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Review on Cluster Head Selection Algorithms

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Abstract — Mobile Ad-Hoc (MANET) System is flexible, Self-Configure with limited bandwidth and power using wireless connections. Its topology changes very fast and undirected because of node movement. It does not require any pre-configure infrastructure. In MANET due to decentralize of resources every nodes have to perform the routing functionalities themselves. Communication in such type of network is challenge and complex. To overcome these problems Clustering is the best solution for wide, flexible and high portability Ad-Hoc System. It increases the potential of network and reduces the routing overhead for efficient routing in MANET. Different types of phases involve in Cluster are Designing of Cluster and Maintenance of Cluster. In Cluster designing, selecting proper cluster head is one of the primary issues of research. For Maintenance of cluster an efficient system is required so that cluster head can keep update all the data of cluster, due to change in cluster structure because of nodes mobility. This paper basically focused on the Weight Based Clustering (WCA) algorithms in MANET.

Keyword — Clustering, MANET, Cluster Head, Design of Cluster, WCA

1. INTRODUCTION

Infrastructure type wireless networks communication happens between the wireless nodes and the central device. In this environment wired backbone is used to setup the network. This is not feasible in situations such as law enforcement operation, battle field communication, disaster management and many more. This situation demands the network where independent portable nodes are deployed and nodes exchange the messages with each other, without using centralized device. This type of network is characterized as AD-HOC networks (MANETs). A MANET is the organization of portable mobile devices to deploy a network when it is required, without depending on the current internet Infrastructure or some other type of fixed stations.

Routing is the basic issue in MANETs. Routing is a technique for selecting the way to send the packet in the network. In Ad-Hoc network, main task of the routing protocol is to setup efficient route between two nodes, to deliver message on time. Route setup is done with least overhead and bandwidth. In this network path failure is high due to restriction of energy, transmission range and node mobility. To overcome with path failure, routing protocols are devise for MANETs. In MANET routing protocols are divided mainly into two divisions such as Table-Driven and On-demand. Table-driven routing keeps update every node's routing table information on time to time basis. On-demand routing, does not update rather route is discovered when it is required. A few illustrations routing protocols are given in Table-1

Table-1

S.No	Classification	Protocol
1	Proactive	Dynamic Destination Sequenced Distance-Vector (DSDV)
2	Proactive	Cluster Head and Gateway Switching Routing (CGSR)
3	Proactive	Wireless Routing Protocol (WRP
4	Reactive	Dynamic Source Routing (DSR),
5	Reactive	Ad Hoc On-Demand Distance Vector (AODV
6	Reactive	Temporally-Ordered Routing Algorithm (TORA
7	Hybrid	Zone Routing Protocol (ZRP)

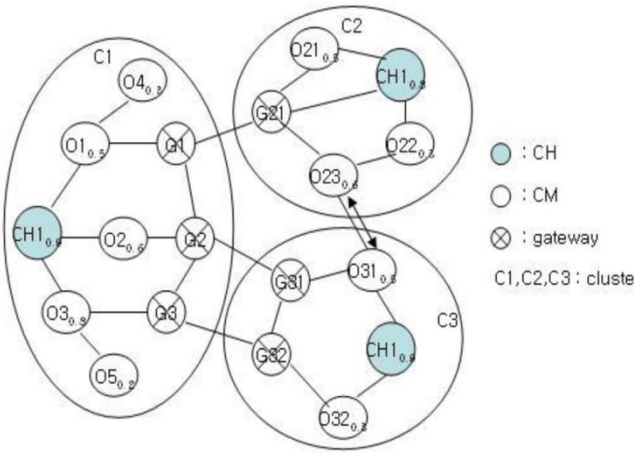
The rest of the paper is organized as follows. Clustering in mobile ad hoc network explained in section II. Literature Survey presented in section III. Concluding remarks are given in section IV.

2. Clustering in Mobile Ad hoc Network (MANET)

Clustering is a technique which will optimize resource management in MANET. Clustering is to attain scalability in huge networks and high mobility. Every portable device in the cluster advertises the messages to setup the connection. If any device change its cluster, then just that device which are in corresponding clusters are required to update the information, there is no need to refresh the complete network. Different parts of clusters are

a) Cluster Head(CH)
b) Cluster Members(CM) and
c) Cluster Gateway(CG)

CH node is a coordinator of its own cluster. CM is an ordinary node that communicates only with its cluster head. CG is a node which works like a bridge to forward information between clusters.



Clustering of Nodes

Figure-1

2.1 Advantage of Clustering:-

The cluster design ensures well ordered performance with respect to huge dense ad hoc networks. The benefit of cluster is as follows:

1) It permits the protocol for the better execution at MAC layer by enhancing the throughput and versatility.
2) It decreases the scale of routing table, and enhanced the routing.
3) Updating the routing tables due to topological changes will result in reduce of transmission overheads.
4) It helps to reduce the bandwidth and energy consumption in ad-hoc networks

Disadvantage of Clustering: -

1) Clustering related data interchange, increases overhead on the network.
2) Reconstruct of Cluster Structure in Case of Network Structure change is resource consuming.
3) Communciation Complexity increases due to Control Messages exchange.
4) Their is no general solution for clustering.

3. Literature Survey

There are lots of methods proposed to setup the clusters. Various methods among these have considered single parameter for selecting the cluster head (CH). The parameter may be node identification number (NID), Power of battery (PoB), Node availability (NA), Node portability (NP) etc. Network quality may be reduced when we consider single performance parameter for calculating the node quality to become cluster head. Many researches are completed / under process in this field where performance parameters are combined to select quality based nodes as cluster head (CH).

In the remaining section we will discuss about different clustering algorithm (see classification in figure 2).

Single Performance Factor Based Clustering

These scheme consider only one performance variable for clustering choices. A number of clustering algorithm has been proposed under this scheme. Some of them are listed underneath:

In **Lowest ID Cluster method** (LIC) [2], a node with the least ID is picked as a Cluster Head(CH). To every node a unique ID is allotted. Intermittently, the node telecasts the list of nodes that it can listen. A node with least ID will act as a CH. Disadvantage of this algorithm is that certain nodes are disposed to power drain out because of serving as CHs for longer period of time.

In **Highest Connectivity Clustering** Algorithm (HCC) [2], the degree of a node is computed in view of its separation from others. Every Node telecasts its ID to the Node that is inside of its transmission range. The Node with most extreme number of neighbors (i.e. most extreme degree) is picked as a CH.

Classification of Clustering Algorithms	
Single performance factor based clustering	Multiple performance factor based clustering
Lowest ID	Weight-based distributed
Highest Connectivity	Weight-Based Adaptive
K-CONID	Entropy-based Weighted
Adaptive multihop	Connectivity, Energy and Mobility driven Weighted
Mobility based d-hop	x
3-hop	x
Load Balancing Clustering	x

Figure-2

The disadvantage of this algorithm is that it doesn't have any restriction on the upper-bound on the quantity of nodes in a cluster. When number of nodes in a cluster is expanded, the throughput gets diminished. The re-alliance count of nodes is high because of Node mobility and the Cluster Head (CH) may not be re-chosen regardless of the fact that it loses one neighbor.

K-CONID [2], consolidates two clustering algorithms such as LID and HCC. So as to choose CHs, connectivity is considered as a first criterion, and least ID is considered as a second criterion.

Adaptive multihop Clustering algorithm [2] sets upper bound and lower bound on the number of cluster members within a cluster that a Cluster Head can deal with. At the point when the number of cluster members in a cluster is not exactly the lower bound, the cluster needs to converge with one of the neighboring cluster. Furthermore, if the number of cluster members in a clustering is more noteworthy than the upper bound, the cluster is separated into two clusters.

Mobility based d-hop clustering [3] partitions an ad hoc network into d-hop clusters based in view of versatility metric. The goal of forming d-hop clusters is to make the cluster diameter more adaptable. Local Stability is figured out all to choose a few nodes as Cluster Heads (CHs). A node might turn into a Cluster Head if it is observed to be the most stable node among its neighbors. Along these lines, the Cluster Head will be the node with least value of local stability among its neighbors.

3-hop between adjacent cluster heads (3-hBAC) algorithm [2] presents another node status, called "cluster visitor", which implies this node is not inside of the transmission scope of any CHs, however inside of the transmission scope of some cluster members. At the point when a mobile node finds out that it can't serve as a CH or join a cluster as a cluster member, yet some neighbor is a cluster member of some cluster, it joins the relating cluster as a cluster visitor.

Load Balancing Clustering (LBC) [2] give a close-by balance of load on the choose cluster heads. Once a node is chosen as a Cluster Head, it is alluring for it to stay as a Cluster Head up to indicated measure of time. At first, mobile nodes with the Highest ID in their neighborhood territory will be assign as a Cluster Head. LBC limits the maximum time units that a node can serve as a Cluster Head persistently, when a CH exhaust its length of time spending as cluster head, it resets its VID to 0 and turns into an ordinary node. The drawback is that, the cluster head serving time alone may not be a good indicator of energy consumption of mobile nodes.

MULTIPLE PERFORMANCE FACTOR BASED CLUSTERING

Multiple measurements based clustering or weight based clustering takes a number of measurements into record for cluster setup. Primary advantage of this scheme is that it can adapt-ably conform the weighting variables for every metric to acclimate to various scenarios. For instance, in a framework where battery power is more imperative, the weight component connected with energy capacity can be set higher.

The decision of the Cluster Head depends on a non specific weight (i.e., a real number>=0), connected with every node. The node with the highest weight in its territory will be elected as a Cluster Head (CH). When the weight of a node is inversely proportional to its speed, the node with least weight will be chosen as cluster head. Subsequent to, these nodes either don't move or move slower than different nodes, their cluster is ensured to have a more life.

The **weight-based distributed clustering** algorithm (WCA) [3] takes into consideration, node degree, transmission power, mobility, and battery power of mobile nodes. Contingent upon particular applications, any or all of these parameters can be utilized as a part of the metric to choose the Cluster Head (CHs). This depends on completely distributed methodology, where all the nodes in the mobile system will share the same responsibility and act as Cluster Heads. The time required to recognize the CHs relies on upon the diameter of the fundamental network graph. This technique keeps a predefined threshold value for number of mobile nodes in a cluster. The CH decision technique is summoned just on-demand in this way it reduces routing control overhead.

Advanced Efficiency and Stability Combined weight based Distributed clustering algorithm [4], proposes consolidated weight-based distributed clustering approach with various hierarchical structure that can ready to keep up MANET topology as steady as could be expected under the circumstances.

To diminish the starting overhead that is created during clustering setup phase, this algorithm utilizes "local minima" rather than utilizing "global minima". That is, minimum weight is figured for all nodes in the network to choose and manage CH.

The cluster head in every cluster group is chosen with a minimum weight among its one-hope neighbors, and plays the role of cluster head (CH) inside of the scope of predefined edge. In this calculation, if a hub separated specifically from the CH due to versatility, and if convey portal associated to the same bunch, it can keep on interfacing with its group head through the conveyed passage. In this way, the group part does not needs to perform re-grouping process despite the fact that it moves, hence enhances security of the whole system.

Weight Based Adaptive Clustering in Wireless Ad Hoc Systems (WBACA) [1], beats the disadvantage of WCA calculation. That is, it utilizes the idea of "global minima". That is, every node in the network must calculate its weight before beginning the clustering process. This procedure might take lot of time. Likewise, two cluster heads can be one-hop neighbors, which superfluously bring about shaping two different clusters rather than one. Along these lines, WBACA utilizes the idea of "local minima". That is, the node with the minimum weight is picked as the cluster head.

Entropy-based Weighted Clustering Algorithm (EWCA) [2] reduces the recurrence of re-affiliation in the network. Since, frequent re-affiliation in the network might reduce the performance of the network.

Connectivity, Energy and Mobility driven Weighted Clustering Algorithm (CEMCA) [3] depends on standardization. The standardized value of mobility, degree, energy level is figured and is utilized to find the quality for every node (standardized to 1). The node shows its quality to its neighbors so as to acquire the better node among them. Furthermore, the node with the best quality is picked as cluster head.

4. CONCLUSION

Clustering is the best answer for extensive and thick mobile adhoc network with high mobility. Selecting proper cluster head is one of the principle research issues. In this way in this paper, we thought about the single metric and numerous metric based clustering algorithm and observed that the numerous based algorithm (ie., weighted clustering algorithm) sounds gainful than single metric based clustering algorithm.

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