

# A Hierarchical Classification of Various Clustering Schemes for MANETs

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**Abstract**— Clustering is the most widely used performance solution for Mobile Ad Hoc Networks (MANETs), enabling their scalability for a large number of mobile nodes. The design of clustering schemes is quite complex, due to the highly dynamic topology of such networks. Many clustering schemes have been proposed for ad hoc networks. A systematic classification of these clustering schemes enables one to better understand and make improvements. A large variety of approaches for ad hoc clustering have been developed by researchers which focus on different performance metrics. This paper presents a survey on classifications of different clustering schemes.

**Keywords**— Mobile ad hoc networks, Clustering, Cluster-head, Routing, Gateway

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## I. INTRODUCTION

In an ad hoc network, mobile nodes communicate with each other using multihop wireless links [2]. There is no stationary infrastructure; for instance, there are no base stations. Each node in the network also acts as a router, forwarding data packets for other nodes. Given the nodes heterogeneity, nodes may have highly variable amount of resources, and this produces a hierarchy in their roles inside the network. Nodes with large computational and communication power, and powerful batteries are more suitable for supporting the ad hoc network functions (e.g., routing) than other nodes.

Cluster-based routing is a solution to address nodes heterogeneity, and to limit the amount of routing information that propagates inside the network. The idea behind clustering is to group the network nodes into a number of overlapping clusters. Clustering makes possible a hierarchical routing in which paths are recorded between clusters instead of between nodes. This increases the routes lifetime, thus decreasing the amount of routing control overhead. Inside the cluster one node that coordinates the cluster activities is clusterhead (CH). Inside the cluster, there are ordinary nodes also that have direct access only to this one clusterhead, and gateways. Gateways are nodes that can hear two or more clusterheads.

Ordinary nodes send the packets to their clusterhead that either distributes the packets inside the cluster, or (if the destination is outside the cluster) forwards them to a gateway node to be delivered to the other clusters [3].

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.

## II. CLUSTER HEAD SELECTION

Cluster head (CH) is 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 [3].

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 act as the cluster head. When the node 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.

### III. SECURITY IN CLUSTERS IN 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 [14].

### IV. CLUSTERING ALGORITHMS IN MANET

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. A description of various clustering schemes is given below in table no. 1 and classification of each method is presented in fig no.1 [5], [7], [8], [13].

TABLE I  
 VARIOUS CLUSTERING SCHEMES IN MANET

Clustering Schemes	Description
<b>Identifier-based clustering[1]</b>	A unique ID is assigned to each node. Each node in the network knows the ID of its neighbors. The cluster head is selected based on criteria involving these IDs such as the lowest ID, highest ID...etc.
<b>Connectivity-based clustering[6]</b>	The cluster head is chosen based on a metric computed from the network topology like node connectivity.
<b>Mobility-aware clustering[4,8,9]</b>	An ad hoc network is partitioned into clusters based on mobility metric. The cluster head is selected based on the factors like local stability, relative speed, low variance value etc.
<b>Low cost of maintenance clustering[10]</b>	Perform clustering for upper-layers and reduce the maintenance cost. Reduce Re-affiliation and Re-clustering, lower the communication overhead. •Re-affiliation: change the affiliation cluster for a node •Re-clustering: change the structure of a cluster
<b>Power-aware clustering[11]</b>	The battery power of node is a constraint that affects directly the lifetime of the network, hence the energy limitation poses a severe challenge for network performance. CH performs special tasks such as routing causing excessive energy consumption.
<b>Combined-weight based clustering[12,15]</b>	Cluster head is selected based on combination of weighted metrics such as: transmission power, node degree, distance difference, mobility and battery power of mobile nodes... etc. The weighting factors for each metric may be adjusted for different scenarios.

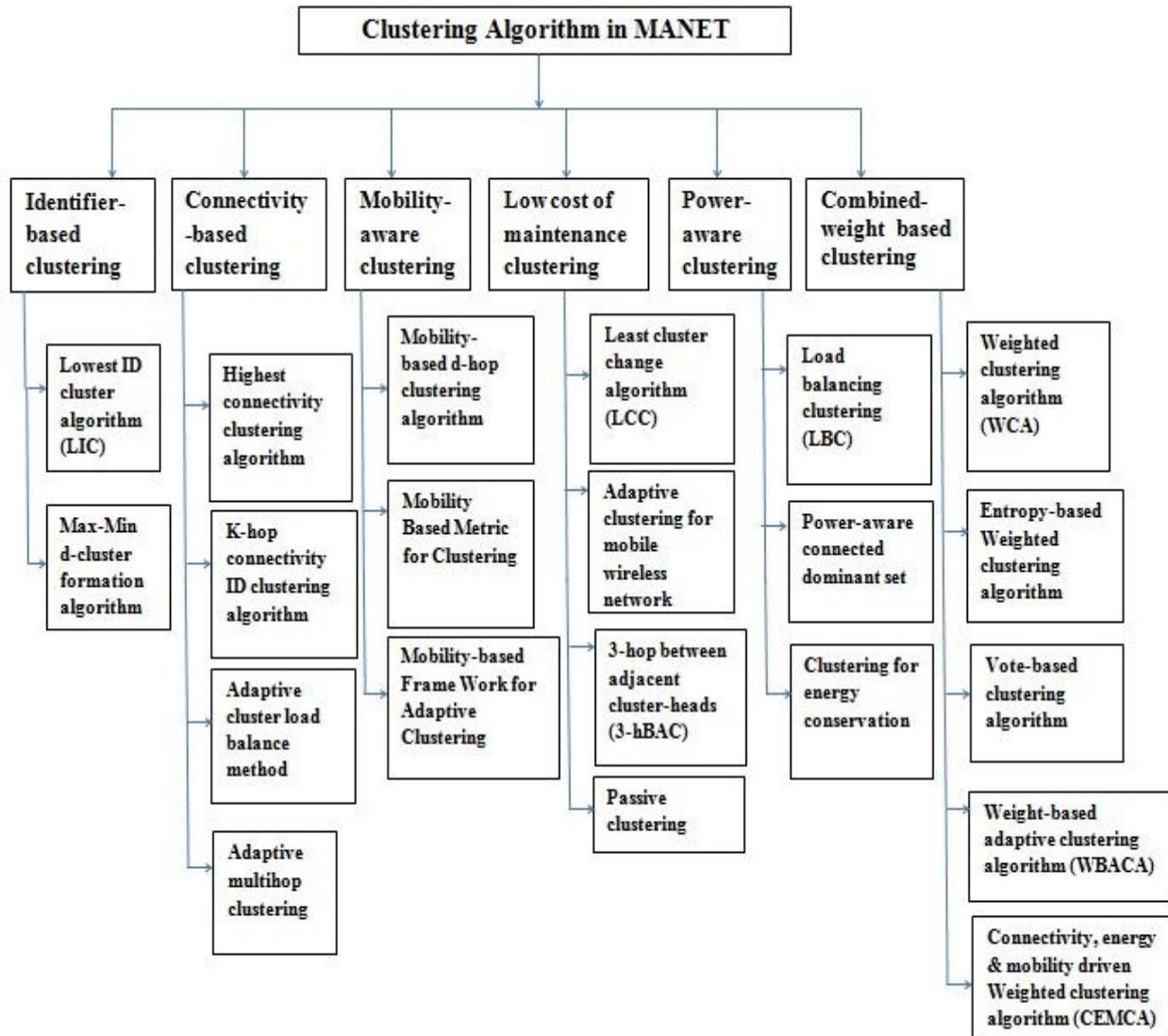


Fig no. 1: Classifications of clustering schemes in MANET

## V. CONCLUSION

In mobile ad-hoc networks, many cluster hierarchy algorithms have been proposed to solve the scalability issue. In this paper, we first provided fundamental concepts about MANET, Cluster Head selection for a large dynamic MANET Clustering. Then we provided security in clustering and finally classified proposed clustering schemes into five categories based on their main objectives in choosing the Cluster Head Selection Procedure. Different types of clustering schemes may have a different focus and objectives such as Identifier –Based, connectivity –based, Mobility based, low cost of maintenance based, and Power-aware based. Although each scheme is well suited for certain scenarios, based on its efficient Cluster Head it is not guaranteed that any one of them is the best for all situations. The future research will be focused on the more efficient and effective clustering schemes and a combination of different parameters in choosing the effective Cluster Head in Cluster Topology for MANETs.

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