EFFICIENT LOAD BALANCED CLUSTER TRANSFORMATION ALGORITHM IN MANET

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Abstract-Mobile Ad-Hoc Network (MANET) is collection of wireless node which can move freely in any direction. In MANET clustering plays an important role, because clustering makes large network to small cluster and improve the bandwidth utilization by minimizing the communication overhead. A large variety of clustering approaches have been proposed so far. In this paper we proposed a new clustering technique based on lowest Id cluster head selection process and create load balance cluster and minimize the number noise. Cluster head are the backbone of cluster. The performance of the proposed system studied with the help of three different network topologies. By implementing our algorithm in these three topologies, it becomes possible to minimize the number of Noise.

Index terms- MANET, Clustering, Cluster Head, Cluster Member, Noise.

I. INTRODUCTION

Mobile Ad-Hoc Networks (MANET) is comprised of wireless node which can move freely from one position to another and communicate via wireless link. This helps people and different devices to form an internetwork where there is no pre existing infrastructure present. In MANET each and every node behave as router, that means each node can receive or send packets to other nodes which are in transmission range or hop distance away. Ad hoc network has several applications[5], such as conference, conventions, e-mail and transferring of file, and emergency disaster relief personal coordinating, war zone communication etc. Since each and every node in ad-hoc network can send or receive packets, therefore sometimes network congestion occurs. This can be avoided by providing cluster based routing. Clustering technique is not a new idea, several researchs were performed in clustering technique [1,2,7]

In clustering technique, a network transforms to a group of virtual networks of interconnected node or mobile host. these groups are termed as clusters. The backbone of each cluster is cluster head which itself is a node. Each cluster has basically three types of nodes, those are Cluster Head(CH) that dominate the entire cluster and is connected to each and every node of the cluster. Second one is ordinary node that have direct access to the cluster head of the cluster and the third one is gateway which are connected to two or more cluster head.

Clustering makes large network to small cluster and improve the bandwidth utilization by minimizing the communication overhead. In cluster any existing routing protocol can be directly.

The proposed algorithm comprised of two different phase. The first phase is partitioning the network into load balanced cluster and the second phase is re-clustering to connect the single node or noise. Load balancing is accomplished by maintaining the predefine threshold on the degree of cluster head. The re-clustering is initiated when there are some nodes remain in the network which are not included to any cluster. By re-clustering we try to include them in cluster.

II. RELATED WORKS

A variety of related work for MANET have been proposed so far.

In [1] they present a new clustering algorithm TRBC i.e transmission range based clustering. The algorithm works in two phases, the first phase identify the transmission range and select cluster head and second phase check the link stability. The formula to calculate link stability is L=R/D, where R is the transmission range and D is the distance between neighboring nodes.

In [2] they used two different genetic algorithm such as elitism based immigrant genetic algorithm (EIGA) and memory enhanced genetic algorithm (MEGA) to solve the Dynamic Load Balanced Clustering Problem (DLBCP). To select cluster head two parameter were consider, those are distance and energy. EIGA is used to maintain the diversity level and MEGA is used to store the previous environments in memory.

In [5] they proposed an algorithm called Enhancement Weighted Clustering Algorithm (EWCA)and conduct a comparison with WCA. They concentrate in studying the performance of different metrics such as average number of cluster formation that is total number of clusters formed in network, stability of nodes that is how long nodes will remain

in same cluster during simulation and last one is load balancing.

In [7] they proposed the Load Balanced Reclustering Algorithm (LBRA). this algorithm also consist of two different phases. The first phase perform the initial transformation of the network to sets of different clusters by selecting different cluster head. Second phase is the maintenance phase that update the network topology at certain time interval. Re-clustering is initiated to maintain the load balancing.
In [8] proposed a novel energy aware load balancing clustering algorithm``LS-WCA". In cluster head selection process they consider four parameter those are Degree Difference, Energy consumption, mobility and power. Degree difference is the difference between ideal node degree and actual degree. Energy consumption is the total energy consumed by a node in the network, mobility is the running average speed of a node at current time and power is remaining battery power of a node.

In [9] they proposed a load balanced clustering algorithm called Cluster Head Load Balancing Algorithm (CLBA). The algorithm consist of two phases, in the first phase select a cluster head and construct sets of clusters and the second phase is re-clustering phase, where they try to create load balance cluster to minimize the overhead of cluster head.

In [10] a survey of different load balanced cluster was performed, those are AMC (Adaptive Multi-hop clustering) that maintain a multihop cluster structure based on load balancing cluster, DLBC (Degree Load Balancing Cluster) balancing the load of cluster head in all cluster by limiting the number of nodes that a cluster can handle around a predefined threshold value.

III. PROPOSED WORK

Problem Definition

In proposed work we try to minimize the noises. Noises are the node which does not belongs to any cluster.

Methodology

The entire network is divided to different clusters. Each cluster is dominated by cluster head. Different node present in network can be classified as Noise, Cluster Member, Gateway and Cluster Head. Cluster Head are the backbone of cluster.They are directlyconnected to each and every node of cluster. Cluster head are elected on the basis of lowest ID method. Cluster Member are the ordinary node present in thecluster which can directly communicate with cluster head. Gateway are the node which can communicate with two or more cluster head. That means gateway are the connector between clusters. Noise are the node present in network which dose not belong to any cluster.

Algorithm

Step-1: Select cluster head with proper rule.
Step-2: Create load balance cluster using following steps.

a) If number of node connected with CH
δ then construct a cluster with the cluster head CH
else construct a cluster with cluster head CH that contain Number of node = δ
b) If noise is present , try to include it in a cluster by using either of the following steps.

i) If more than one noises are present and are interconnected then Create a cluster with proper rule.
ii) Perform following for each and every clusters.
Check whether the noise has any connection with the cluster head CH or cluster member of that cluster. If there is a connection exist then make the cluster member as new cluster head and reconstruct the cluster.

Working of the algorithm

Following is the detail working of the algorithm. Algorithm has two phases

First phase:

The initial phase transform the entire network to different sets load balance clusters. Each node in the network has different node ID, energy, mobility and degree. Where the degree of node is number of node connected with a node Energy of the node is residual energy. Residual energy can be define as

$$RE = TE - CE$$

Where RE is residual energy, TE is total energy of a node and CE is the power consumed by a node in a network Initially a unique ID is assigned to each node. After that each node broadcast a hello packet. Where the hello packet contain the unique ID, degree and residual energy of the node. Each node also maintain a table to store the hello packet. After receiving several hello packets from connected code it will compare the node Id of hello packets and packet with lowest ID is declared as cluster head and send an acknowledgment to the cluster head. The acknowledged message contain its node ID. When a node is elected as cluster head it will compare its degree with the threshold (δ) value. If degree is 6 then it will include all the node to the cluster. Otherwise if degree of the cluster head exceed the threshold (δ) then it will include numbers of node to the cluster on the basis of ascending order degree. After constructing clusters the algorithm proceed to second phase.

Second phase:

The first phase of the algorithm transform the entire network to several clusters and noises. Noises are the node which does not belong to any clusters. In this phase the algorithm try to minimize the number of noises by re-clustering. If more then one noise is present than check whether a connection is exist between the noise or not. If connection is exist then with proper rule make cluster(s). Otherwise we have to check the different connections of the noise one by one. If a noise is connected with cluster head of a different cluster and number of node present in that cluster is less then than the noise can be directly include to that particular cluster. On the other hand if the noise is connected with any cluster member of a cluster then select that cluster member as cluster head and reconstruct a cluster with proper rule.

IV. PERFORMANCE OF PROPOSED SYSTEM

To check the performance of the proposed system we have taken three different topologies. Following is detail description of Topology-1: This topology contain 12 wireless nodes. Each node has different node ID starting from 1 to 12 and are wire-lessly connected to one another. In the Fig-1 the connections are shown by edges. The figure can be explained with the help of the Table-I. As shown in the table-1 node 1 is connected to the nodes 2, 3 and 10 and degree of node 1 is 3. Similarly node 2 is connected with the nodes 1,3,9 and degree is 3. And this is similar in case of all nodes available in the network. For the topology-1 it is assumed that the predefine threshold (δ) is three(03). Now we are going to transform the network to set of different load balance clusters with the help of the proposed algorithm.

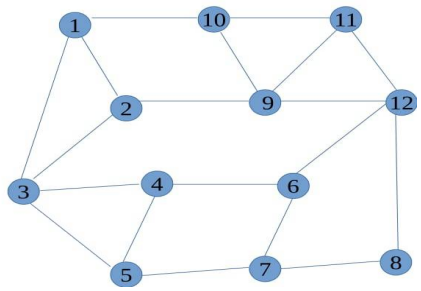

Fig.1 Topology-1

Table-I

Node ID	Connected Node	Degree
1	2, 3, 10	3
2	1, 3, 9	3
3	1, 2, 4, 5	4
4	3, 5, 6	3
5	3, 4, 7	3
6	4, 7, 12	3
7	5, 6, 8	3
8	7, 12	2
9	2, 10, 11, 12	4
10	1, 9, 11	3
11	9, 10, 12	3
12	6, 8, 9, 11	3

Initially all nodes are holding the status “undecided”. Since each node is undecided therefore a hello message is broadcasted form each node. After broadcasting the hello message all nodes are enable to gather necessary informations of its neighbours. Based upon gathered information each node will check the hello message, node with lowest ID will change its status to CH i.e cluster head and sends a join request message to its neighbors. After receiving the join request message the receiver will check its status. If its status is undecided then it will respond to the join request message and change the status to member. This process will continue until all node become cluster head or member or noise. In topology-1 first node 1 change its status to CH and sends request to the node 2,3 and 10. After getting the request these nodes respond to the CH and change their status to “member”. Since node-2 and node-3 has already a status i.e “member” therefore node-4 change its status to CH and sends join request to node-5 and node-6. As the status of node-5 and node-6 is undecided so it respond to the join request and change its status to “member”. Now node-5 and node-6 has status “member” so these node will not participate in cluster head election. Node-7 change its status to CH and sends join request to 5,6 and 8, but node-5 and node-6 are already members of other cluster so these node will not respond to the join request, on the other hand node-8 has status “undecided“ therefore it will respond to the request and change its status to ”member“. Now node-9 change its status to CH and sends join request to node-11 and node-12. after getting the request these node will respond and change its status to ”member“. Now the entire network is transformed to set of clusters and are shown in Table-II and Fig-2.

Table-II

Sl No	Cluster Head	Cluster Member
1	1	2, 3, 10
2	4	5, 6
3	7	8
4	9	11, 12

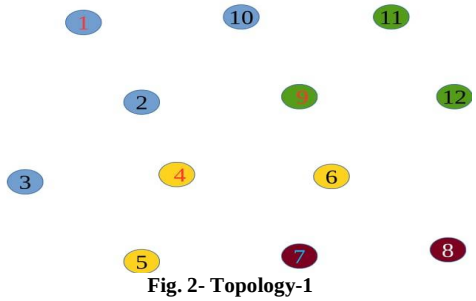

Fig. 2- Topology-1

Topology-2: This topology contain 18 nodes having node ID from 1 to 18 as shown in the Fig.3. All nodes are wirelessly connected.The figure can be explained with the help of **Table-III**

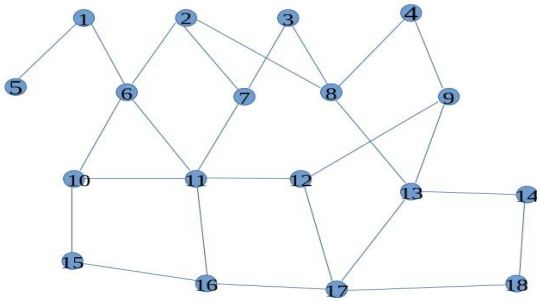

Fig.3- Topology-2

Table-III

Node ID	Connected Node	Degree
1	5, 6	2
2	6, 7, 8	3
3	7, 8	2
4	8, 9	2
5	1	1
6	1, 2	2
7	2, 3	2
8	2, 3, 4	3
9	4, 12, 13	3
10	1, 9, 11	3
11	6, 7, 10 12, 16	5
12	9, 11, 17	3
13	8, 9, 14 ,17	4
14	13, 18	2
15	10, 16	2
16	11, 15, 17	3
17	12, 13, 16 18	4
18	14, 17	2

The detail description of Table-III is similar to Table-I, which we have already discuss in Topology-1. In Topology-2 firstly node-1 will change it status to CH and send join request to node-5 and node-6. These nodes will respond to the join request and change its status to ”member“. Similarly this process will continue until all nodes in the network have a status like CH or ”member“ or ”noise“. After completing the process the entire network transforms to different sets of clusters and noises. Which are shown in Fig.4 and Table-IV

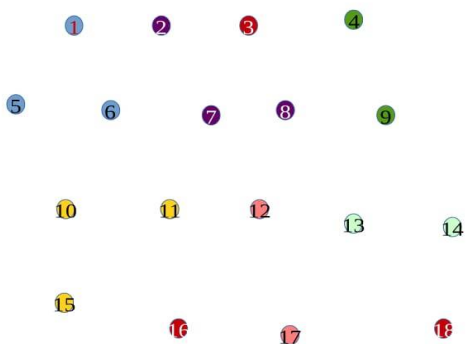

Fig.4-Topology-2

Table-IV

Sl. No	Cluster Head	Cluster Member	Remarks
1	1	5, 6	
2	2	7,8	
3	3	------	NOISE
4	4	9	
5	10	11, 15	
6	12	17	
7	13	14	
8	16	------	NOISE
9	18	------	NOISE

In Table-IV it observed that there are three noise nodes those are node-3, node-16 and node-18. Among the noises the lowest id node, i.e node-3 will send join request message to node-7 and node-8. Since node-7 has lower ID than node-8 therefore node-7 become cluster head and change its status to CH and broadcast a message to its linked nodes. In the process the node-2 becomes member of cluster form by the node-7. But in this re-clustering process, node-8 becomes a noise. Table-V shown the detail description of the above mentioned re-clustering process. Now node-8 will send join request message to its neighbouring linked nodes except node-2 and node-3. So, node-8 will send message to node-4 and node-13. Since node-4 has lower-ID and also a cluster head, so it simply add the node-8 as member. Detailed description is shown in the Table-VI

Table-V

Sl. No	Cluster Head	Cluster Member	Remarks
1	1	5, 6	
2	7	2,3	
3	4	9	
4	8	-------	NOISE
5	10	11, 15	
6	12	17	
7	13	14	
8	16	------	NOISE
9	18	------	NOISE

Table-VI

Sl. No	Cluster Head	Cluster Member	Remarks
1	1	5, 6	
2	7	2,3	
3	4	8,9	
4	10	11, 15	
5	12	17	
6	13	14	
7	16	------	NOISE
8	18	------	NOISE

In Table-VI we have noticed that there are two noises, those are node-16 and node-18. For these noise nodes same process will repeat as explained above for the noise node-3 available in Table-IV. The result is shown in Table-VII and Table-VIII respectively.

In Table-VIII final set of clusters is achieved with minimum possible noise. In our case the node-15 remain as the only noise out of 18 nodes. Initially before the application of our scheme,the topology-2 had 16.67% of noise but after the application of proposed scheme the performance of cluster formation becomes more efficient with 5.5% noise. Which is much better than traditional formation of load balanced clustering. Fig:5 shows the final clusters of Topology-2. The proposed scheme is applied to even a bigger topology with 40 nodes, the clusters are formed with only one noise. So here the noise is only 2.5%.

Table-VII

Sl. No	Cluster Head	Cluster Member	Remarks
1	1	5, 6	
2	7	2,3	
3	4	8,9	
4	11	10, 16	
5	12	17	
6	13	14	
7	15	------	NOISE
8	18	------	NOISE

Table-VIII

Sl. No	Cluster Head	Cluster Member	Remarks
1	1	5, 6	
2	7	2,3	
3	4	8,9	
4	11	10, 16	
5	12	17	
6	14	13,18	
7	15	------	NOISE

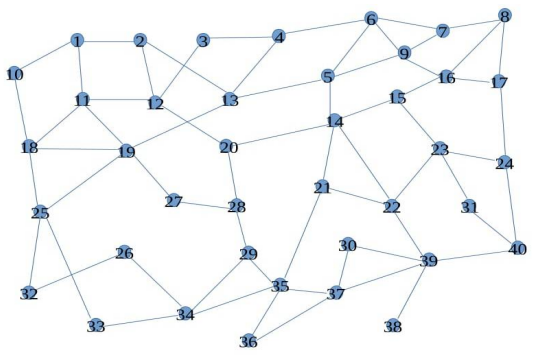

Fig.6- Topology-3

Topology-3 is shown in Fig:6. Connections are explained in Table-IX. Transformation of clusters for topology-3 are shown in Table-X to XX. In initial cluster formation phase there are four noises but after implementing our scheme noises are reduce to one. Table-XX and Fig:7 shows the final cluster.

Table-IX

Node ID	Connected Node	Degree
1	2,10,11	3
2	1,12,13	3
3	4,12	2
4	3,6,13	3
5	6,9,13,14	4
6	4,5,7,9	4
7	6,9,8	3
8	7,16,17	3
9	5,6,7,16	4
10	1,18	2
11	1, 12, 18, 19	4
12	2,3,11,20	4
13	2,4,5,19	4
14	5,15,20,21,22	5
15	14,16,23	3
16	8,9,15,17	4
17	8,16,24	3
18	10,11,19,25	4
19	11,13,18,25,27	5
20	12,14,28	3
21	14,22,35	3
22	14,21,23,39	4
23	15,22,24,31	4
24	17,23,40	4
25	18,19,32,33	4
26	32,34	2
27	19,28	2
28	20,27,29	3
29	28,34,35	3
30	37,39	2
31	23,40	2
32	25,26	2
33	25,34	2
34	26,29,33,35	4
35	21,29,34,36,37	5
36	35,37	2
37	30,35,36,39	4
38	39	1
39	22,30,37,38,40	5
40	24,31,39	3

Table-X

Sl. No	Cluster Head	Cluster Memeber	Remarks
1	1	2,10,11	
2	3	4,12	
3	5	6,9,13,14	
4	7	8	
5	15	16,23	
6	17	24	
7	19	18,25,27	
8	20	28	
9	21	22,35	
10	26	32,34	
11	29	———	Noise
12	30	37,39	

13	31	40	
14	33	————	Noise
15	36	————	Noise
16	38	————	Noise

Table-XI

Sl. No	Cluster Head	Cluster Memeber	Remarks
1	1	2,10,11	
2	3	4,12	
3	5	6,9,13,14	
4	7	8	
5	15	16,23	
6	17	24	
7	19	18,25,27	
8	28	20,29	
9	21	22,35	
10	26	32,34	
11	30	37,39	
12	31	40	
13	33	————	Noise
14	36	————	Noise
15	38	————	Noise

Table-XII

Sl. No	Cluster Head	Cluster Memeber	Remarks
1	1	2,10,11	
2	3	4,12	
3	5	6,9,13,14	
4	7	8	
5	15	16,23	
6	17	24	
7	25	18,19,33	
8	27	————	Noise
9	28	20,29	
10	21	22,35	
11	26	32,34	
12	30	37,39	
13	31	40	
14	36	————	Noise
15	38	————	Noise

Table-XIII

Sl. No	Cluster Head	Cluster Memeber	Remarks
1	1	2,10,11	
2	3	4,12	
3	5	6,9,13,14	
4	7	8	
5	15	16,23	
6	17	24	
7	25	18,19,33	
8	28	20,27,29	
9	21	22,35	
10	26	32,34	
11	30	37,39	
12	31	40	
13	36	————	Noise
14	38	————	Noise

Table-XIV

Sl. No	Cluster Head	Cluster Memeber	Remarks
1	1	2,10,11	
2	3	4,12	
3	5	6,9,13,14	
4	7	8	
5	15	16,23	
6	17	24	
7	25	18,19,33	
8	28	20,27,29	
9	35	21,36	
10	22	————	Noise
11	26	32,34	
12	30	37,39	
13	31	40	
14	38	————	Noise

Table-XV

Sl. No	Cluster Head	Cluster Memeber	Remarks
1	1	2,10,11	
2	3	4,12	
3	14	5,22	
4	6	———-	Noise
5	9	———-	Noise
6	13	———-	Noise
7	7	8	
8	15	16,23	
9	17	24	
10	25	18,19,33	
11	28	20,27,29	
12	35	21,36	
13	26	32,34	
14	30	37,39	
15	31	40	
16	38	————	Noise

Table-XVI

Sl. No	Cluster Head	Cluster Memeber	Remarks
1	1	2,10,11	
2	3	4,12	
3	14	5,22	
4	7	6,8	
5	9	———-	Noise
6	13	———-	Noise
7	15	16,23	
8	17	24	
9	25	18,19,33	
10	28	20,27,29	
11	35	21,36	

12	26	32,34	
13	30	37,39	
14	31	40	
15	38	————	Noise

Table-XVII

Sl. No	Cluster Head	Cluster Memeber	Remarks
1	1	2,10,11	
2	3	4,12	
3	14	5,22	
4	7	6,8,9	
6	13	———-	Noise
7	15	16,23	
8	17	24	
9	25	18,19,33	
10	28	20,27,29	
11	35	21,36	
12	26	32,34	
13	30	37,39	
14	31	40	
16	38	————	Noise

Table-XVIII

Sl. No	Cluster Head	Cluster Memeber	Remarks
1	2	1,13	
2	10	———-	Noise
3	11	———-	Noise
4	3	4,12	
5	14	5,22	
6	7	6,8,9	
7	15	16,23	
8	17	24	
9	25	18,19,33	
10	28	20,27,29	
11	35	21,36	
12	26	32,34	
13	30	37,39	
14	31	40	
16	38	————	Noise

Table-XIX

Sl. No	Cluster Head	Cluster Memeber	Remarks
1	2	1,13	
2	3	4,12	
3	14	5,22	
4	7	6,8,9	
5	15	16,23	
6	17	24	
7	18	10,11,19,25	
8	33	————	Noise
9	28	20,27,29	
10	35	21,36	
11	26	32,34	
12	30	37,39	
14	31	40	
16	38	————	Noise

Table-XX

Sl. No	Cluster Head	Cluster Memeber	Remarks
1	2	1,13	
2	3	4,12	
3	14	5,22	
4	7	6,8,9	
5	15	16,23	
6	17	24	
7	18	10,11,19,25	
8	33	————	Noise
9	28	20,27,29	
10	35	21,36	
11	26	32,34	
12	39	30,37,38	
14	31	40	

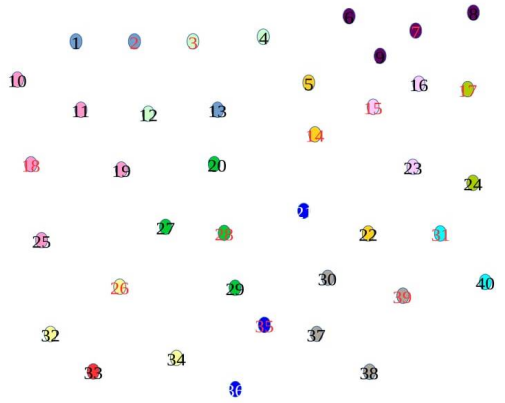

Fig.7- Topology3

CONCLUSION

In this paper we proposed a load balance clustering algo-rithm to minimize the number of noises generated during the formation of clusters. We theoretically examined three differ-ent topologies with the proposed algorithm. In the process it is found that number of noises which were visible in three different topologies at the cluster formation before applying our scheme. But after application of our scheme, the clusters are formed with minimum noise.

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