# A Secure and Efficient Cluster Head Selection Algorithm for MANET

Mandeep Singh
Department of CSE, CEC College, Landran

Mr.Gagangeet Singh
Assistant Professor, (CSE), CEC College, Landran

**Abstract – Mobile ad hoc networks consists of mobile nodes which communicates with each other without any fixed topology. In these networks data is transferred between the mobile nodes by using the intermediate nodes which communicates with each other. As the mobile ad hoc networks have limited energy resources so cluster head selection, imbalanced energy consumption and security is a great challenge for MANET these days. Optimizing Cluster head selection minimizes the energy consumption in a particular network and also reduces the overall data transmission overheads. In Wireless Sensor Network we use LEACH protocol for cluster head selection on energy basis but in MANET it is still a dispute. For better utilization of energy, bandwidth, secure transmission there must be an efficient algorithm for cluster head selection. In this paper we study different cluster head selection algorithms for security and energy consumption of a particular cluster which increases the lifetime of the network and makes the data transmission more reliable.**

**Index Terms – MANET,cluster, cluster head, security, energy consumption.**

## 1. INTRODUCTION

### 1.1MANET

MANET is a network in which nodes are connected by wireless links. In this topology of network changes rapidly and nodes can independently move in a network. Nodes in a network communicates with each other by using intermediate nodes like routers for end to end data transfer. Example- Personal area networking (laptops, mobile), emergency operations (search and rescue operations, disaster recovery).

Characteristics of MANET:-

1. Topology of network changes dynamically. The nodes in a network are free to move .Any node can enter into the network and leaves the network.

2. As capacity of wired systems is higher than wireless so bandwidth constraints are present.

3. Energy conservation is necessary as nodes are highly dependent on energy sources like battery.

4. Security is a major issue for reliable transmission of data through any insecure channel .So, any no. of nodes can join and leave the network. Due to this, attacks are occurred like denial-of-service, spoofing.

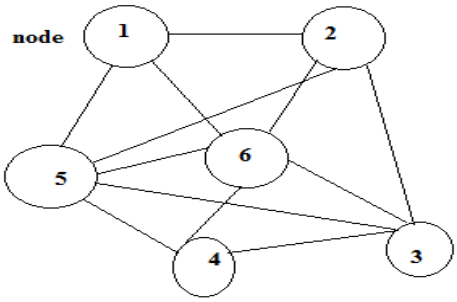


Fig 1:- Structure of MANET

### 1.2 Attacks in MANET-

- Passive Attack- In this, the main motive to attacker is just to gather some important information like to disturb the data transmission, causes congestion in the network. Content of data remains unchanged. Example- Denial of Service in which the information becomes unavailable for sometimes.
- Active Attack-In this, the motive of attacker is to alter or change the data .It includes deletion of messages, add any useless information, violating the data integrity, authentication. Sometimes, the attacker gains the overall access to the transmitted data. Example-Eavesdropping in which the attacker obtains the confidential information.

## 2.CLUSTERING

Clustering is a technique for dividing the network into different group of nodes and manages the transmission of the data among the interacting nodes. Each group is known as cluster. In a cluster set of nodes gathered around a node known as cluster head. All cluster heads are interconnected with each other for reliable communication as limited energy

resources are present. Each cluster is a architecture in which the cluster head (CH) responsible for maintenance of cluster and communication between the cluster nodes. Cluster head selection includes two variants-

i) Distance Constrained Selection-According to this selection process, every node in a cluster must be located at certain distance from the cluster head which is nearer to it.

ii) Size Constrained Selection-Acc. to this, each cluster in a network must have limited no. of members.

Basically 3 types of nodes are present in a cluster.

i) Cluster Head-It is a leader node that makes co-ordination among nodes, maintains list of nodes and path to every node in a cluster.

ii) Cluster Member-It is a part of a cluster that transmits information to their cluster heads which further compresses the information received from cluster member and forward it to the other cluster heads and base station.

iii) Cluster Gateway-Its main purpose is to connect one cluster with another cluster and forward the information among clusters. Gateways are basically non-cluster heads.

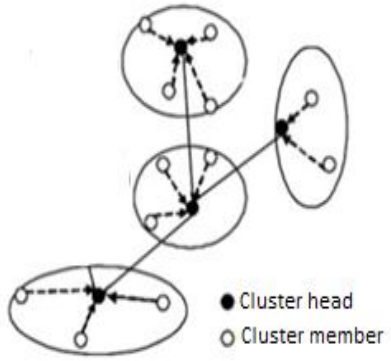


Fig 2:-Basic diagram of cluster

Here communication done in 3 steps:-

i) Firstly cluster head receives data from its cluster members.
ii) Then it compresses the data.
iii) After this, it finally transmits data to base station or other cluster heads.
Advantages:-
i) Scalability.
ii) Routing Control Overhead decreases.
iii) Amount of routing information decreases.

## 3.CLUSTER HEAD SELECTION

In this we select a node as a leader node. Initially, all nodes act as cluster heads and they transmit hello messages .These messages are received by each of the nodes from its neighboring nodes. When any node receives hello message from neighboring nodes then it adds a new entry in the neighbor table. When hello messages are received from all neighbor nodes then it assigns priority to each node according to energy level and total no. of nodes present. Then it compares the electing node with highest priority with itself ,if priority of electing node is greater than that node's priority then it acts as a cluster head else if priority is not greater then node itself acts as a cluster head.

Selection of node done on the basis of following factors:-

- Location of a node among other nodes.
- Mobility
- Energy
- Trust
- Throughput

Generally cluster head selection includes following steps-

- Firstly we setup the threshold value and only those nodes will act as the cluster head whose value is greater than the threshold value.
- Then measure the energy level of the nodes and the node with maximum energy level will acts as the cluster head.
- When the node with is selected as the cluster head then the counter time must be setup for that node to stay as the cluster head for certain amount of time.
- After timeout of the first node, next maximum energy level among the nodes will be checked and the next node with maximum energy level will be selected as the cluster head.
- If in between new node arrived then the energy level for this node also be measured and compared with the threshold value.

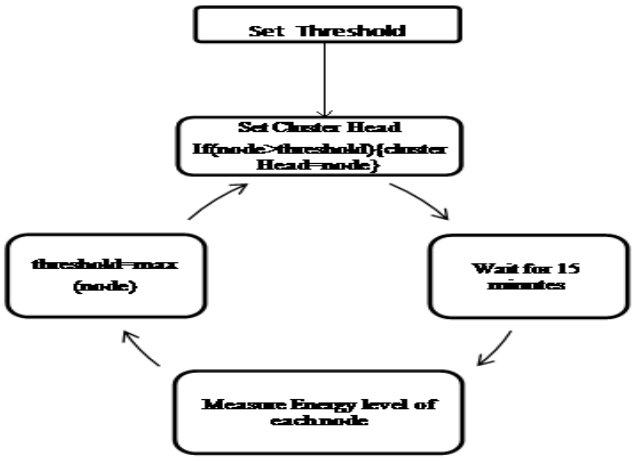


Fig 3:-Cluster Head Selection Process [11]

3.1Security in Cluster MANETs

Security is a major issue in routing of information between clusters. There are no. of attackers present which finds the identity of the cluster nodes, drops the communication .The information collected by attacker is useful for making attack plans for the Certification authority node and disturbs the overall cluster process. So in order to provide security and protect the identity of individual node some techniques like threshold signature must be used. Threshold signature consists of basic operations like generation of pairing parameters, private keys. Algorithm like Trust based Cluster Head Selection is used for providing security by computing TRUST VALUE from the neighbor nodes. Each node collects the trust values which helps in the selection of cluster head and improves the authentication and confidentiality.

3.2 Energy Consumption

We have to reduce the energy consumption and interference of nodes or signals. A technique called topology control is used for reducing the energy consumption, interference among signals and extend the lifetime of network by selecting accurate transmission power for each node. Topology control includes parameters like energy efficiency, scalability, and k-connectivity and network lifetime.

## 4.CLUSTERING ALGORITHMS

4.1Lowest Id Cluster (LIC) algorithm

In this unique ids assigned to each node. Node with minimum id selected as cluster head. Ids of neighbor nodes are always greater than the cluster heads. A gateway node is a node which lies in between the two or more cluster heads transmission range. Gateway nodes are responsible for the routing between the clusters. LIC concerns only with lowest id nodes to which arbitrary numbers are assigned without taken into account the qualification of node and QoS parameters.

Drawbacks-

1. Power drainage occurs if certain node acts as a cluster head for a long time.

2. Security factors are not included.

4.2 Power Awareness Load Balancing Clustering (LBC) algorithm

It provides the balancing of load among the elected cluster heads. In this algorithm each node assigned with a variable virtual ID (VID) and this value sets as its ID number. Node with a highest ID always selected as a cluster head node. Cluster head assigned with a specific time or budget for which the node acts as a cluster head. The budget is generally a restriction which is defined by the user in order to meet the characteristics of the system like battery life of the nodes. If the budget of a node exhausted then it sets it VID to 0.If two cluster head nodes budget get exhausted at the same time then the node with higher VID gets a cluster head role.

Drawbacks-

1. Cluster head serving time does not provide better utilization of energy.

2. Quality of Service parameters are not considered.

4.3 K-hop Connectivity ID Clustering Algorithm (KCONID)

In this cluster heads are selected on the basis of connectivity and the lowest id. The node with maximum connectivity selected as a cluster head .Here all other nodes are at distance of at most k-hops from the cluster head. If the connectivity of two nodes has same value then the node with lowest id selected as a cluster head. A pair did (d,id) is assigned to each node in the network where d represents the connectivity of node and id represents the identifier of the node. There is another approach for this algorithm which is based on the energy level. Here the node which has maximum energy level always selected as a cluster head.

Drawback-

As selection is done on the basis of energy then energy drainage of cluster head occurs if one node becomes cluster head for a long time.

4.4 Highest connectivity clustering algorithm (HCC)

Here each node transmits or broadcasts its ids to the nodes which are present within the transmission range of that node. The node which has maximum number of neighboring nodes will be selected as cluster head node. The neighboring nodes which becomes the members of the cluster head do not participate in the election process .Here cluster heads are not directly connected with each other, only one cluster head is present per cluster. The nodes present in a cluster is either a cluster head or ordinary node.

Drawback-Some resources are assigned to the cluster which are shared by the cluster members. Due to this, the throughput of the system decreases as the number of nodes increases.

4.5 Least Cluster Change (LCC) algorithm

This algorithm considers the cost for the maintenance of cluster and some issues like cluster re-clustering. LCC clustering algorithm has two parts-

- Cluster Formation
- Cluster Maintenance

Cluster formation phase follows the Lowest Id Cluster algorithm in which the node with lowest id is selected as cluster head. Re-clustering is done in two cases-

- When two cluster heads must be reached within each other's transmission range then one leaves the cluster head role.
- When any mobile node does not access any cluster head or it does not come within the reach range of any cluster head then the structure of the cluster is reconstructed according to the LIC algorithm.

Drawback- Large communication overheads as the structure of the cluster can be rebuild due to the one mobile node which cannot access any cluster head.

4.6 Weighted Clustering Algorithm (WCA)

In this the cluster head is selected according to some parameters like the number of nodes which can be handled by the cluster head battery power, transmission power and mobility of the nodes. The selection of the cluster head must be done according to the weight value which is associated with each node. The weight value of the node k is defined as-

$Wk = w1\ \Delta k + w2\ Dk + w3\ Mk + w4\ Pk$

The node which has minimum weight must be selected as the cluster head.

Mk -represents the mobility of the node which is the average running speed of every node within a specific time T.

Δk- represents the degree difference which is obtained by calculating the no of neighbors for each node. This calculation's result is defined by the dk. For the purpose of load balancing the degree difference must be calculated as $|dk-\delta|$ where δ represents the pre-defined threshold.

Dk- represents the sum of all distances of a given node to its neighbors.

Pk- measures the consumption of battery power.

Drawback- More consumption of battery power by the cluster head as it has many responsibilities.

## 5. PROBLEM FORMULATION

In clustering, cluster head performs the major role for the transmission of the data among various nodes. If selection of cluster head is not done with efficient technique by considering the important parameters then the communication becomes unreliable .A security and imbalanced energy consumption is a major concern in the selection of cluster head for the clustering of MANETs as attackers or any unknown node enters into the network and access or alters the information and disturbs the cluster communication. Here, the problem arises is of imbalanced energy consumption if one node acts as a cluster head for a long time. There are no. of algorithms like lowest id clustering, power awareness load balancing etc. which provides the cluster head selection on the basis of energy and security by using the IDs of the nodes but there is no efficient algorithm which provides both security and energy efficiency. The main disadvantage of these techniques is that they require a large setup time for the cluster. Other factors like trust, throughput, checking black list of nodes are also are not considered for the cluster head selection.

## 6. CONCLUSION

We have reviewed various clustering algorithms on the basis of security and energy in the mobile adhoc networks in which cluster head is selected among various nodes present in the cluster by comparing their ID values. The main aim of every algorithm is to select the cluster head which increases the network lifetime and transmission rate. Selection of cluster head is a difficult task. As in these algorithms same node selected as cluster head next time due to the independent network topology which results in imbalanced energy consumption. Security problem arises because there is not any fixed infrastructure for the network. It is difficult to maintain the stability of the network. Many algorithms are developed for this purpose of which security and energy efficiency is a new area for research. So, there should be an efficient algorithm which taken into account the security, energy, trust, fault tolerance and checking black list of nodes.

## REFERENCES

[1] A.S.Salunkhe,Dr.S.V.Sankpal, January 2013, "Performance Evaluation Using Cluster Based Routing Protocol for MANET"
[2] Sandeep Kr. Agarwal, Amit Garg and K. V. Arya, "Security Issues & Clustering Based Solutions in Mobile Ad-hoc Networks - A Survey", Journal of International Academy of Physical Sciences, Vol. 16 No.3 (2012).
[3] Raihana Ferdous, Vallipuram Muthukkumarasamy and Elankayer Sithirasenan, "Trust-based Cluster head Selection Algorithm for Mobile Ad hoc Networks", Trust, Security and Privacy in Computing and Communications (TrustCom), 2011 IEEE 10th International Conference on. IEEE, 2011.
[4] Wei Liu, Hiroki Nishiyama, Nirwan Ansari, Jie Yang, and Nei Kato, "Cluster-based Certificate Revocation with Vindication Capability for Mobile Ad Hoc Networks"
[5] Yao Yu and Lincong Zhang, "A Secure Clustering Algorithm in Mobile Ad Hoc Networks", IPCSIT vol. 29 (2012).
[6] Rakesh Kumar, Dr Piush Verma and Dr Yaduvir Singh, "A Review and Comparison on Manet Protocols with Secure Routing Scheme Developed using Evolutionary Algorithms", International journal of Computer Engineering & Technology (IJCET), Volume 3, Issue 2, 2012, pp.
[7] Dang Nguyen, Pascale Minet, Thomas Kunz and Louise Lamont, "On the Selection of Cluster Heads in MANETs," IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 2, March 2011.
[8] R. Vennila and V. Duraisamy "QoS Based Clustering Technique for Multicast Security in MANET," European Journal of Scientific Research, ISSN 1450-216X Vol.81 No.1 (2012), pp.33-46.
[9] Mao YE, Chengfa LI, Guihai CHEN, and Jie WU "An Energy Efficient Clustering Scheme in Wireless Sensor Networks," Ad Hoc & Sensor Wireless Networks, Vol. 3, pp. 99-119 April 21, 2006
[10] A.S.Nargunam and M.P.Sebastian, "Fully Distributed Cluster Based Routing Architecture for Mobile Ad Hoc Networks," Proc. IEEE Int'l Conf. Wireless and Mobile Computing, Networking, and Communications.

[11] A.E.Narayanan, R.Devi and Dr.A.Vincent Jayakumar," An Energy Efficient Cluster Head Selection for Fault Tolerant Routing in MANET" International Journal of Engineering and Technology (IJET).
[12] R. Agarwal and D. Motwani, "Survey of clustering algorithms for MANET," http://arxiv.org/abs/0912.2303.
[13] M. Chatterjee, S. Sas, and D. Turgut, "An on-demand weighted clustering algorithm (WCA) for ad hoc networks," *In Proceedings of the IEEE Global Telecommunications Conference (GLOBECOM '00)*, 2000.
[14] Ratish Agarwal, Dr. Mahesh Motwani, "Survey of clustering algorithms For MANET", IJCSE, Vol. 1 Issue No. 2, pp. 98-104
[15] P.Chatterjee, "Trust based clustering and secure routing scheme for mobile ad hoc networks," *International Journal of Computer Networks and Communication*, vol. 1, no. 2, pp. 84–97, 2009.
[16] S. Chinara and S. K. Rath, "A survey on one-hop clustering algorithms in mobile ad hoc networks," *Journal of Network and Systems Management*, vol. 17, no. 1-2, pp. 183–207, 2009.
[17] K. Ramesh and D. K. Somasundaram, "A comparative study of clusterhead selection algorithms in wireless sensor networks,"*International Journal of Computer Science& Engineering Survey*, vol. 2, no. 4, 2011.
[18] S. Rohini and K. Indumathi, "Probability based adaptive invoked clustering algorithm in MANETs, http://arxiv.org/abs/ 1102.1754.
[19] L.Xu and Y. Zhang, "An ewreputation-based trus management strategy for clustered ad hoc networks," in *Proceedings of the International Conference on Networks Security, Wireless Communications and Trusted Computing (NSWCTC '09)*, pp. 116– 119, April 2009.
[20] A. Zabian, A. Ibrahim, and F. Al-Kalani, "Dynamic head cluster election algorithm for clustered Ad-Hoc networks," *Journal of Computer Science*, vol. 4, no. 1, pp. 42–50, 2008
[21] N. Gupta, M. Shrivastava, A. Singh, "Cluster Based on Demand Routing Protocol for Mobile Ad Hoc Network," IJERT, Vol. 1, Issue No. 3,2012.