A STUDY ON CLUSTERING SCHEMES IN MANET

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ABSTRACT

Mobile Ad-hoc Network (MANET) has become an essential technology in the field of research In MANET, Clustering plays a very important role in the field of research area, it offers several advantages which helps to improve stability and decreases the network overhead to increase the network efficiency. Each Clustering Technique uses various parameters for selecting Cluster head in cluster. Cluster head acts as a leader and maintains the whole network information which decreases the computation cost and routing overhead of the network in MANET. 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 of different clustering techniques.

Keyword : - *MANET, Clustering, cluster head, gateway*

1. Introduction

Ad-hoc networking is a concept in computer communications, which means that users wanting to communicate with each other form a temporary network, without any form of centralized administration. Each node working as router, forwards data packets to the destination node of the network. In Clustering, the mobile nodes in a network are partitioned into distinct virtual groups. Nodes are assigned geographically adjacent into same cluster according to some rules [1]. Cluster based network describes the three types of nodes in the network

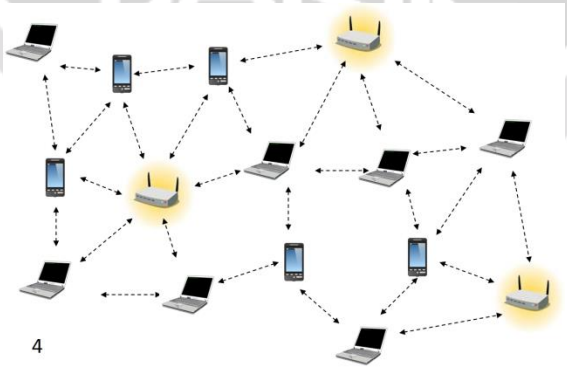

Fig-1: MANET

Cluster Head (CH): it is the coordinator of the cluster.
Gateway: is a common node between two or more clusters.
Member Node (Ordinary nodes): is a node that is neither a CH nor gateway node. Each node belongs exclusively to a cluster independently of its neighbors that might reside in a different cluster.

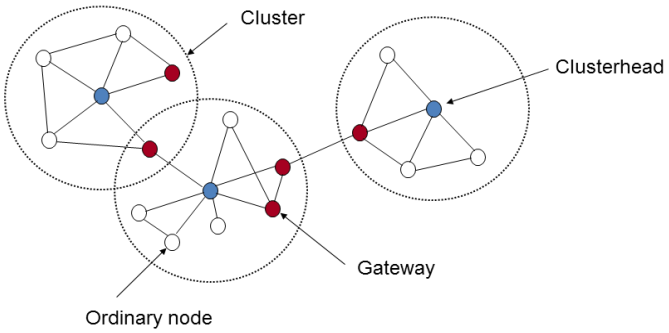

Fig-2: Clustering

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. By replacing the nodes with clusters, existing routing protocols can be directly applied to the network. Only gateways and clusterheads participate in the propagation of routing control/update messages. In dense networks this significantly reduces the routing overhead, thus solving scalability problems for routing algorithms in large ad hoc networks.

Benefits :

1.It increases system capacity by reusing available resource[2]

2. When nodes moves to another cluster only the node within the cluster should maintain node information.

3.Reduces control packets in routing[2].

4. Reduces communication overhead for both single and multi hop

Disadvantages:

1.Node updation leads to reclustering of the network

2. All nodes are mobile modes hence cluster formation changes the routing strategies which reduces the performance of the network.

2. CLUSTERING SCHEMES IN MANET

2.1 Identifier based clustering

2.1.1 Lowest ID Clustering (LIC)[3]

The node with the minimum node-id is chosen to be a clusterhead .The node id of the neighboring nodes will be higher than the clusterhead. A node is called a *gateway* if it lies within the transmission range of two or more clusters. *Distributed gateway* is a pair of nodes that reside within different clusters, but they are within the transmission range of each other. Initially, all nodes have status of ordinary node; periodically each node in the network broadcasts its ID and its neighbors IDs. Subsequently, the node with the smallest ID is selected as cluster head. A node which can hear two or more cluster heads is a gateway. The process repeats until every node belongs to at least one cluster. Nodes with a small ID are more likely to be selected as cluster heads so they quickly consume their energy.

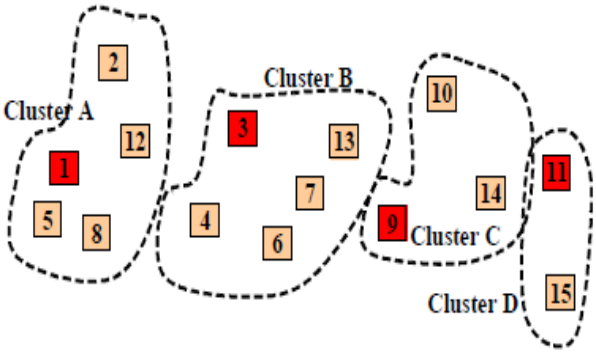

Fig-3: Lowest ID Clustering

2.2 Topology based clustering

2.2.1Highest Degree Clustering (HDC)[4]

This algorithm computes the degree of a node based on the distance (transmission range) between the node and the other nodes. The node with the maximum number of neighbors (maximum degree) is chosen to be a cluster head and any tie is broken by the node ids. The main disadvantage is a clusterhead cannot handle a large number of nodes due to resource limitations. Load handling capacity of the cluster head puts an upper bound on the node-degree. The throughput of the system drops as the number of nodes in cluster increases

2.3 Weight based clustering

2.3.1Weighted Clustering Algorithm (WCA)

In this algorithm the node-weights are assigned to nodes based on the suitability of a node being a clusterhead. The node is chosen to be a clusterhead if its node-weight is higher than any of its neighbor's node-weights and any tie is broken by the minimum node ids. The main drawback is there is no concrete criteria of assigning the node-weights. It works well for "quasi-static" networks where the nodes do not move much or move very slowly. The main disadvantage is since it is biased towards nodes with smaller node-ids, leading to battery drainage . It does not attempt to balance the load across all other nodes. It focus on four factors such as degree difference(D_1),summation of distance(P_v),mobility(M_v) and cumulative time (T_v)..The weight value associated with node v is defined as $W_v=W_1D_v+W_2P_v+W_3M_v+W_4T_v$

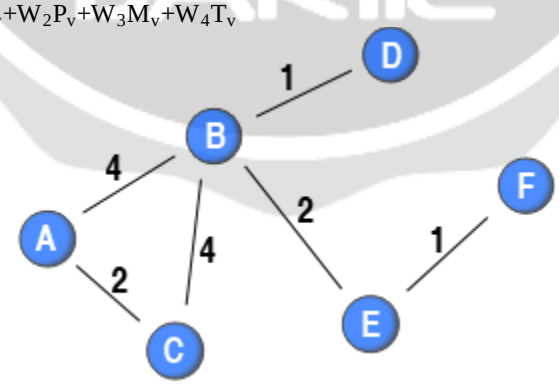

Fig-4: Weight based clustering

2.4 Mobility based clustering

2.4.1Mobility-based d-hop clustering algorithm [5]

This algorithm is based on mobility metric and the diameter of a cluster is adaptable with respect to node mobility. This clustering algorithm assumes that each node can measure its received signal strength. Thus, a node can estimate its distance from its neighbors. The strongest received signal strength implies closeness between two nodes. This algorithm requires the calculation of five terms: the estimated distance between nodes, the relative mobility between nodes, the variation of estimated distance over time, the local stability, and the estimated mean distance. Relative mobility corresponds to the difference of the estimated distance of one node with respect to another, at two successive time moments. This parameter indicates if two nodes move away from each other or if they become closer. The variation of estimated distances between two nodes is computed instead of calculating physical distance between two nodes. This is because physical distance between two nodes is not a precise measure of closeness.

2.5 Cost based clustering

2.5.1Passive clustering [6]:

Most of the clustering algorithms require all the mobile nodes to announce cluster dependent information repeatedly to build and maintain the cluster structure, and thus clustering is one of the main sources of control overhead. A clustering protocol that does not use dedicated control packets or signals for clustering specific decision is called Passive Clustering. In this scheme, a mobile node can be in one of the following four states: initial, clusterhead, gateway, and ordinary node. All the mobile nodes are with initial state at the beginning. Only mobile nodes with initial state have the potential to be clusterheads. When a potential clusterhead with initial state has something to send, such as a flood search, it declares itself as a clusterhead by piggybacking its state in the packet. Neighbors can gain knowledge of the clusterhead claim by monitoring the cluster state in the packet, and then record the Cluster head ID and the packet receiving time. A mobile node that receives a claim from just one clusterhead becomes an ordinary node, and a mobile node that hears more claims becomes a gateway. Since passive clustering does not send any explicit clustering-related message to maintain the cluster structure, each node is responsible for updating its own cluster status by keeping a timer. When an ordinary node does not receive any packet from its clusterhead for a given period, its status reverts to initial.

2.5.2Adaptive clustering for mobile wireless network[7].

Ensures small communication overhead for building clusters because each mobile node broadcasts only one message for the cluster construction. In this adaptive clustering scheme, every mobile node i keep its own ID and the ID of its direct neighbors in a set Gi. Each mobile node with the lowest ID in their local area declares to be a clusterhead and set its own ID as its cluster ID (CID). The CID information includes a mobile node's ID and CID. When a mobile node i receives CID information from a neighbor j, it deletes j from its set Gi. If the CID information from j is a clusterhead claim, the mobile node checks its own CID aspect. If its CID is unspecified (it is not involved in any cluster yet) or larger than the ID (CID) of j, it sets j as its clusterhead. The process continues till all mobile nodes access some cluster. After cluster formation is completed, clusterheads are no longer used in any further cluster maintenance phase. In the maintenance phase, when a mobile node i finds out that the distance between itself and some node j in the same cluster becomes greater than 2-hop, it invokes a cluster maintenance mechanism. If node i is a direct neighbor of the node with the highest intra-cluster connectivity in its cluster, it remains in the cluster and removes node j; otherwise, it joins a neighboring cluster. As soon as there is no proper cluster to join, it forms a new cluster to cover itself. Since this mechanism likely forms new clusters but without any cluster elimination or merge mechanisms, the cluster size decreases and the number of clusters increases as time advances. Eventually, almost every mobile node forms a single-node cluster, and the cluster structure disappears.

2.6 Energy based clustering

2.6.1Load balancing clustering (LBC) [8]:

Load balancing clustering provide a nearby balance of load on the elected clusterheads. Once a node is elected a clusterhead it is desirable for it to stay as a clusterhead up to some maximum specified amount of time, or budget. The budget is a user defined restriction placed on the algorithm and can be modified to meet the unique characteristics of the system, i.e., the battery life of individual nodes. In this algorithm each mobile node has a variable, virtual ID (VID), and the value of VID is set as its ID number at first. Initially, mobile nodes with the highest IDs in their local area win the clusterhead role. LBC limits the maximum time units that a node can serve as a clusterhead continuously, so when a clusterhead exhausts its duration budget; it resets its VID to 0 and becomes a non clusterhead node. When two clusterheads move into the reach range, the one with higher VID wins the clusterhead role. When a clusterhead resigns, a non-clusterhead with the largest VID value in the neighborhood can resume the clusterhead function. The newly chosen mobile node is the one whose previous total clusterhead serving time is the shortest in its neighborhood, and this should guarantee good energy level for being a new clusterhead. However, the drawback is that the clusterhead serving time alone may not be a good indicator of energy consumption of a mobile node.

2.6.2Clustering for energy conservation

It assumes two node types: master and slave. A slave node must be connected to only one master node, and a direct connection between slave nodes is not allowed. Each master node can establish a cluster based on connections to slave nodes. The area of a cluster is determined by the farthest distance between the master node and a slave node in the cluster. Master nodes are s selected in advance, and can only serve a limited number of slave nodes. The purpose of of this scheme is to minimize the transmission energy consumption summed by all master-slave pairs and to serve as many slaves as possible in order to operate the network with longer lifetime and better performance. Two schemes, single-phase clustering and double-phase clustering, are proposed in .

In single-phase clustering, initially every master node will page slave nodes with the allowed maximum energy . For each slave that receives one or multiple paging signals, it always sends an acknowledgment message back to the master from which it receives the strongest paging signal. Since a master node can serve only a limited number of slaves, it first allocates channels for slaves that only receive a single paging signal from itself. If any free channels remain, other slave nodes, which receive more than one paging signal, are allocated channels in the order of the power level of the paging signal received from the master node. For those slave no des, which do not receive a channel from a master in the channel allocation phase, are dropped in the further communication phase. This mechanism can reduce the call drop rate by giving priority to those slave nodes that only receive single paging signals in channel allocation. Slave nodes, which receive multiple paging signals, always try to communicate with the nearest master. Each connected master-slave pair communicates with the minimum transmission power in order to save energy. To further lower the call drop rate, double-phase clustering re-pages for slaves, which do not receive a channel in the first round, in its range. The channel allocation procedure also follows the received signal strength. The drawback of this scheme are paging process before each round of communication consumes a large amount of energy. Master node election is not adaptive, and the method of selecting the master node is not specified

3. CONCLUSION

This paper discusses about how Clustering, partitiones the mobile nods in the network into distinct virtual groups . Several clustering schemes are discussed. These clustering schemes helps to organize MANETs in a hierarchical manner and presented some of their main characteristics, objective, mechanism, and performance. Most of the presented clustering schemes focus on important issues such as cluster structure stability, the total control overhead of cluster formation and maintenance, etc

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