An Adaptive Cluster Head Election Algorithm for Heterogeneous Mobile Ad-hoc Network

Abhilasha Sharma [#1], Dr. M.S. Deora [*2]

[#1]*Research Scholar, Paher University, Udaipur, Rajasthan*

[*2]*HOD-Computer Studies, Bhupal Nobles Institute, Udaipur, Rajasthan*

***Abstract*– Mobile ad-hoc network characterized as a homogenous and heterogeneous on the basis of node capabilities. Heterogeneity property may make issues for mobile ad-hoc network in context of coverage area, link stability, lifetime etc. To resolve these issues, require a mechanism to adapt different characteristics and make decision for smooth functioning. Heterogeneity also leads effective routing problem that occurs instability in route or path. Though to make effective routing in this situation, efficient clustering algorithm may be apply. In this paper, the effects of heterogeneity property are studied and analyzed. A cluster head algorithm is also suggested to deal with the effects of the property. Suggested algorithm is simulated in network simulation and performance is evaluated in context of computation cost, lifetime and number of clusters.**

Keywords: **Mobile Ad hoc Network, Homogeneous MANET, Heterogeneous MANET, Clustering, Cluster formation, Cluster-head**.

I. INTRODUCTION

Mobile ad-hoc network have increases its demand as timeline increases for its economic and self managing property. In this network, communication works without central control that may causes several issues [1]. Mobile ad-hoc network may be homogenous and heterogeneous based on nodes properties. Nodes mobility property results topology changes and frequent failure links that causes overhead of routing algorithm [2]. To ensure efficient routing process and Quality of Service (QoS) support even as bearing in mind the significant channel capacity and battery power consumption face major issues. Therefore, one promising move toward to deals with routing issues of the network environment is to construct hierarchies between the nodes, such that the network topology can be abstracted[3]. This process is usually belonging to as clustering and the substructures that are distorted in superior levels are called clusters [4]. The thought of clustering is not new; various algorithms that regard as dissimilar factors and concentrate on intricate objectives have been future [5]. Though, most of approach fails to guarantee stable cluster formations. Additional significantly, they are based on periodic distribution of control messages consequential in amplified expenditure of network traffic and energy. Apart from that the working of clustering may also be change according to property of nodes in the network. Subsequent section describes the homogenous and heterogeneous network, loose coupled and tight coupled clustering, suggested algorithm, simulation and evaluation.

II. HOMOGENEOUS AND HETEROGENEOUS MANET

Mobile ad-hoc network classified in two types on the basis of nodes capabilities. Node capabilities defined as characteristics of device.

A. Homogeneous MANET- Homogeneous manet is comprises of devices with distinct properties such as mobility, transmission range, transmission power, battery power, bandwidth etc. Figure 1 show the model of homogenous network in which each node has same transmission range, battery power and velocity.

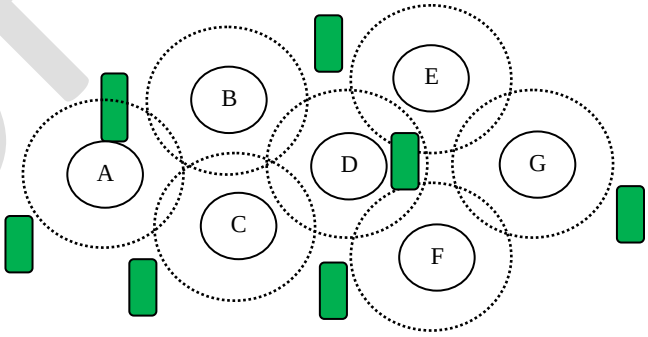

Figure 1: Homogeneous MANET

B. Heterogeneous MANET- Heterogeneous manet is comprises of devices with different properties such as transmission range, transmission power, battery power, bandwidth etc. Figure 2 show the model of homogenous network in which each node has different transmission range, battery power and velocity.

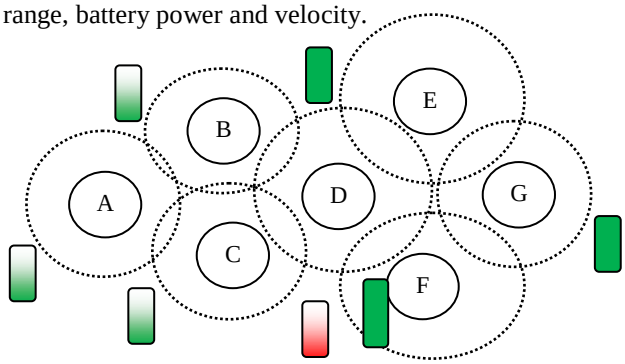

Figure 2: Heterogeneous MANET

III. CLUSTERING AND CLUSTER HEAD

In mobile ad-hoc networks, clustering is a method to deals with scalability and routing issue. Network topology logical splits into definite groups. Clustering works in cluster formation, cluster head election and gateway nomination steps. Depending on the diameter of the network there are two types of cluster formation way that are recognized as one-hop clustering and multi-hop (k-hop) clustering. In one-hop clustering, every node is one hop neighbor of the cluster head [6]. Another k-hop clustering defined as k distance between cluster head and member. In this paper, one hop clustering is focused.

A node is elected as cluster head which manages the cluster behavior like managing cluster procedure, routing information, detection of new routes. Other nodes are called member nodes or ordinary nodes. Nodes having interred cluster links which can communicate with additional than one cluster are called Gateway Nodes (GN). If the purpose is within the cluster, ordinary nodes send the packets to their cluster head that distributes the packets within the cluster, or if to be delivered to additional cluster then forward them to a gateway node. In such way, only cluster heads and gateways take part in the propagation of routing update or control [7].

Figure 3 shows schematic cluster topology of network where one hop clustering method is applied. This figure shows cluster head, cluster member and gateway nodes.

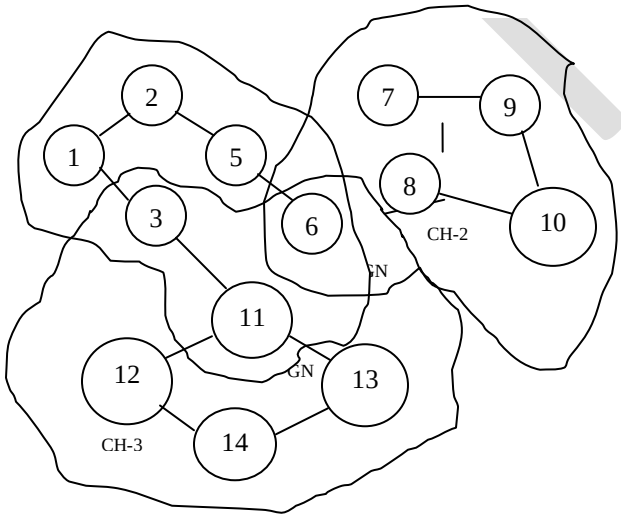

Figure 3: Cluster topology in MANET

Clustering may also apply in heterogeneous manet. But it face some issues such as frequent cluster head election due low battery power or high mobility, low cluster lifetime, cluster computation cost etc. Clustering is very important for better performance of network. Depending on the network where different clustering algorithms apply. Here some of the points which specify importance of clustering [8]

A. *Node Mobility*- The majority of the network architectures suppose that nodes are stationary. But occasionally it is compulsory to support the mobility of nodes. Node mobility makes clustering a very challenging task because the node membership will animatedly change, forcing clusters to develop above time.

B. *Traffic Load*- Events that are monitored by a sensor network can moreover be recurrent or intermittent. Intermittent monitoring generates traffic in the network only when identify the occasion of interest, whereas continual monitoring produce traffic at regular intervals as they recurrently sense information.

C. *Overlapping clusters:* The cluster head CH might be pre-designed by the network designer or selected by the sensors in the network. If the later one is opted there is a likelihood that a member of one cluster mightdevelop into the member under a different CH. This makes the overlapping clusters furthermore to be measured in the design problem. It is consequentlysignificant to ascertainneeded mechanisms for identify the existence of overlapped clusters and organize among clusters to avoid unfairness, malnourishment or deadlock through source struggle.

D. *Load Balancing:* Load balancing is biggest issues in ad hoc networks where CHs are picked from the given nodes. The member mobile nodes require to be uniformly scattered among the different cluster head available. If it fails leads overload cluster head that results failure of cluster head.

E. *Number of Clusters:* The count of formed clusters occurred is too high that leads network overhead in management context. To resolve this issue, optimal number of cluster formation is required.

F. *Cluster Formation Time*: Cluster formation process involves forming of cluster, election of cluster head and allotment of cluster member to head that needs time which should be less.

IV. RELATED STUDY

In the previous few years, lot of work contributed on design efficient and effective cluster formation and head election methods for mobile ad-hoc networks that enable mobility property of networks. But in existing methods, mobility factors are fixed or vary according to time is not specified.

As a result, the upcoming methods do not scale well in sensible network, where the mobility factors of the nodes vary as demand of time. To find the most favorable method to the cluster formation and head election is difficult and extremely

complicated if we suppose that the association way and mobility factors of the nodes are haphazard variables.

The initially scheme for cluster-head election is "lowest id clustering" deals with the lowest ID of nodes to elect as a cluster-head. Therefore, the *ids* of the neighbors of the clusterhead will be advanced than that of the CH. A node is called gateway if it is lies between ranges of two or more cluster. Gateway nodes are in general used for routing among clusters. Each node has assigned unique id. Eventually, the node transmits the list of nodes that it can hear [9].

- Node that has id is lower than other nodes id nominated as cluster head.
- Apart from lowest id node that designated as cluster head all are member nodes of cluster.
- Nodes which lie two or more than cluster refer as gateway nodes.

Another one is WCA selects a mobile node as a cluster head according to the number of nodes it can handle, mobility, broadcast power and battery power. To guarantee that cluster heads resolve not be over-loaded a pre-defined threshold is used which designate the number of nodes each cluster head can preferably support. WCA choose the cluster heads according to the burden value of every node. The burdenconnected to a node v is defined as [10]:

$$W_y = w1.\Delta_y + w2.D_y + w3.M_y + w4.P_y$$

More over Highest-Degree algorithm further refer as connectivity-based algorithm is also advised. This algorithm is lies on which degree nodes assumed to be the number of neighbours of a given node. When the selectionprocess is required, nodes transmit their Identifier (ID) which is assumed toward be unique in the same network [11].

Partitions wireless network d-hop clusters based onmobility metric. The purpose of forming d-hop clusters is to make the cluster width additional bendable. The basis of the algorithm is mobility factors and the diameter of a cluster is bendable with deference to node mobility. This clustering algorithm supposes that every node can assess its received signal strength. In this method, a node can approximation its detachment from its neighbors. High transmitting signal strength implies proximity between two nodes [12].

Knowledge automata based subjective cluster configuration algorithm called MCFA [13] proposed that deals with the mobility parameters of the hosts are unspecified to be random variables with unidentified distributions. In the planned clustering algorithm, the predictablecomparative mobility of every host with approbation to all its neighbors is predictable by sampling its mobility parameters in different epochs.

Cluster based routing protocols for superior performance the presentation of large-scale networks. A mechanism is proposed for intra and inters cluster routing in different cases [14]. The motive of the approach was to benefited features of on-demand and proactive routing protocols. In this common node of the cluster considered as gateway which work as bridge to transport data from one cluster to another.

To optimize energy consumption in ad-hoc network, an approach was proposed that splits network into logical regions that refer as a clusters [15]. It worked on the basis of determine the value of energy consumed of the network.

An approach was proposed named as AMQR which amplify parameters like addictiveness, competence, scalability and moreoverdecrease end-to- end postponement. The AMQR also regard as the attendance and the connectivity among of the nodes, network connected status of links like delay knowledgeable, and obtainable bandwidth in links etc. It also includes certain suggestions to overcome the weakness of the proposed systems [16].

Recently a stable loose clustering algorithm was present which consider intricate characteristics of nodes to elects cluster heads [17]. It is assumed that proposed approach after simulation leads better results as earlier.

V. PROPOSED METHODOLOGY

In mobile ad-hoc network, mobility property of nodes affects on cluster head stability. There is need to focus on mobility factors during the formation of cluster head election methods. Clustering technique has advised for homogenous network is not appropriate for heterogeneous network due to intricate characteristics of nodes such as battery power, mobility etc. Some efforts have putted to make appropriate cluster head election method for heterogeneous network that focused on mobility factor and power of nodes. Sometimes, here is dilemma to elect cluster head when similar power and mobility have more than one node. To handle this situation, an approach is proposed that consider transmission coverage along with mobility and power to elect cluster head. Proposed approach uses Friis' free space propagation model to determine relative mobility of nodes. The ratio of received signal strength and transmit power of node is results mobility of nodes. The proposed approach aligned with designed algorithm which defined below.

A. Algorithm- The designed algorithm for proposed approach works in four phases consists of neighbor discovery via hello signal; calculation of mobility, power and range; election of cluster head and routing. Various nomenclatures are used in the algorithm those are given in table1.

Table1. Nomenclatures used in algorithm

Nomenclatures	Descriptions
N[ ]	Number of Nodes
N_p[ ]	Power of Nodes

N_m[ ]	Mobility of Nodes
N_r[ ]	Range of Nodes
CH	Variable for Cluster Head
CM[ ]	Cluster Member
Count[ ]	Number of clusters
NB_l	Neighbor List
F	Flag

```
Algo ACHEA (N[ ], id)
{
DECLARE i, j;
    Repeat i=1 to n
    {
     Send (hello, Node[i], Node[j]);
     For all nodes
    (Node[j]==id) in receive (hello, id)
    NBl (Node[i], Node[j]) =1
  //Calculate mobility, power and range of neighbor's nodes using mobility model, energy model and propagation model.
    Nm [i]= Mobility Model (N[i]);
    Np [i]= Energy Model (N[i]);
    Nr [i]= Propagation Model (N[i]);
// Elect cluster head based on the low mobility, high power and range from the all neighbor nodes.
        If (Nm [i]> Nm [i+1] && Np [i] > Np [i+1] && Nr [i]> Nr [i+1]) {
          F=1;
            }
        Else
        F=0;
        If (F==1)
        {
         CH=N[i];
        CM[ ] = {N[i+1],…..N[j]);
        }
}
```

VI. SIMULATION AND RESULT ANALYSIS

A. Simulation- Proposed approach is simulated in Network Simulator-2(NS-2) tool considering different network simulation parameters that shown in table 2.

Table2. Network Parameters and Values

Parameters Name	Value
Number of nodes	100
Dimension of simulated area	800×600
Simulation time (seconds)	100
Radio range	100, 200, 300m
Propagation Model	Two Ray Ground
Traffic type	CBR, 3pkts/s
Packet size (bytes)	512
Routing Protocol	AODV
Connection Type	TCP

Proposed clustering approach is simulated using NS-2 considering table 1 parameters that shown in figure 4.

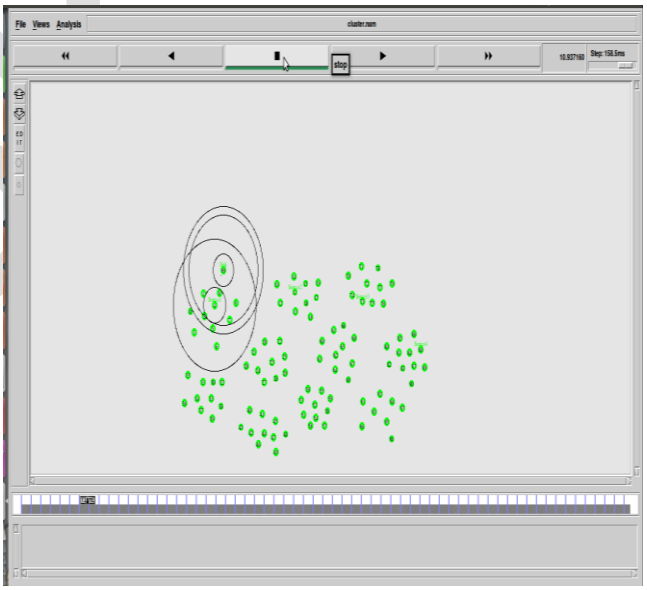

Figure 4: Simulation Windows

B. Evaluation Parameters- The network performance is evaluated after simulating proposed approach on the basis of following evaluation parameters.

- *Cluster Formation Overhead*- This overhead is measure by number of hello packet broadcasted per time interval.

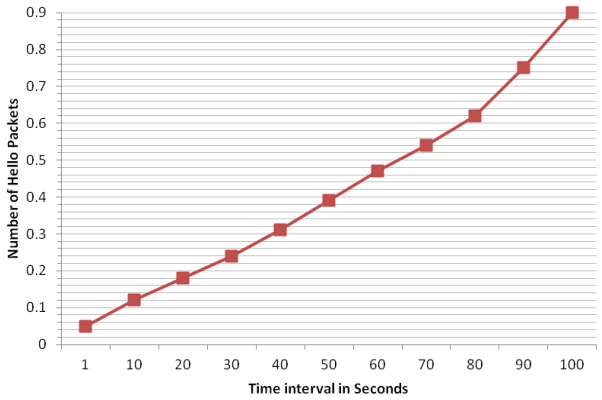

Figure 5: Cluster head formation overhead

- *Cluster Lifetime*- Cluster lifetime is time period in which cluster head is active and deal with cluster member nodes. It is computed respective of different cluster coverage. Figure 6 shows cluster lifetime when cluster coverage 100m.

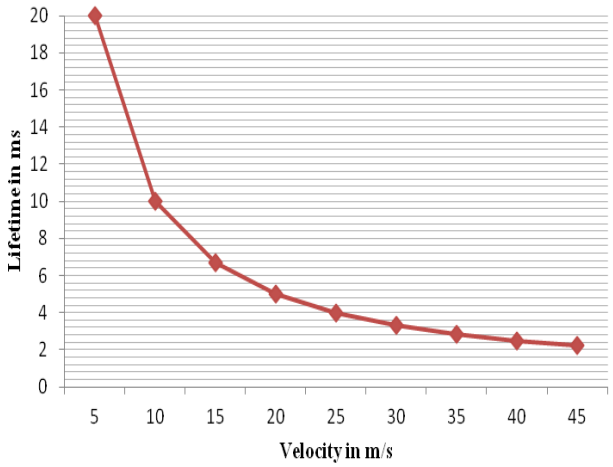

Figure 6: Cluster lifetime with 100m coverage

Figure 7 show cluster lifetime when cluster coverage 200m.

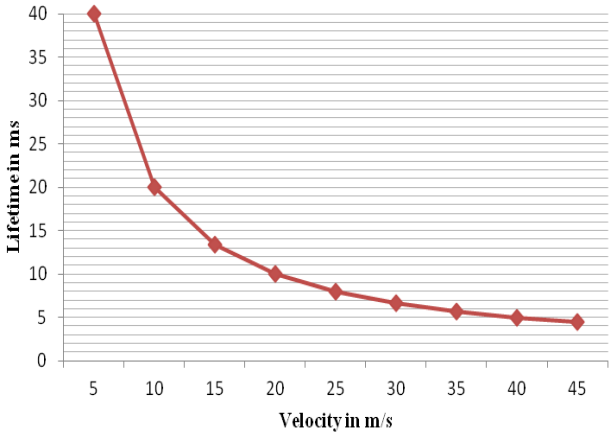

Figure 7: Cluster lifetime with 200 m coverage

Figure 8 show cluster lifetime when cluster coverage 300m.

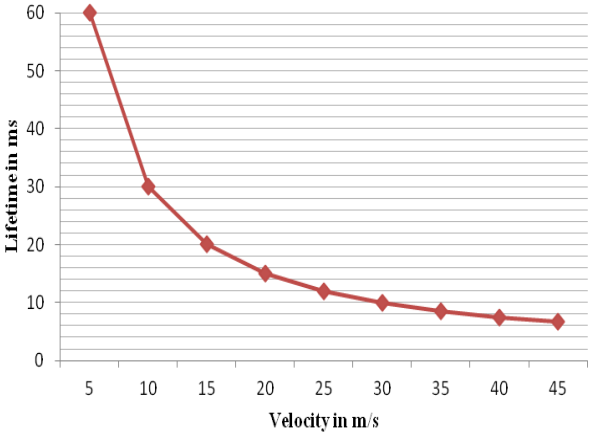

Figure 8: Cluster lifetime with 300 m coverage

VII. CONCLUSION

Numerous clustering algorithms are studied which helps to establish MANETs in a hierarchical manner and their main properties are presented. To analysis it is seen that a cluster-based MANET has many significant issues to observe, such as the cluster structure stability, the regulate overhead of cluster construction and conservation, the energy consumption of mobile nodes with dissimilar cluster-related status, the traffic load supply in clusters. Hence a solution is needed which confirms the selection ofa consistent cluster head, which can handle extreme traffic and maintain stability of cluster head.

REFERENCES

[1] C. Perkins, "Ad Hoc Networking", Addison-Wesley, 2001.
[2] X. Hong, K. Xu, M. Gerla, "Scalable Routing Protocols for Mobile Ad Hoc Networks", IEEE Network, 16(4), pp. 11-21, July-Aug 2002.
[3] C. R. Li, M. Gerla, "Adaptive Clustering for Mobile Wireless Networks", IEEE Journal of selected Areas in Communications, 15(7), pp. 1265-1275, 1997.
[4] J. Yu, P. Chong, "A Survey of Clustering Schemes for Mobile Ad Hoc Networks", IEEE Communications Surveys, 7(1), pp. 32-48, March 2005.
[5] J. Yu, P. Chong, "A Survey of Clustering Schemes for Mobile Ad Hoc Networks", IEEE Communications Surveys, 7(1), pp. 32-48, March 2005.
[6] Md. Shafakhatullah Khan, Mourad Mohamed Henchiri, "Clustering of Wireless Ad Hoc Networks: An Efficient Probabilistic Technique", International Journal of Engineering Research & Technology (IJERT), Vol. 2 Issue 12, December – 2013
[7] Chinara, Suchismita, "Analysis and Design of Protocols for Clustering in Mobile Ad Hoc Networks", Dissertation, National Institute of Technology Rourkela, 2011.
[8] K. Pradeepa and W. Regis Anne, "Design and Implementation Issues of Clustering in Wireless Sensor Networks", International Journal of Computer Applications (IJCA), Volume 47– No.11, June 2012
[9] Ratish Agarwal and Dr. Mahesh Motwani, "Survey of clustering algorithms for MANET", International Journal on Computer Science and Engineering Volume 1, Issue 2, PP. 98-104, 2009.
[10] K. Tang, M. Gerla, Fair Sharing of MAC under TCP in Wireless Ad hoc Networksl, Proceedings of IEEE MMT'99, Oct., 1999.
[11] Hussein, Abdel Rahman H., SufianYousef, and Omar Arabiyat "A Load-Balancing and Weighted Clustering Algorithm in Mobile Ad-

Hoc Network" IT Security conference for the Next Generation, University of East London, London, UK, November 21-22. 2009.

[12] I. Er and W. Seah, "Mobility-based d-hop clustering algorithm for mobile ad hoc networks", IEEE Wireless Communications and Networking Conference Vol. 4, pp. 2359-2364, 2004.

[13] Torkestani, JavadAkbari, and Mohammad Reza Meybodi, "A mobility-based cluster formation algorithm for wireless mobile ad-hoc networks." Cluster Computing 14.4 (2011): PP. 311-324.

[14] Sharma, Dhirendra Kumar, Chiranjeev Kumar, and SurajitMandal, "An efficient cluster based routing protocol for MANET", 2013 IEEE 3rd International IEEE Advance Computing Conference (IACC), 2013.

[15] Choukri, Ali, Ahmed Habbani, and Mohamed El Koutbi. "An energy efficient clustering algorithm for MANETs", 2014 International Conference on IEEE Multimedia Computing and Systems (ICMCS), 2014

[16] Karthikeyan, P., et al. "Impact on Self-Organization in Mobile Ad-hoc Networks: An Comprehensive Review", Proceedings of the 2015 International Conference on Advanced Research in Computer Science Engineering & Technology (ICARCSET 2015) ACM, 2015.

[17] V. V. Neethu and Awadhesh Kumar Singh, "Mobility Aware Loose Clustering for Mobile Ad hoc Network", Eleventh International Multi-Conference on Information Processing-2015 (IMCIP-2015), Procedia Computer Science Volume 54, PP. 57 – 64, 2015.