International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-8 Issue-10, August 2019

Routing Protocol for Clustered Bee-Ad Hoc MANETS with Proper node Utilization

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Abstract: ***Making MANETs energy efficient has been a biggest challenge from many years. In this regard in the previous works routing protocols have been introduced for stabilized clustering scheme with swarm intelligence where the MANETs are made energy efficient with well balanced multipath routing protocols. But in all the proposed protocols the cluster structures are non overlapping where there is a probability that some of the nodes may be left without any consideration in the clusters of MANET as nodes are highly dynamic in nature. These nodes usually do not belong to any of the clusters thus cannot take part in the routing process unless cluster splitting takes place. In that case certain time error may occur if any such kind of node carries any special information. For that the clusters may be made overlapping but in that case number of clusters may increase leading to complicated structure where efficiency may decrease suddenly in case of node movement or failure. For this a novel clustering and routing procedure has been introduced in the paper where not only all the nodes take part in data transmission but also number of clusters are minimized to improve efficiency. The work has been carried by using NS-2 simulator.***

Index Terms**: *Energy-efficient, MANET, Clustering, Non-overlapping, Node-utilization, Stable.***

I. INTRODUCTION

Highlight a section that you want to designate with a certain Mobile AdHoc Networks (MANETs) are self organized structures which are very important for any wireless communication structure starting from home to defense. As MANETs are not fixed to any preapproved structure [1], [2] so they can have many applications. In the previous work in [3], [4] routing processes have been introduced where swarm intelligence with proper cluster maintenance scheme has been introduced for routing in MANET. For further improvement in [5], [6], [7] schemes have been introduced where the routing process is made multi path and more energy efficient with a well balanced hierarchical clustered MANET structure. In all the schemes the nodes are given a virtual ID which is decided according to their residual energy and received signal strength. A cluster head (CH) has been selected in all the clusters which takes the major part in transferring the data from source to destination and also carries highest VID. Also in the above proposed routing algorithms the clusters of MANET are considered which are non overlapping. But in all the cases while doing clustering there is a probability that some of the nodes are left which could not be considered in any of the clusters as nodes are highly dynamic in any MANET structure. These nodes can also carry certain information or can help in the routing process.

Manuscript published on 30 August 2019.
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But proper node utilization can't be done as some of the nodes may not get a membership as forager or scout in any of the cluster since they fail to have minimum required residual energy or received signal strength unless cluster splitting takes place. This problem can be come over if the clusters are made to be overlapping. Where the distance between such kind of node and CH reduces and no doubt that node can get cluster member identity. But this leads to a problem where the number of clusters increases rapidly and it affects the overall efficiency of the MANET structure since with increase in number of clusters the system becomes unstable where the rapid movement or failure of any node has to be always taken care to rebuild the clusters. Also by this more updation of the table is required which consumes more of the band resource. As a solution to the above mentioned problem the clustering scheme has been changed a bit which is influenced by 3HBAC (3-HOP BETWEEN ADJACENT CLUSTERS) scheme as per [9]. To take care of the above problems a new algorithm has been introduced where-

- Care has been taken so that all the newly joining nodes should be at least declared as cluster member of any one cluster where a new identity is given to such kind of nodes as "cluster guest".
- In this way all the nodes in any MANET structure can take participation in the routing process may be directly or indirectly.
- The overlapping node concept is overruled by which the MANET is made more efficient.
- By avoiding the overlapping cluster concept the CH changing frequency has been reduced which increases the stability of the system.

II. PREVIOUS WORK CARRIED OUT

In the previous work carried out several steps has been taken so that the routing protocol in the MANET can be made very much energy efficient.In this regard in [3] bee inspired routing along with clustering is selected as the best routing process for MANET where each of the nodes according to their residual energy and received signal strength are given some virtual ID and classified as cluster head (CH), foragers and scouts. Here the complete MANET structure is devided into clusters. In [4] care has been taken for the stability of the clustering scheme where the change in the CH is reduced by introducing stable cluster maintenance scheme.

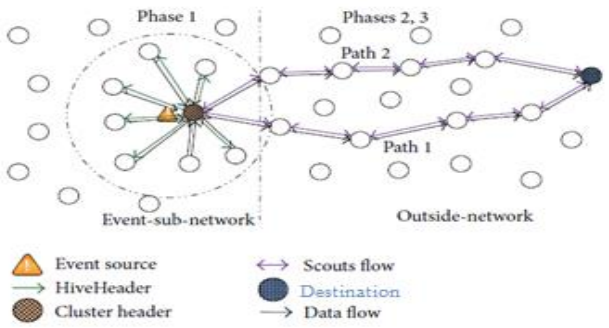

Fig-1: Workflow of Bee-AdHoc-C Network

But in both cases the routing process was random as the nodes were moving randomly outside the cluster in search of the destination which may increase the traffic and thus the delay in the routing process can be increased. In [5] the clustering scheme has been made more systematic by introducing nodes as Border Cluster Nodes (BCNs) which work as gateways between adjacent clusters. Here if the nodes don not get the destination within the cluster then they donnot move arbitrarily to other cluster rather the process is made systematic where BCNs are used for inter cluster communication. But still the process was not fully efficient as the load was not fully balanced among the clusters and the shortest route finding was consuming unnecessary time. To come over this problem a load balanced improved routing technique was introduced in [6] where care has been taken that none of the cluster head gets overloaded with more number of nodes or any cluster head will be with less load. Here cluster merging and cluster splitting are introduced with proper selection of CH in each of the cases. Also the shortest route is found between the source and destination by calculating the hop count. For further improvement of the scheme in [7] care has been taken for multipath routing where the neighboring nodes from adjacent path should not disturb the routing process.

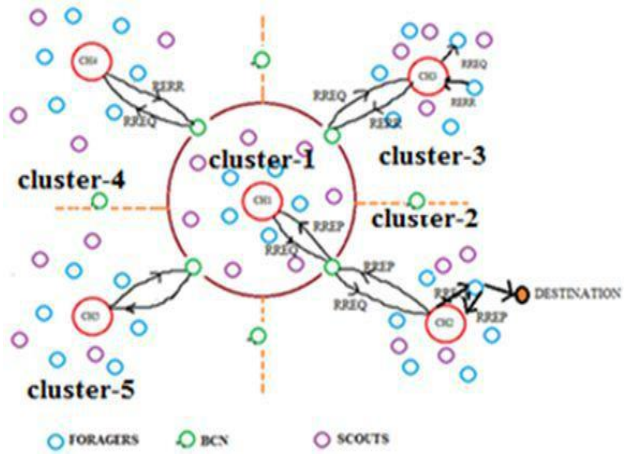

Fig.2. Functionality of Improvised Bee AdHoc-C Network

In all the above cases the number of clusters and the minimum and maximum number of cluster members are predetermined. But as in any MANET structure there is no central control over the nodes movement and the nodes highly dynamic to move arbitrarily so any time new nodes can enter the MANET. In that case there is a probability that the number of members in any cluster can increase suddenly and the cluster has to go for cluster splitting and again should satisfy the minimum member consideration in the newly formed cluster. This may lead to certain delay. To come over this problem the present algorithm is introduced where the newly added nodes immediately do not bring a condition to split the cluster rather if they can access any of the nodes of the cluster then they are considered as cluster guest. This will also help in reducing the data loss and the efficiency of the system increases. In the present protocol proper utilization of all the nodes is given priority.

III. PROPOSED TECHNIQUE FOR EFFICIENT NODE UTILIZED ROUTING FOR CLUSTERED BEE-ADHOC MANETS

In all the routing protocols explained above Border Cluster Nodes are the nodes considered with lowest Virtual ID which are supposed to be far from the Cluster Heads of adjacent clusters but should carry a predefined residual energy (RE) and received signal strength (RSS) to be considered as a cluster member. Usually they are the common nodes for many clusters which are adjacent and share the common boundary. But in this way certain free nodes may not be considered as a valid cluster member in any of the clusters since their RE and RSS are very low when they enter the cluster structure suddenly. In such a case these nodes cannot take any participation in the routing process. But sometimes if these nodes also take active participation that can be useful. Though these nodes are seen to be far from the CH but mostly they are seen to be very nearer to some other nodes (Foragers, Scouts or BCNs) of the cluster where it is easy for them to communicate with these nearby nodes. In that case these nodes are introduced as “cluster guests” and the nearby nodes which are already cluster members are considered as APs (Access Points).

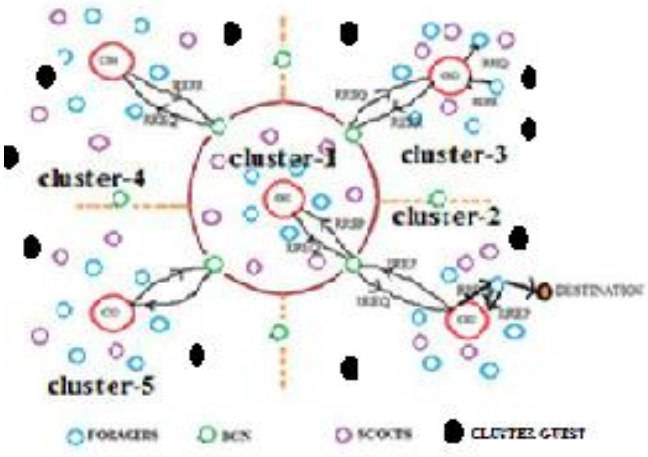

Fig.3. Functionality of Node Utilized Improvised Bee AdHoc-C Network with cluster guest

Thus in the above figure all the members of any clustered MANET structure are shown as CH, Foragers, Scouts and Cluster Guests.

Working of the model

The working of the proposed model is discussed step by step starting from the formation of cluster to transfer of data from source to destination.

Retrieval Number: I8467078919 /19©BEIESP
DOI: 10.35940/ijitee.I8467.0881019
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Cluster Formation

The MANET structure considered here is a liner network where the x-axis of the working area and the range of communication decide the number of clusters.

Selection of Cluster Members

The different cluster members are selected according to their RSS and RE. According to these two values they are assigned with VID. The node with highest VID is known as CH. The other nodes are assigned as Foragers and Scouts.

Where Foragers' VID is set to be greater than the VID of Scouts. The nodes with lowest VID are taken as BCNs which are common and stand as gateways to more than one cluster. Here all the nodes maintain a status table where they maintain their VID as well as they declare their status as CH, Forager or Scouts. Here a change has been done where any node which moves out of the transmission range of all existing cluster heads but still able to communicate with any of the cluster member is considered as a "cluster guest" of the specific cluster. At that time that specific node joins the cluster and considers the nearest cluster member as its Access Point (AP).

Cluster Maintenance

In this case the number of cluster members for any cluster is predefined as per [6]. Where if the minimum and maximum cluster members are not maintained then cluster merging and cluster splitting takes place and new CH is selected. In addition to this procedure if at any time any node finds that it can communicate only with the node with a status of "cluster guest" it forms a new cluster. Where the member behaves as a cluster head with all its immediate cluster neighbors as cluster members. For that new cluster again all the nodes are divided as Foragers, Scouts and BCNs. Here usually the AP of the cluster guest is considered as CH and the cluster guest is considered as Forager. But in this case also the minimum and maximum number of members in cluster is maintained as per [6]. Also if any time any CH can find that all its cluster members can be cluster guests of some other cluster and can access the cluster head of other clusters at that time it relinquishes its cluster head role and that CH joins a neighboring cluster as a cluster guest. In this case the AP for the CH which is newly turned to cluster guest of any other cluster becomes one of its former cluster members. By merging the clusters in this way the number of clusters can reduce so that the cluster members can be maintained at a more constant low level during the complete routing process.

Simulator	Network Simulator 2.35
NUMBER OF NODES	50-100
AREA	1000m x 200m
COMMUNICATION RANGE	200m
INTERFACE TYPE	Phy/Wireless Phy
MAC TYPE	IEEE 802.11
QUEUE TYPE	Drop tail/Priority Queue
QUEUE LENGTH	50 Packets
ANTENNA TYPE	Omni Antenna
PROPAGATION TYPE	Two Ray Ground
ROUTING AGENT	NU-IBAC, LBEE-IBAC
TRANSPORT AGENT	UDP
APPLICATION AGENT	CBR
INITIAL ENERGY	10 Joules
TRANSMISSION POWER	20mW
RECEPTION POWER	10mW
SIMULATION TIME	50seconds

Routing process

Once any event occurs and destination is decided the CH sends a signal to it immediate Forager to search the destination. In turn the Forager first searches the destination within all the Foragers and then sends a request signal to all the neighboring Foragers. If the destination is found among the neighboring Foragers then an acknowledgement signal comes from the destination Forger and the shortest route is decided between the source to destination by calculating minimum number of hops as stated in [6]. But if the destination is not found among the Foragers then a request signal is sent by al the Foragers to their neighboring scouts and the destination is searched within the cluster. If the destination is not found within the cluster then an error signal is sent by the Scouts to Forager and Forager to CH. Then the CH sends a request signal to the attached BCNs to search the destination outside the cluster. In turn the BCNs send request signal to the respective adjacent cluster's CH and the search of destination continues in the adjacent cluster. All the procedure has already been discussed in [6] which may some times give delay. But in the proposed algorithm since new mobile nodes are introduced as Cluster Guests so they are also used in the routing process. Usually the Cluster Guests have nodes as their Access Points which are either BCNs or nodes nearer to BCNs. In this case when a destination is not found within the cluster and any BCN gets a request signal by the CH then the BCN not only sends a request signal to the adjacent CH but also it sends a signal to the nearby "cluster guest". After this the respective cluster guest tries to find its destination through its access points and other cluster guests. If the cluster guests find the destination then it sends a reply to the BCN in turn BCN sends an acknowledgement signal to the respective CH of the cluster where source is present. After that the best route between source and destination is decided by calculating the minimum hop count using the waggle dance formula as stated in [6]. By this method, the routing process can be made more stable and the delay in routing can be reduced.

IV. SIMULATION MODEL

The simulation model is taken in X-Y coordinator where X- shows the length and Y- shows the width of the MANET structure. For the present simulation work, the length has been selected to 1000m. and the width has been selected to 200m. The maximum range of communication has been selected to 200m. on X-axis. Thus the complete network area is divided to 5 clusters. The total number of nodes considered for simulation is 50-100. The minimum residual energy of any node to be considered as a cluster member as Forager or Scout is 10J.

Simulation Model

Simulation Scenario

The simulation for the model has been carried using NS 2.35. The different simulation criteria are taken as snap shots. Here each figure specifies different conditions of simulation.

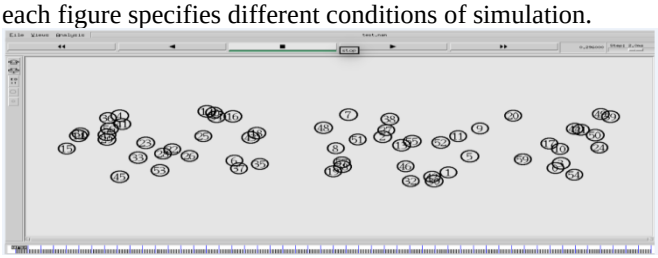

Fig 4 (a) The nodes are distributed randomly in the simulation area

The above figure shows a condition at the beginning of the simulation process. Here more than 50 nodes are distributed in the simulation area randomly.

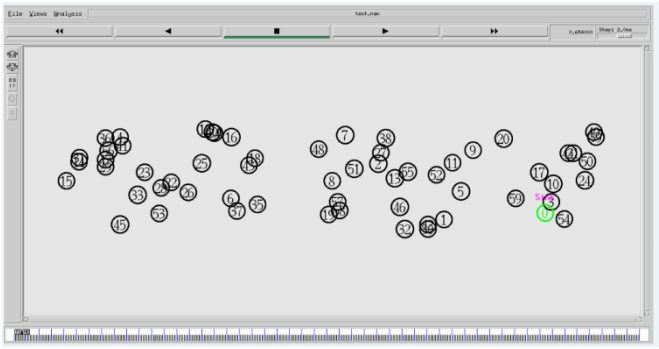

Fig 4 (b) Destination is identified in the simulation area

The above figure shows a condition where the nodes are distributed randomly in the simulation area and the destination is identified

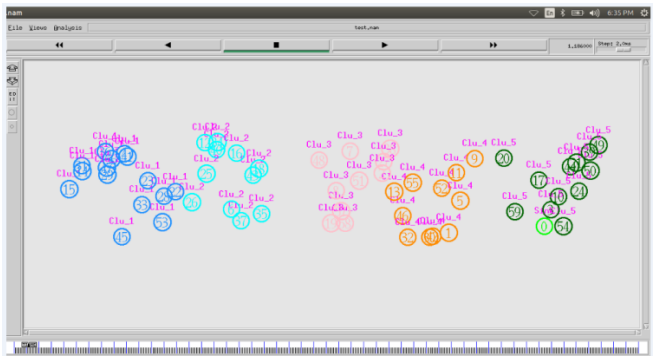

Fig 4 (c) Different clusters are formed

In the above figure, different clusters are formed and nodes are distributed in different clusters. The nodes are identified as CH, Foragers and Clusters.

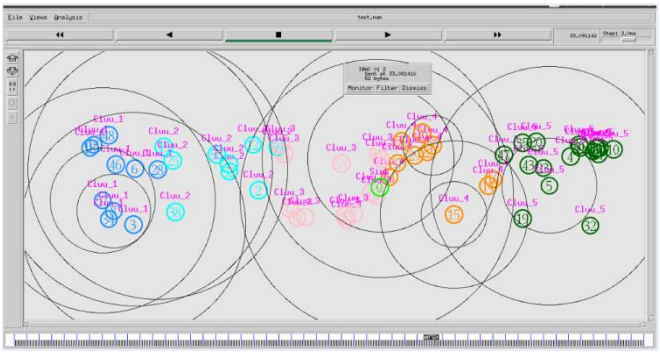

Fig. 4 (d) Routing between source to destination through different paths

After creation of different clusters the routing paths are decided between the source to destination in the above figure.

V. Simulation Results

The present routing protocol has been named as Node Utilized Improvised BAC (NU-IBAC). This method is tested for different parameters to find the working efficiency of any MANET structure like Packet Delivery Ratio and Route discovery time in seconds. The performance of the proposed routing protocol has been compared with the performance of Load Balanced Energy Enhanced – IBAC (LBEE-IBAC) discussed in [6].

Packet Delivery Ratio: This shows the ratio between number of packets delivered to the destination and the packets generated at the source end (CH).

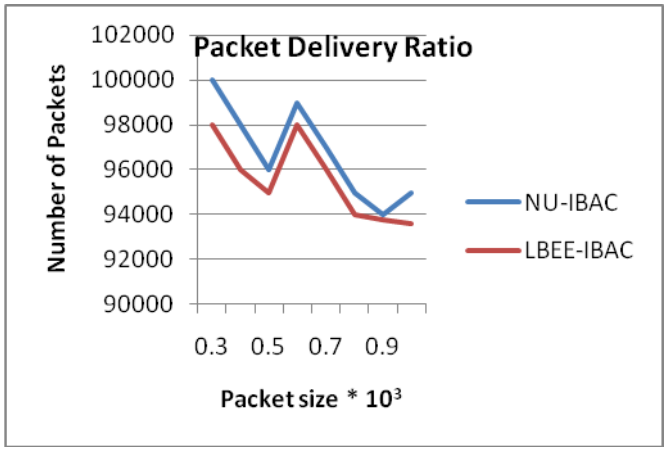

Fig. 5 (a) Packet Delivery Ratio

As in figure 5(a), PDR is varying in both protocols while with respect to traffic load. Especially PDR decreases for any protocol with increase in packet size. PDR in proposed protocol is better than existing which does not change much with increase in packet size. Route discovery time: It is the time taken for a source-generated packet to find route to the destination. In the present scenario, the CH takes all the initiative to send the packets from source to destination. Here it is found by finding the difference between sending time of forward scout and receiving time of backward scout at CH.

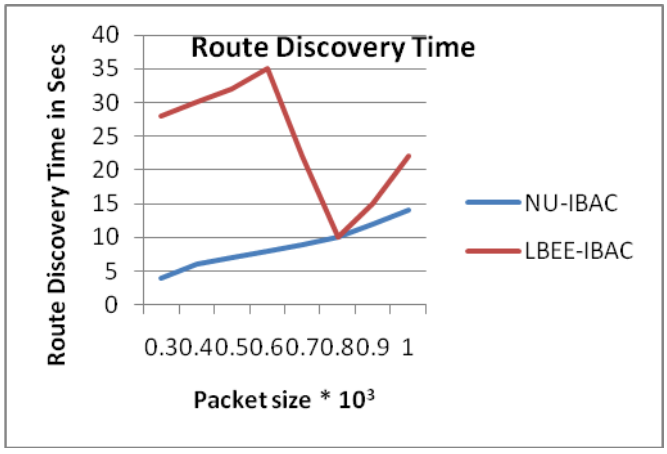

Fig. 5 (b) Route discovery time in sec

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As in figure 5(b), route discovery time is increased in both protocols while increasing the traffic load. But still in the proposed protocol the route discovery time is reduced to a greater extend due to the introduction of new nodes in any cluster as “cluster guests”.

VI. CONCLUSION AND FUTURE SCOPE

The system is made more stable by introducing the new agents in the cluster as “cluster guest”. The main reason to introduce these new agents is as MANET is a self-organized structure so there is always a chance of entering new mobile nodes to the cluster of any network area. In this case if cluster splitting is carried as the immediate solution since the cluster structures have to meet the minimum and maximum number of nodes condition in the cluster then sometimes the system leads to instability as well as the delay in routing increases. To come over this sometimes for a smooth routing process the protocol can be used and the cluster guests are properly utilized.

But in certain practical cases if many of these nodes are considered as cluster members there is a probability that the properly balanced cluster structure may get disturbed leading to further delay in finding the destination. Further work can be carried to take care of all these problems and the efficiency of the routing protocol can be estimated in terms of certain new parameters as energy efficiency, end to end delay and throughput etc.

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