact each other to send messages from the sender device to a recipient device. Suppose there are two nodes between long distances due to signal transmission range limitation. In that case, they cannot communicate directly because they both use a lot of energy to communicate [4]. So Clustering & Routing is required.

Clustering separates the whole network into smaller synchronous subgroups named clusters [5]. As a result, clustering creates an extensive system that will emerge lesser also with low energetic. In a typical cluster, various mobile devices assign different functions; for example, cluster head, cluster gateway, and cluster member [6]. The cluster head plays like the local coordinator for all clusters also make transfers inside its Cluster. A cluster member is a non-cluster-head device that makes cluster transmissions. A cluster gateway is a non-cluster head device that plays like the link between the clusters. The path selection process is named routing in networks.

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In MANET, each device determines the shortest way to send messages between the other devices. There exist two kinds of protocols for routing. These are reactive routing protocol also proactive routing protocol [7], [8]. First, the Proactive routing protocol includes the Destination-Sequenced Distance-Vector routing (DSDV), the Optimized Link State Routing protocol (OLSR), with Wireless Routing Protocol (WRP) [9], [10]. Also, Reactive routing protocol instances are Ad-hoc on-demand Distance Vector (AODV) routing, Dynamic Source Routing (DSR) and Temporarily Ordered Routing Protocol (TORA) [11].

1.1. Problem Statement

The existing clustering and cluster head chosen techniques available on the MANET include location-based, motion-based, neighbourhood, power, and weight-based clustering. These techniques have overhead due to high cluster numbers, limited device coverage and device energy waste. Furthermore, the previous routing protocols did not take into account the power of the nodes. Because MANET devices do not want to care about other devices since they operate using their battery energy [12]. Therefore, all devices do not want to consume more power than the other nodes. In these situations, previous protocols fail.

1.2. Research Objective

This work proposed a Secure Multipath Routing (SMR) based on Splitting and Merging-based Clustering (SMC) algorithm to deal with this problem. This algorithm first cluster network using the Splitting and Merging technique. Followed by this algorithm, discover multiple routes using clusters. The proposed algorithm is effective and efficient to increase the MANET lifetime.

This paper's remaining structure structured as follow: Section 2 explain the related work about MANET clustering and routing. Section 3 describes the Secure Multipath Routing based on splitting and Merging-based Clustering algorithm and assessing the experimental outcome provided in section 4. At last, Section 5 provides the conclusion.

2. RELATED WORK

Alameri et al. explored the effectiveness of numerous mobile ad hoc network routing protocols. The authors utilized DSDV and AODV as their bases because these are the two very usual used protocols in proactive and reactive routing, respectively. The authors distinguished these to AntHocNet's effectiveness of ant colony optimization execution. This protocol acts as a hybrid protocol, which uses reactive and proactive components. The authors presented their discoveries by implementing simulations in numerous visions based on the NS2 network simulator. Guleria et al. initiated clustered based routing algorithms using ant colony optimization. In this algorithm, the nodes are clustered based on the ant code enhancement based algorithm, while routing done utilising the nodes' worth. From the value, attacks are decided based on the confidence table. The authors could compute MANET nodes from the confidence table. Rana et al. implemented a well-organized routing plan that merged the altered manner of LEACH with AOMDV. LEACH is utilized for cluster formation and provides data regarding the nodes' power; if the specific node's power is more significant than LEACH, that node is chosen for data transfer. AOMDV utilized for multiple path routing. Therefore, the authors proposed reliable communications accompanied by less overhead and less power on the MANET.

Mohammad et al. [13] provided a useful cluster method based on probability for discovering intrusion systems that must be energetic on a devoted mobile network. A recommended probability method of cooperation based on Cluster among intrusion discovery at region devices minimizes personal overlays to keep victorious communications. IDS usually explore each node to supervise the network's performance, which keeps battery node overheads concerning energy and system resources. Thus, the authors aim is to control the top control pocket of the IDS in the absence of compromising on its performance. The author's interaction method among an intrusion discovery game is also a cluster in the multi-player game to verify the presented model. Players contain somewhat collaborative with somewhat contradictory objectives and utilize blocks of K-mean. Clustering methods connected with a proper routing algorithm can significantly advance the packet delivery ratio in CEAACK MANETs. [14].

Ambidi et al. [15] carry out a platform to assist the fundamental functions of OR and decision-making in finding the MANET's optimum way. The authors then presented a flexible approach to manipulating the OR like the Markov decision problem (MDP). Eventually, relevant research of the Markov chain-based protocol recommended based on the average delay and overhead control.

PEGADyn proposed by Raghavan et al. [16] - the mixture version of PEGASIS in the novel power-proficient routing protocol for MANET. PEGADyn generates a virtual phase classification of devices using the nodes' present position, then developing a cluster of devices at every virtual phase.

Rajesh et al. [17] proposed a new cluster-based data sharing program that seeks to take advantage of both clustering and proactive routing. The authors clustering algorithm splits the MANET into cluster members, cluster gateways, and cluster heads. Authors control the DSTV routing protocol inside the Cluster, thus decreasing routing table size and control overhead.

Ghaleb et al. [18] presented an effective multipath AODV routing algorithm that decides whether a device is broadcast

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on a network or is silent in the path detection procedure. The routing algorithm suggested by the authors manages obstruction and improves execution on the system because not all network devices contain to cooperate in path finding for a specific source-target pair.

Saha et al. [19] proposed a routing protocol named Acceptance-Based Clustering Routing Protocol (ABCP) to MANETs, ensuring secure routing over the MANET by selecting the acceptable cluster head score, one device then contacts merely with that secure node. This choice of protected management nodes minimizes different dangers.

The network devices in MANET have a similar communication range [20]. The adjacent nodes must coordinate with each other to bring out prosperous information communication. In this approach, the trusted nodes identified using the filtering technique for efficient data transmission [21]. Wireless networks need many security measures, and the cryptographic algorithm is necessary to attain this. The cryptographic algorithm may be asymmetric or symmetric using the employed vital choice plan.

Ahmad et al. [22] presented an extensive review of the latest CAs on MANETs. The authors further provide the aims and participations of the newest analysis. Likewise, innovations, challenges and future directions mentioned. The verification movement model of each work is seriously examined based on the simulation tool utilized at the simulation, the simulation measurements with the effectiveness measurements utilized at the verification procedure.

Aftab et al. [23] presented the self-regulation clustering program on MANET using the zone-based set ability to move freely, enhancing scalability also solidity of the whole MANET. This presented method uses Bio-inspired Behavior research to accumulate birds to create and maintain clusters on MANETs. An energetic approach to the cluster organization's size decreases MANET obstruction and enhances group mobility. An algorithm recommended managing isolated nodes to utilize resources properly and reduce additional power usage.

Sivanantham et al. [24] proposed a connection lifespan forecast approach that would detect the node's lifespan so that the minimum route could continue by the source node and the maximum lifespan node. Implementing this approach would decrease data loss and even out the effectiveness of the transfer. Furthermore, Suman et al. [25] proposed EPARGA, a Resourceful Power-Aware Routing Protocol for MANETs.

Tripathi et al. [26] studied the effect of an attack, namely wormhole, on usual reactive type routing algorithms of MANET, in particular, DSR and AODV. Outcomes obtained from the simulation will disclose that this attack has very much infected the DSR. Therefore, as a resolution, the routing algorithm for DSR using reliability presented to avert the retention of malicious nodes.

By separating the network into clusters, Ahmad et al. [27] concentrated on enhancing the ZRP protocol's execution and attaining power improvement on the MANET by choosing heads inside groups using the Neoteric RA them as a random cluster head chosen based routing method. Path integration is recognized to play an essential role in controlling the routing scaling issue in internet routing. As the number of devices linked to the Internet increased, so did require increasing the routing table's size to hold the raised number of devices. The router utilized as a mechanism to bypass this route. It functions by avoiding a set of ways and changing the particular mode of advertising. The RA method verifies to be extremely productive in enhancing numerous QOS parameters, mainly reducing the average power used.

Usha et al. [28] provide a short notion regarding MANET accompanied by a survey of its challenges, usage and routing protocols. The authors further offered the idea of upgrading OLSR accompanied by a clustering method to decrease network overheads and raise the packet distribution rate useful in the Vehicular ad hoc Network (VANET).

Yadav et al. [29] put forward a fundamental survey of the numerous types of attacks and protocols used to thwart those attacks. The authors also explain the small relationship between various protocols accessed by routing disembarked in MANET and MANET's fundamental features and challenges.

Hamzaoui et al. [30] proposed an analysis of feasible ways to use clustering techniques to resolve issues in MANET's routing networks [31]. A comprehensive study of MANET networks' problems executed, accompanied by the feasibility of determining them based on clustering using neural networks. Particular executions of cluster algorithms for routing application presented using a multidimensional choice of network parameters. It is feasible to utilize these techniques in traditional routing protocols. Table 1 shows a comparison of the literature review.

Author	Description	Clustering
Mohammad et al. [13]	Chaotic maps and Cluster-based mutual authenticated key contract for mobile ad hoc networks	✓
Mohanakrishnan et al. [14]	Peer to peer protocol based on a trusted waterfall framework for energy-efficient and reliable data transmission in MANETs	✓

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Ambidi et al. [15]	Anonymous Secured Communication and Adaptive Risk Prediction in MANET for Medical Informatics	X
Raghavan et al. [16]	PEGADyn: Power proficient Routing Protocol based on clustering for Ad Hoc Networks	✓
Rajesh et al. [17]	A new power proficient cluster based routing protocol for highly dense MANET architecture	✓
Ghaleb et al. [18]	Energy-Efficient Multipath Routing Using Multi-Objective Grey Wolf Optimizer based Dynamic Source Routing Algorithm for MANET	X
Saha et al. [19]	Clustering Routing Based on Acceptability Protocol in MANET	✓

Table 1 Literature Review Comparison

3. SECURE MULTIPATH ROUTING (SMR) BASED ON SPLITTING AND MERGING BASED CLUSTERING (SMC)

MANET nodes cannot directly contact each other if two nodes located over long distances use too much power to try to communicate due to signal transmission range limitation. A Secure Multipath Routing (SMR) based on Splitting and Merging Clustering (SMC) algorithm proposed to tackle this problem. Figure 1 demonstrates a flow diagram of SMR based on the SMC algorithm.

3.1. Importance of Splitting and Merging the Cluster

Suppose there are two nodes between long distances due to signal transmission range limitation in MANET. In that case, they cannot communicate directly because they both use a lot of energy to communicate. So clustering is needed. Clustering separates the whole network into smaller synchronous subgroups named clusters. As a result, clustering creates an extensive system with low energetic.

SMC algorithm builds a hierarchy of clusters through either frequently splitting a bigger cluster into lesser ones or combining two lesser clusters into a bigger one. Master plans for the SMC algorithm typically fall into two approaches:

(i) The merging approach constructs a bigger cluster by combining two lesser clusters in a bottom-up manner.

(ii) The splitting approach separates a bigger cluster into two lesser ones in a top-down way.

To choose which clusters must be merged (for merging) or where a cluster must be separate (for splitting), a measure of dissimilarity among sets of mobile nodes is necessary. This was attained at the SMC algorithm by utilizing a suitable metric (a measurement of distance among groups of mobile nodes pairs).

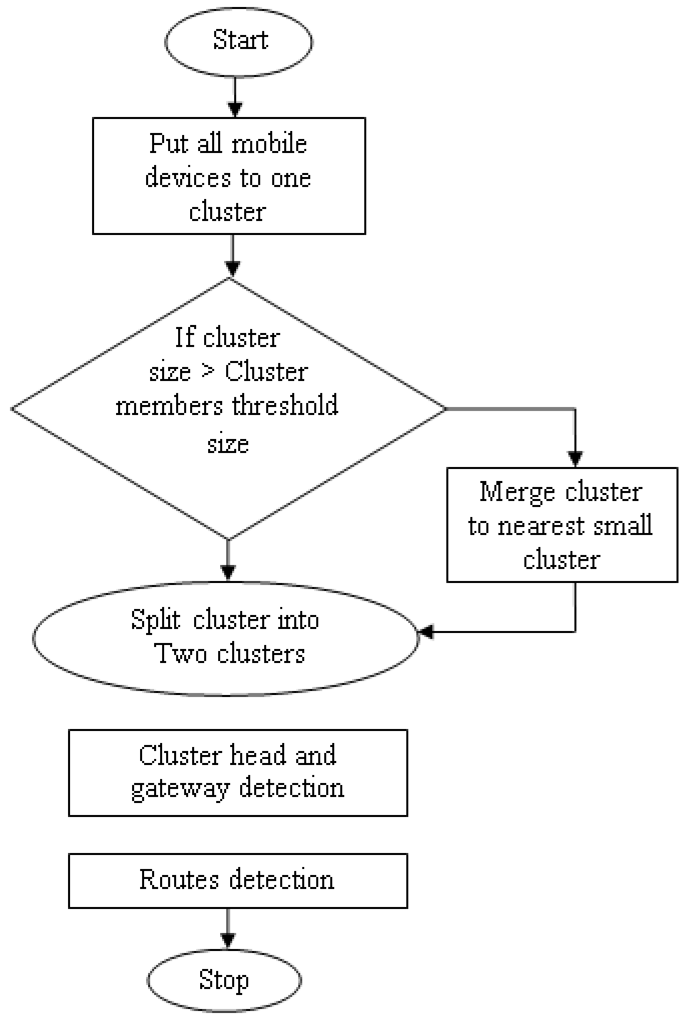

Figure 1 Flow Diagram of SMR Based on the SMC Algorithm

Algorithm 1 describes the proposed SMR based on the SMC algorithm. Before executing this algorithm, the MANET network created based on the location list of the MANET nodes. Initially, allocate every MANET devices to a single set to shape one Cluster (Step 2). Find the most significant Cluster of CLU (Step 3), and the technique discovers which Cluster includes an utmost amount of devices. When the dimension of a giant cluster is below or equivalent to threshold T (Step 4), after that iteration would end. The

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MANET Network Clustering algorithm contains two sub algorithms called SplitCluster (splitting Cluster into sub-clusters (Algorithm 2)) and MergeCluster (combining two sub-clusters into a single cluster (Algorithm 3)).

Input: Location list of the MANET nodes, Cluster Members Threshold (T), Source Node (S), Destination Node (D)

Output: Clusters (CLU), Multiple Routes (MR)

Splitting and Merging based Clustering (SMC) algorithm

Step 1 : CLU[] = {}

Step 2: Put all Mobile devices to CLU[0]

Step 3: HC = Discover Huge Cluster of CLU

Step 4 : While (HC.size() > T)

Step 5 : SplitCluster(CLU,T) // Algorithm 2

Step 6 : MergeCluster(CLU,T) // Algorithm 3

Step 7: HC = Discover Huge Cluster of CLU

Step 8: End

Secure Multipath Routing (SMR) algorithm

Step 9 : GNCLIds = Extract_All_Gateway_Nodes(CLU)

// Gateway Nodes with Cluster Ids // Algorithm 4

Step 10 : Routes = Routes_Discovery (CLU, S, D, GNCLIds) // Algorithm 5

Algorithm 1 Secure Multipath Routing (SMR) Based on Splitting and Merging based Clustering (SMC) Algorithm

3.2. Cluster Splitting

In the SMC algorithm, the splitting approach separates a bigger cluster into two lesser ones in a top-down manner.

Algorithm 2 demonstrates a SplitCluster Algorithm. In Step 1, a vast cluster (HC) identified. The identified HC more separated into several sub-clusters. This procedure maintains up to the dimension of HC is below or equivalent to the threshold T (Step 2-8). In Step 3, a value of signal broadcast range computed based on a randomly chosen quantity of mobile devices in HC; discover the nearby neighbours of every mobile device based on Euclidean Distance if a calculated broadcast range STR value is 0, after that, the transmission range would update. In Step 4, an HC divided into several sub-clusters (SC) using an STR. A primary mobile device at HC utilized to generate 1st Cluster. Subsequently, nearby neighbours' discover based on Euclidean Distance. When a distance was below or equivalent to STR, next to a current mobile device is attached to the present Cluster; or else, the latest Cluster would form. This procedure would stop while every mobile device in a MANET covered. An HC removed from the CLU (Step 5), and SC will add to CLU (Step 6).

Input: Clusters (CLU), Cluster Members Threshold (T)

Output: Updated Clusters (CLU)

Step 1: HC = Get Huge Cluster from CLU

Step 2 : While (HC.size() > T)

Step 3: STR = Calculate signal transmission range using nearest neighbours of each node based on Euclidean Distance

Step 4: SC = Divide HC into numerous sub-clusters using STR

Step 5: Eliminate HC from CLU

Step 6: Add SC to CLU

Step 7: HC = Get Huge Cluster from CLU

Step 8: End While

Algorithm 2: SplitCluster (CLU,T)

3.3. Clusters Merging

In the SMC algorithm, the merging approach constructs a more significant cluster by combining two lesser sets in a bottom-up manner. Algorithm 3 demonstrates a MergeCluster Algorithm utilized to connect two groups within one Cluster. A Cluster Cp is combined with Cq when a subsequent equation (1) is correct.

$$(EuqDist + CpSTR) <= CqSTR \qquad (1)$$

Where EuqDist is a Euclidean Distance among Cluster Cp with Cluster Cq. CpSTR also CqSTR are a signal broadcast range of Cluster Cp Cluster Cq respectively.

Input: Clusters (CLU), Cluster Members Threshold (T)

Output: Updated Clusters (CLU)

Step 1 : For each Cluster Cp from CLU

Step 2 : CpSTR = Calculate signal transmission range of Cp

Step 3 : For each Cluster Cq from CLU

Step 4 : CqSTR = Calculate signal transmission range of Cq

Step 5 : EuqDist = Calculate Euclidean distance of Cp, Cq

Step 6 : If((EuqDist+CpSTR) <= CqSTR)

Step 7: Merge Cp with Cq

Step 8 : End If

Step 9 : End For

Step 10 : End For

Algorithm 3 MergeCluster (CLU,T)

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3.4. Cluster Head Selection and Gateway Nodes Detection

A cluster head is a device that collects information from the source cluster member mobile device and passes this information to another destination cluster member mobile device through the gateway. A node has more power and more neighbour nodes in each Cluster that node will select as the cluster head (CH). Furthermore, the device which contributes in many clusters, that specific node is named Gateway nodes in MANET. It described in Algorithm 4. Initially, it puts GN with CLID record to clear (Step 1). After that, it gets all nodes within the Cluster (Step 2) also verifies which a specific device is obtainable in one more Cluster (Step 3 & 4). When a device is available in one more Cluster, it attaches that particular device as GN (Step 5) and connects its cluster identity to CLID (Step 6).

Input : Clusters (CLU)

Output : Gateway Nodes with Cluster Ids

Step 1 : GN = {}, CLId = {}

Step 2 : For each Node Ni in Cluster Ci do

Step 3 : For each Node Nj in Cluster Cj do

Step 4 : If(Ni == Nj)

Step 5 : GN[i] = Ni

Step 6 : CLId[i] = Ci,Cj

Step 7 : Break;

Step 8 : End If

Step 9 : End For

Step 10 : End For

Algorithm 4 Extract_All_Gateway_Nodes

3.5. Routes Discovery

In MANETs, during the broadcast of data, there is a possibility of a lot of energy consumption, so that the optimal route discovery should be made. Reactive routing protocol decides a path to an exact destination when an exacting packet is going to transmit. Here this section proposes a route discovery approach, which is utilized to discover optimal ways to the destination with lower overhead.

Source device needs total presented paths to communicate destination device—routes discovery described in Algorithm 5. Initially, the Source device creates Route Request (RREQ) with its identity with destination identity (Step 1). Afterwards, the source transmits RREQ to its CH (Step 2). Next, CH verifies destination device is existing or not in its Cluster (Step 3). When the destination is inaccessible in its Cluster, CH adds its Identity to RREQ (Step 4). Next, CH gets every GN ids (Step 5) also forwards RREQ to these every GN (Step 6). Next, GN attaches its identity to RREQ (Step 7) also broadcasts RREQ to one more CH (Step 8). After that, rerun Step 3 to Step 10 up to CH verifies D is obtainable inside its Cluster. When the destination is available inside its Cluster, CH gathers every Identity from RREQ also creates Route Reply (RREP) accompanied by its identity (Step 11). (Source-Intermediate Nodes-Destination) also, CH transmits RREP to the Source device (Step 12). After that, the Source device gathers every path from received RREP's (Step 13).

Input : Clusters (CLU), Source Node (S), Destination Node (D), Gateway Nodes with Cluster Ids

Output : All Available Routes between S to D

Step 1 : S creates RREQ, and its identity and destination identity added

Step 2 : S transmits RREQ to CH // CH - Own Cluster Head

Step 3 : WHILE(CH checks D is unobtainable in possess Cluster)

Step 4 : CH add its Identity to RREQ

Step 5 : For each GN in Cluster, Head CH do

Step 6 : CH Forwards RREQ to GN

Step 7 : GN Attach its Identity to RREQ

Step 8 : GN transmits RREQ to one more CH

Step 9 : End For

Step 10 : End WHILE

Step 11 : CH Collects all identities from RREQ, also generates RREP and its identity added

Step 12 : CH sends RREP to S

Step 13 : S gathers paths from RREP.

Algorithm 5 Routes_Discovery

4. EXPERIMENTAL RESULTS

This section provides the results got by simulating various situations below various MANET size and different packet sizes. Location-aware MANET networks utilized for simulation analysis. Java is used for simulation to assess SMR based on the SMC algorithm. To determine the routing algorithm, compare the SMR based on the SMC algorithm with other popular routing algorithms, such as the AODV and DSR algorithm, concerning power consumption, throughput, and one-way delay (OWD) and speed. This model presumes 100 mobile devices regularly distributed with location awareness in the 900m × 600m unit region. The radio transmission range for all devices is 100 m; the nodes' early power is 100 J. The power threshold for transmitting and

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receiving a packet is 0.6 J with 0.4 J, correspondingly. Table 2 shows the simulation parameters.

Area	900 m x 600 m
No. of Nodes	100
Packet Size	512 bytes
Nodes Initial Energy	100 J
Nodes Initial Cost	100 Rs
Receiving Power (Er)	0.4 J
Transmission Power (Et)	0.6 J
Signal Transmission Range	100 m
Algorithm	SMR based on SMC

Table 2 Simulation Parameters

Numerous runs accompanied by various node sizes for every situation, also information gathered on those run for contrast. MANET network showed in Figure 2.

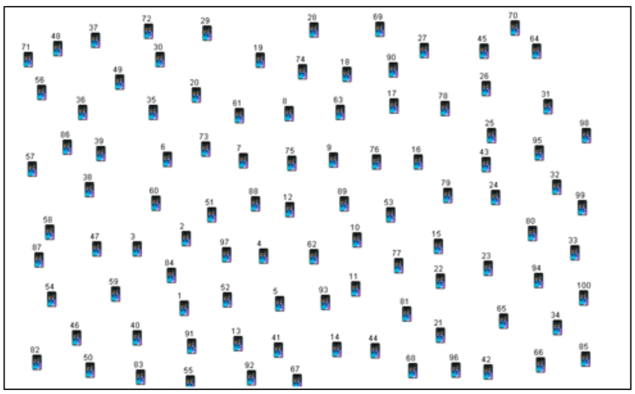

Figure 2 MANET Nodes Deployment

Splitting and Merging based MANET clustering showed in Figure 3. It offers all mobile devices are grouped into one or more clusters. Each Cluster has a unique cluster identity.

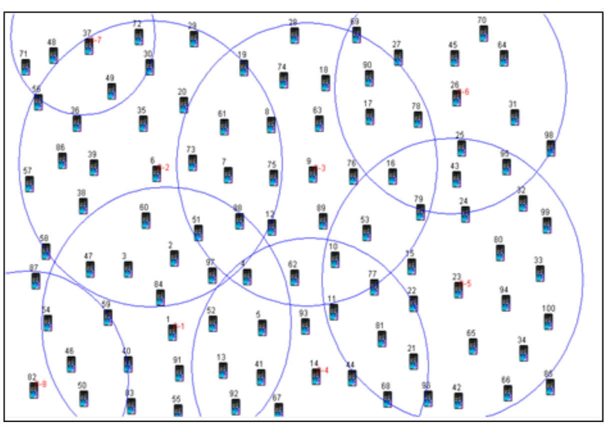

Figure 3 MANET Clustering

After clustering, Cluster Head Selection showed in Figure 4. A node has more power and more neighbour devices at every Cluster that device will select as a cluster head.

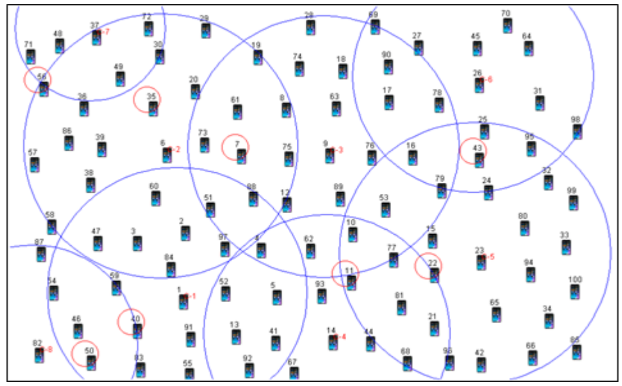

Figure 4 Cluster Head Selection

After Cluster Head selection, gateway nodes discovery showed in Figure 5. The node which contributes in many clusters, that specific node is acting as Gateway nodes.

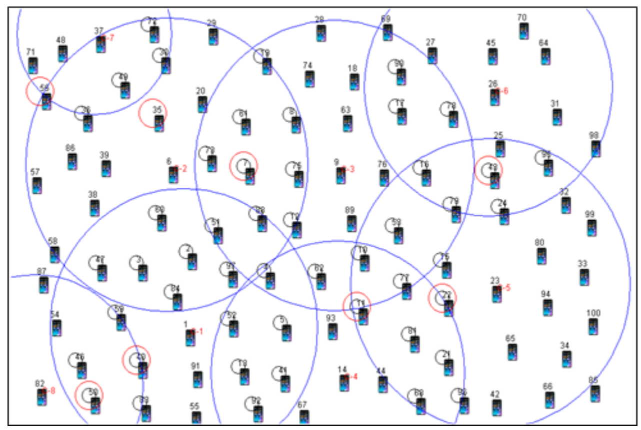

Figure 5 Gateway Selection

After gateway selection, multipath routes between source node - 57 to destination node - 100 showed in Figure 6. For multipath route discovery cluster heads and gateways are used.

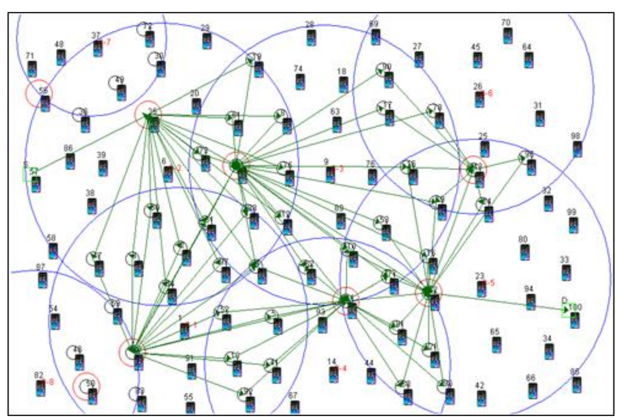

Figure 6 Multipath Routes between Source Node - 57 to Destination Node – 100

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Table 3 demonstrated Various Routing Protocols comparison using No of Nodes vs Energy Consumption outcomes to analyze the performance of proposed SMR based on the SMC algorithm.

No of Nodes	Energy Consumption (J)				
	SHM	MEA-DSR	EEPMM	PBGTR	SMR based on SMC
20	70	65	40	13	10
40	80	70	45	9.8	7

Table 3 No of Nodes VS Energy Consumption

Figure 7 also demonstrated Various Routing Protocols comparison using No of Nodes vs Energy Consumption outcomes to analyze the performance of proposed SMR based on the SMC algorithm.

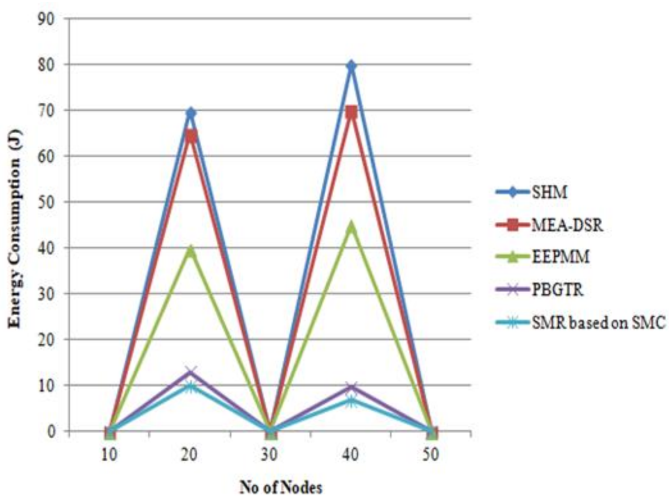

Figure 7 Number of MANET Devices Vs Energy Consumption

While using 20 mobile devices, the SMR based on the SMC algorithm consumes 10 J, and while using 40 mobile devices, the SMR based on the SMC algorithm consumes 7 J. In MEA-DSR and SHM, similar devices utilised for broadcasts; therefore, a few chosen devices obtain overuse quickly and reduce MANET lifetime. Compared with MEA-DSR and SHM, EEPMM uses less power. Then compare with EEPMM, the PBGTR algorithm uses significantly fewer powers. Compared with EEPMM, MEA-DSR, SHM, PBGTR [32] proposed SMR based on the SMC algorithm, consumes considerably less power for transmission. These existing works transmit extensive data through a single path, and all participated devices consume a lot of energy. But, the proposed SMR based on the SMC algorithm is simultaneously using multiple ways through a network. So it consumes less power compared with others. Table 4 demonstrated Various Routing Protocols comparison using No of devices versus Routing Cost outcomes.

No of nodes	Routing Cost (in Rs)			
	DSR	VCG	PBGTR	SMR based on SMC
20	1	0.8	0.65	0.49
40	2.2	1	0.49	0.28

Table 4 No of Nodes Vs Routing Cost

Figure 8 demonstrated Various Routing Protocols comparison using No of devices versus Routing Cost outcomes.

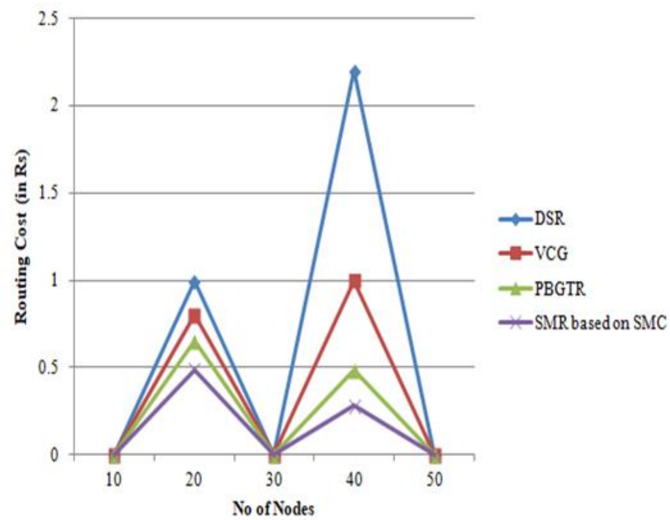

Figure 8 Number of MANET Devices Vs Routing Cost

While using 20 mobile devices, the SMR based on SMC algorithms routing cost was ₹ 0.49 and while using 40 mobile devices, its routing cost was ₹ 0.28. Compared with VCG and DSR, PBGTR algorithm takes the smallest amount of Routing price. But Compared with DSR, VCG, and PBGTR [32] proposed SMR based on the SMC algorithm takes the minimum amount of Routing price. Because these existing works consume a lot of energy compared with SMR based on the SMC algorithm. High consumption leads to high routing cost. So these works are consumed high routing cost than SMR based on the SMC algorithm.

Speed (in m/sec)	End-To-End Delay (in Sec)			
	PEER	LSEAMR	PBGTR	SMR based on SMC
12	9	8	4	3
22	11	9	3	2

Table 5 Speed Vs Delay

Various Routing Protocols comparison using Delay Vs Speed outcomes are demonstrated in Table 5. MANET speed

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measures the transfer rate of information from a sender device to the receiver device. The end-to-end delay means packet transmission time between the sender to the receiver device. Different Routing Protocols comparison using Delay Vs Speed, outcomes are demonstrated in Figure 9.

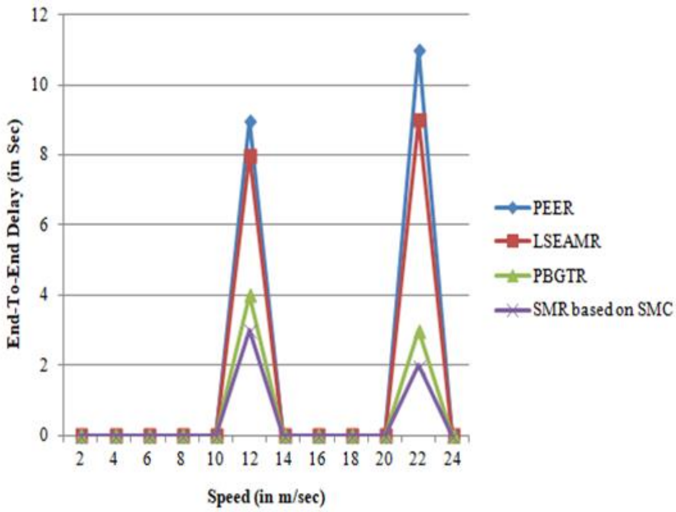

Figure 9 Speed Vs Delay

While using SMR based on the SMC algorithm, if a packet broadcasts 12 m/sec speed, it takes 3 sec for End-to-End delay. Furthermore, if a packet broadcasts at the speed of 22 m/sec, it takes 2 sec for the End-to-End delay. Compared with LSEAMR and PEER, the PBGTR algorithm gets significantly less one-way delay (OWD). But Compared with PEER, LSEAMR and PBGTR [32], the proposed SMR based on the SMC algorithm provides significantly fewer End-to-End Delay. The proposed SMR, based on the SMC algorithm, is simultaneously using multiple paths through a network. So it transmits each packet quickly. Furthermore, Cluster creation time showed in Table 6. Cluster creation time is shown in Figure 10.

Nodes count	2Cls	4Cls	6Cls	8Cls	10Cls
25	638	641	644	646	-
50	639	643	645	647	651
75	641	642	643	648	652
100	634	638	637	644	645

Table 6 Cluster Creation Time

Figure 10 shows how the proposed SMR based on the SMC algorithm takes how many milliseconds create clusters at several nodes. The proposed SMR based on the SMC algorithm takes 638 milliseconds to create 2 clusters at 25 nodes. Furthermore, Table 7 shows the cluster head election time. Figure 11 shows the cluster head election time.

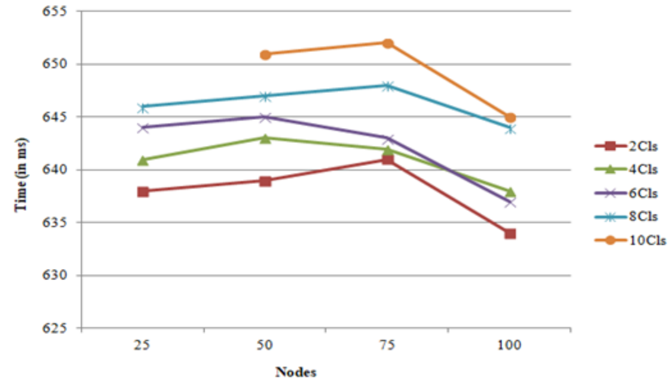

Figure 10 Cluster Creation Time

Nodes count	2Cls	4Cls	6Cls	8Cls	10Cls
25	3000	2000	1450	1300	-
50	3300	2700	1400	1100	1000
75	3100	2000	1300	1050	1000
100	3100	2000	1400	1000	900

Table 7 Cluster Head Election Time

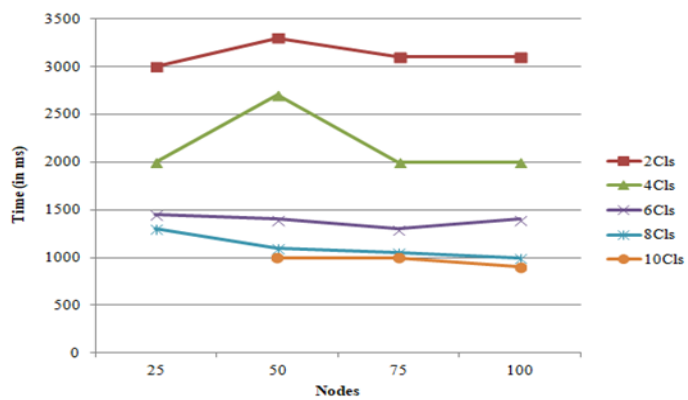

Figure 11 Cluster Head Election Time

Figure 11 shows the proposed SMR based on the SMC algorithm takes how many milliseconds select some cluster heads at some nodes. The proposed SMR based on the SMC algorithm takes 3000 milliseconds to choose 2 cluster Head at 25 nodes. Furthermore, packet delivery ratio with throughput is used to analyses proposed SMR based on the SMC algorithm. Table 8 shows Packet Delivery Ratio Vs No of nodes comparison. To show the effectiveness of proposed SMR based on SMC algorithm, five traditional routing protocol values are taken from [33]. Figure 12 shows Packet Delivery Ratio Vs No of nodes comparison.

From the above-given results in Figure 12, we can say that DSDV returns a poor outcome as we increase the number of nodes. AODV and DSR protocols produce the best work and achieve a packet delivery ratio in the range of 95% to 99%.

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But as we start increasing the number of nodes, results fall below 95%. The AOMDV results are better than DSDV but fall as compared with AODV. But compared with all proposed SMR based on the SMC algorithm gives a good outcome and brings a 99% ratio in packet delivery.

No of Nodes	Packet Delivery Ratio					
	DSDV	DSR	AODV	AOMDV	OLSR	SMR based on SMC
50	89	99	99	98	93	99
80	86	98	98	97	97	99
100	85	99	99	97	96	99

Table 8 Packet Delivery Ratio Vs No of Nodes

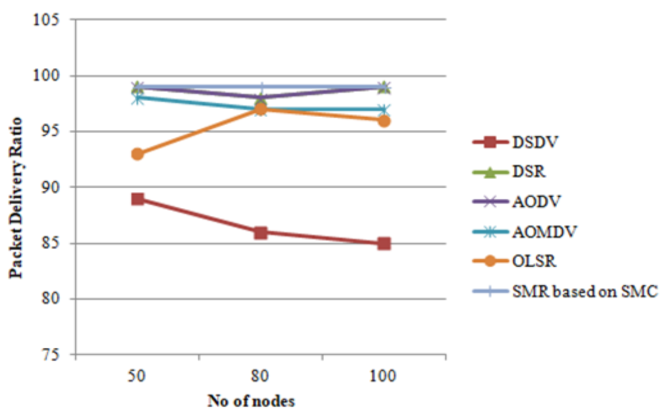

Figure 12 Packet Delivery Ratio Vs No of Nodes

Table 9 shows Throughput Vs No of nodes comparison. To display the effectiveness of the proposed SMR based on the SMC algorithm, five traditional routing protocol values are taken from [33]. Figure 13 shows Throughput Vs No of nodes comparison.

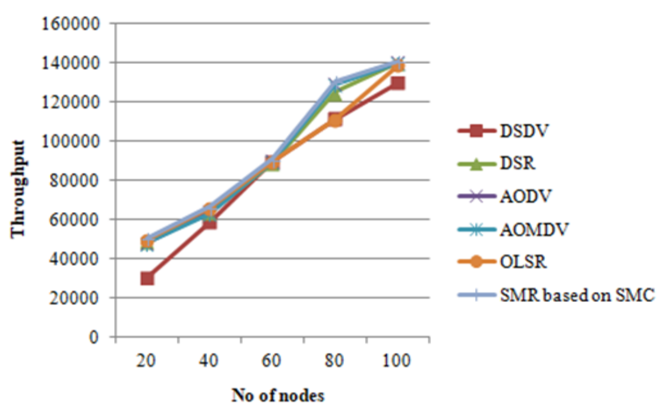

Figure 13 Throughput Vs No of Nodes Comparison

No of Nodes	Throughput					
	DSDV	DSR	AODV	AOMDV	OLSR	SMR based on SMC
20	30500	49000	48500	48000	50000	50500
40	59000	64000	64500	63000	66000	66500
60	90000	89000	90500	90000	90000	91000
80	111500	125000	130000	129000	111000	130500
100	130000	140000	140500	140000	139000	141000

Table 9 Throughput Vs No of Nodes

Figure 13 illustrates the performance of a proposed SMR based on the SMC algorithm in cycles of Throughput by modifying the number of nodes. Packet drops typically arise because of a network bottleneck or for loss of plan. Compared with all other routing algorithms, the proposed SMR based on the SMC algorithm returns the best result and achieves better throughput.

5. CONCLUSION

In MANET, two devices situated between long distances due to signal transmission limitations cannot communicate directly because they both use a lot of energy to try to communicate. Secure Multipath Routing (SMR) based on splitting and Merging-based Clustering (SMC) algorithm proposed for Secure Packets Transfer and Reduces Power Usage in MANET to overcome this issue. Compared with existing algorithms, the experimental result showed that the proposed SMR based on the SMC algorithm provides significantly fewer power expenditure and the smallest routing price and less end-to-end delay. A lot of packets received for transmission at the same time, and an intermediate node suffers overloaded. Therefore, a new routing protocol is needed to deal with this problem in the future.

REFERENCES

[1] Alameri IA., Aug. 2019. "A Novel approach to comparative analysis of legacy and nature inspired ant colony optimisation based routing protocol in MANET", Journal of Southwest Jiaotong University, 54(4): 1-10.

[2] Sharma, A.K., D. C. Noida, A. Mishra, Mar. 2019. "A Study of Energy Optimization for MANET", IEEE 6th International Conference on Computing for Sustainable Global Development, 1: 264-267.

[3] Usha, R., B. S. Premananda, K. V. Reddy, Jun. 2017. "Performance analysis of MANET routing protocols for military applications", IEEE International Conference on Intelligent Computing and Control Systems, 1: 1063-1068.

[4] Guleria, Kalpana, Verma AK., Sep. 2018. "An energy efficient load balanced cluster-based routing using ant colony optimisation for WSN", International Journal of Pervasive Computing and Communications, 14(3/4): 233-246.

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[5] Ozera K, Sakamoto S, Elmazi D, Bylykbashi K, Ikeda M, Barolli L., 2017. "A fuzzy approach for clustering in MANETs: performance evaluation for different parameters", International Journal of Space-Based and Situated Computing, 7(3): 166-176.
[6] Rana, B., D. Rana, Aug. 2017. "Energy-efficient load balancing with clustering approach in MANET", IEEE International Conference on Energy, Communication, Data Analytics and Soft Computing, 1: 2019-2020.
[7] Chaudhari SS, Biradar RC., 2018. "Resource prediction-based routing using agents in mobile ad hoc networks", International Journal of Communication Networks and Distributed Systems, 20(4): 413-445.
[8] Prabha K. Performance assessment and comparison of efficient ad hoc reactive and proactive network routing protocols. SN Computer Science. 2020 Jan; 1(1):1-7.
[9] Shruthi, S., Feb. 2017. "Proactive routing protocols for a MANET - A review", IEEE International Conference on I-SMAC, IoT in Social, Mobile, Analytics and Cloud, 1: 821-827.
[10] Singh GG. An Efficient Routing Protocol For Shortest Path Selection In Mobile Adhoc Networks. Nimit Mai Review Journal. 2020; 3(1).
[11] Thakrar PM, Singh V, Kotecha K. Improved route selection algorithm based on TORA over mobile adhoc network. Journal of Discrete Mathematical Sciences and Cryptography. 2020 Feb 17; 23(2):617-29.
[12] Kumari SV, Paramasivan B., Apr. 2017. "Game Theory Based Defense Technique for Jamming Attacks in Mobile Ad Hoc Networks", Journal of Computational and Theoretical Nanoscience,14(4): 1735-1743.
[13] Mohammad AA, Mirza A, Vemuru S., Jul. 2016. "Cluster based mutual authenticated key agreement based on chaotic maps for mobile ad hoc networks", Indian Journal of Science and Technology, 9(26): 1-11.
[14] Mohanakrishnan, U., Bhagavathiperumal, R., & Jayaraman, S., 2018. "A trusted waterfall framework based peer to peer protocol for reliable and energy-efficient data transmission in MANETs", Wireless Personal Communications, 102(1): 95-124.
[15] Ambidi N, Katta R.L.R., May 2019, "Adaptive Risk Prediction and Anonymous Secured Communication in MANET for Medical Informatics", Journal of medical systems, 43(5): Article Number: 115.
[16] Raghavan Vinojitha, Airehrour David, Ndashimye Emmanuel and Baffa, A.B, 2018. "PEGADyn: A Cluster-Based Energy Efficient Routing Protocol for Ad Hoc Networks", IEEE 28th International Telecommunication Networks and Applications Conference (ITNAC), 1: 1-6.
[17] Rajesh MV, Gireendranath TV, Murthy JV., 2017. "A novel energy efficient cluster based routing protocol for highly dense MANET architecture", International Journal of Computational Intelligence Research, 13(5): 719-744.
[18] Ghaleb SA, Vasanthi V., 2020. "Energy Efficient Multipath Routing Using Multi-Objective Grey Wolf Optimizer based Dynamic Source Routing Algorithm for MANET", International Journal of Advanced Science and Technology, 29(3):6096-6117.
[19] Saha, Himadri Nath, Avimita Chatterjee, and Baisakhi Chatterje, 2018. "Acceptability Based Clustering Routing Protocol in MANET", IEEE 9th Annual Information Technology, Electronics and Mobile Communication Conference (IEMCON), 1: 1172-1180.
[20] Sathiamoorthy, J., Ramakrishnan, B., & Usha, M., Feb. 2015. "A reliable and secure data transmission in CEAACK MANETs using a distinct dynamic key with a classified digital signature cryptographic algorithm", IEEE International Conference on Computing and Communications Technologies (ICCCT), 1: 144-151.
[21] Sathiamoorthy, J., & Ramakrishnan, B., 2018. "A competent three-tier fuzzy cluster algorithm for enhanced data transmission in cluster EAACK MANETs", Soft Computing, 22(19): 6545-6565.
[22] Ahmad, Masood, A. Hameed, A. A. Ikram and I. Wahid, 2019. "State-of-the-Art Clustering Schemes in Mobile Ad Hoc Networks: Objectives, Challenges, and Future Directions" IEEE Access, 7: 17067-17081.
[23] Aftab, F., Z. Zhang and A. Ahmad, Nov. 2017. "Self-Organisation Based Clustering in MANETs Using Zone-Based Group Mobility", IEEE Access, 5: 27464-27476.
[24] Sivanantham, S, G.Balakrishnan, M.Jaidev and S.Mahesh, 2019. "Efficient and Opportunistic Routing in MANET using Link Lifetime Prediction". IEEE 3rd International Conference on Trends in Electronics and Informatics (ICOEI), 1: 590-594.
[25] Suman S, Agrawal EA, Jaiswal AK., May 2016. "EPARGA: A Resourceful Power Aware Routing Protocol for MANETs", International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), 5(5): 1584-1589.
[26] Tripathi, S., Nov. 2019. "Performance Analysis of AODV and DSR Routing Protocols of MANET under Wormhole Attack and a Suggested Trust-Based Routing Algorithm for DSR", IEEE International WIE Conference on Electrical and Computer Engineering, 1: 1-5.
[27] Ahmad I, Masood F and Khan AW, Oct. 2020. "Performance Assessment of QoS Using AODV, TORA and ZRP Routing Protocol in MANET", Mehran University Research Journal of Engineering and Technology, 39(4):744-750.
[28] Usha, M., Ramakrishnan, B., & Sathiamoorthy, J, Feb. 2017. "Performance analysis of spectrum sensing techniques in cognitive radio-based vehicular ad hoc networks (VANET)", IEEE 2nd International Conference on Computing and Communications Technologies (ICCCT), 1: 74-80.
[29] Yadav, N., U. Chug, Feb. 2019. "Secure Routing in MANET: A Review", IEEE International Conference on Machine Learning, Big Data, Cloud and Parallel Computing, 1: 375-379.
[30] Ghode S, Bhoyar K., 2018. "Optimized Energy Efficient Hybrid Routing Protocol (EE-HRP) for Minimum Battery Power Consumption in MANET", International Journal of Intelligent Engineering and Systems, 11(5): 59-73.
[31] Jayaraman, S., Bhagavathiperumal, R., & Mohanakrishnan, U., 2018. "A Three Layered Peer-to-Peer Energy Efficient Protocol for Reliable and Secure Data Transmission in EAACK MANETs", Wireless Personal Communications, 102(1): 201-227.
[32] Preethi R, Sughasiny M. "PBGTR: Price Based Game Theory Routing For Minimum Cost Routing Path In Manet". In2018 2nd International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud)(I-SMAC) I-SMAC (IoT in Social, Mobile, Analytics and Cloud)(I-SMAC), 2018 2nd International Conference on 2018 Aug 30 (pp. 469-474). IEEE..
[33] Desai R, Patil BP. Performance Analysis of Ad Hoc Routing Protocols. In3rd International Conference on Recent Trends in Engineering & Technology (ICRTET'2014). ISBN 2014 (No. 978-93, pp. 5107-220).

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