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PERFORMANCE IMPROVEMENT IN MANET USING CLUSTERING

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Abstract- Ad-hoc network consists of various wireless nodes communicating with each other without any centralized administration. Every node contributes to the routing process in such a network. Nodes being mobile can move to different location over the time leading to the formation of dynamic topology. Routing algorithms in such a network must adapt to such a dynamically changing network topology. Process of clustering that divides the network into interconnected substructures, called clusters. Clusters are the group of entities which allow the clustering algorithm for structuring of network creates a hierarchical structure.Clustering methods allow fast connectionand topology management, better routing and also improvenetwork performance parameters like routing delay, bandwidthconsumption and throughput. This paper deals with a survey of clustering algorithms use in Mobile Ad-hoc Network (MANET).
Keywords– Cluster, MANET, Identifier-based clustering, Connectivity-based clustering, Mobility-aware clustering, Low cost of maintenance clustering, Power-aware clustering.

1. INTRODUCTION

A Mobile Ad hoc network is a collection of independent mobile nodes that communicate with each other using radio waves in an infrastructure-less environment. In an ad hoc network, a node can communicate directly with another node in point-to-point mode when the two nodes are located in the same transmission zone, while communication with a node in another zone is carried out via several intermediary nodes in multi-hop mode[1]. Each node in the network acts as both host and router. It discovers and maintains routes to other nodes in the network. Since the nodes are mobile, the network topology may change rapidly and unpredictably and the connectivity among the terminals may vary over time. The time-varying nature of the ad hoc network topology renders the traditional fixed network routing techniques, such as the shortest-path and link-state protocols, obsolete for Ad hoc networks. An efficient routing protocol is required to cope with such dynamic network condition and must find the path quickly and efficiently. Such protocols must also deal with typical limitations of these networks which include low bandwidth, high power consumption, and low error rates.

Clustering is the process of logically dividing the network into interconnected substructures. A cluster is a sub section within the network that is formed by combining nodes that share same property and behavior. Nodes within a cluster are classified according to their behavior or functionality. A Node is termed as clusterhead if it acts as a local coordinator of the cluster. It coordinates intra-cluster transmission and data forwarding to other cluster[2]. If a non-clusterhead node that is establishes a connection with other cluster and performs inter-cluster communication is termed as clustergateway. Other type of nodes that are non clusterhead and non clustergateway are termed as cluster members. Figure 1 show a typical cluster with its inhabitants.

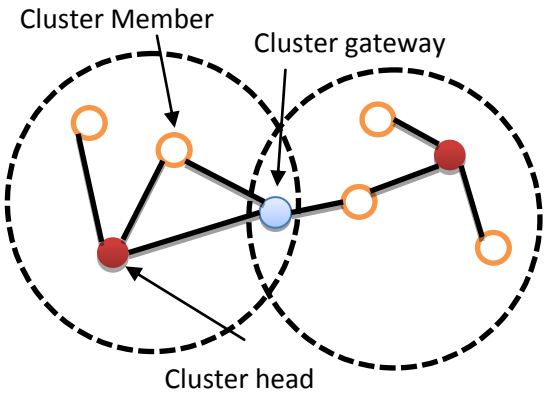

Figure 1: Cluster structure

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Within the cluster, the cluster head has 1-hop connectivity with all members and directly communicate with member nodes. However, member nodes cannot directly communicate with other members of cluster. Gateway node has two or more cluster heads as its neighbors in its vicinity. The routing process itself is performed as source routing by flooding the network with a route request message. Due to the clustered structure there will be less traffic, because route requests will only be passed between clusterheads.There are two ways in which cluster heads can be selected.

1. Connectivity-based method: In this a node with highest number of connected neighbour is elected as the cluster head. During the course of time, if node loses its link, then other node with highest number of connectivity is elected as cluster head.
2. Identifier-based method: Here a node with lowest/highest [3]node-ID is considered as the cluster head.

2. CLASSIFICATION OF CLUSTERING ALGORITHMS

Cluster based algorithms can be classified as i) Identifier-based clustering ii)Connectivity-based clustering ii)Mobility-aware clustering iv)Low cost of maintenance clustering v)Power-aware clustering

2.1 Identifier based clustering

In identifier based clustering uses unique ID of each node to select the cluster head. It is further classified into i) Lowest ID cluster algorithm (LIC) and ii)Max-Min d-cluster.

In Lowest ID cluster algorithm (LIC) [4] a node with the minimum id is chosen as a clusterhead. The ids of all neighbours surroundingclusterheadwill be higher than that of the clusterhead. In such a network, each node is assigned a uniqueid and periodically broadcasts a list of nodes that it canhear. If it hears nodes with id higher thanitself, it assumes to be aclusterhead. As the node ids don't change overtime, the smaller ids node is more likely to become clusterheads than others. One of the drawback of this algorithm is that, nodes with lower id's are prone to power drainage due to serving as clusterheads for longer periods of time. In Max-Min d-cluster formation algorithm [5], the cluster is formed by the collection of nodes that are up to d-hops away from a clusterhead. The value of d is heuristically chosen so as to control the total number of clusterheads or the density of clusterheads in the network. Cluster head is elected based on the maximum node id. Thus a node with higher node id is likely to become a cluster head in the d neighbourhood.

2.2 Connectivity-based clustering

In these algorithms, cluster head is chosen based on a metric computed from the network topology such as node connectivity. There are two algorithms in this category, namely i) Highest connectivity clustering algorithm (HCC) and ii) K-hop connectivity ID clustering algorithm (KCONID)

In Highest connectivity clustering algorithm (HCC), every node broadcasts its id to all its neighbours with its transmission range. The node with highest degree, that is with highest number of connectivity is chosen as a clusterhead. Since cluster head is directly linked to every node, any two nodes in such a cluster is at most two In K-hop connectivity ID clustering algorithm (KCONID) Highest-degree heuristics and LowestIDalgorithms are combined together[6]. Here nodes with highest degree of connecticity are listed first and lowerID nodes is ten selected as cluster head.

2.3 Mobility-aware clustering

In this category, mobility metric of a node is used to decide the clusterhead of a given cluster. There are many algorithms under this category'

Mobility-based d-hop clustering algorithm - This algorithm considers both mobility metric and the diameter of a cluster in deciding the cluster head. Here it is assumed the each node measure the strength of the signal that it receives and can estimate its distance from its neighbours[7]. The calculation is performed based on following terms, namely, the estimated distance between nodes,the relative mobility between nodes, the variation of estimateddistance over time, the local stability, and the estimated meandistance. A node may become a clusterhead if it has the lowest value of local stability among its neighbours. In other words, it is most stable among its neighbourhood.

Mobility-based Frame Work for Adaptive Clustering[8]- Here the network is partitioned into number of multihop clusters based on (a, t) criteria. Where, 't' is the time period over which a path exists between two nodes and 'a; is the probability, regardless of the hop distance between them. This algorithm provides an adaptive hybrid routing strategy that is more responsive and effective when node mobility is low and more efficient when node mobility is high.

2.4 Low cost of maintenance clustering

The protocols under this category, aims to provide stable cluster architecture by reducing the re-affiliation rate and minimizing re-clustering situations. This is because re-clustering is more disturbing than re-affiliation, as it causes more communication overhead, route invalidation, and even ripple effect. Here, re-affiliation refers to a non-clusterhead changing the attached cluster without affecting the corresponding clusterhead(s). By limiting re-affiliation and re-clustering events, the clustering-related control overhead can be reduced accordingly. The algorithms in this category are.

Least cluster change algorithm (LCC) - This algorithm is an improvement over LIC and HCC algorithms. LCC algorithm is divided into two steps [9]: cluster formation and cluster maintenance. The cluster formation simply follows LIC, i.e. initially mobile nodes with the lowest ID in their neighborhoods are chosen as clusterheads. Re-clustering is event-driven and iw invoked only in two cases. Namely, when two clusterheads move within the range of each other, one gives up the clusterhead role. In the second case is when a mobile node cannot access any clusterhead, it rebuilds the cluster structure for the network according to LIC.

2.5 Energy-efficient clustering

These algorithms avoiding unnecessary energy consumption or balance energy consumption for mobile nodes in orderto prolong the lifetime of mobile terminals and a network. Algorithms under this category are.

IDLBC (ID Load Balancing Clustering) - here each node is assigned as virtual ID (VID) in order and a node with the highest ID within a local area is elected as clusterhead[10]. Maximum duration onto which a node can serve as clusterhead decided by Max_Countvalue. When this duration is reached, node's VID is set to 0 and it deported as ordinary node. If two clusterheads move within the same reach range, the one with higher VID win the race and continues to be the clusterhead.

Wu's Algorithm - Set of dominating nodes which function as the cluster heads to relay routing information and data packets is called a Dominating Set (DS). Wu's algorithm is based on the DS [11]. Nodes within DS consume more energy owing to the extra tasks they perform in passing routing information updateand data packet relay. Thus there is a need for lowering energy consumption of a DS. Thus in Wu's algorithms energy level (el) as against ID of the nodes is used in selecting cluster head.One method to reduce energy loss is to decrease the size of a DS. Wu proposed that, the mobile node u can be deleted from the DSwhen its close (open) neighbour set is covered by one (two connected) dominating neighbour(s), and at the same time it hasless residual energy than the dominating neighbour(s).

3. COMPARISONS:

Comparison of the selected algorithms based on the technique used in CH head selection and number of cluster formed as well as total overhead [12] is summarised in the table1 shown below.

Algorithm	Technique Used	CHs Election	Cluster Radius	Number of Clusters	CH Change	Cluster stability	Total Overhead
LIC	ID-Neighbor	Lowest ID	One- hop	High	Very high	Very low	High
Max-Min d-cluster	ID-Neighbor	Node ID	K- hop	High	Moderate	Low	Very high
HCC	Topology	Highest degree	One-hop	High	Very high	Very low	High
K-CONID	Topology	Highest degree	K- hop	Low	Low	High	Very high
Mobility based Dhoc	Mobility	Lowest mobility	K- hop	Low	Low	Very high	Low
LCC	ID- Neighbor	Lowest ID	One- hop	High	High	Low	High

Tabel1: Comparison of algorithms based on their properties

4. CONCLUSION

In this paper we have discussed about various clustering technique used MANET. We have also classified the Clustering algorithms into different categories and reviewed few selected algorithms under each category. Cluster Based Routing approach is more suitable for MANET as it provides better performance over other techniques used for routing in MANET. In future algorithms within each category can be tested either in a real network or on a simulated environment and their performances can be compared.

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