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CLUSTERING AND PARTITIONING IN MANETS: IMPORTANCE AND RELEVANCE

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ABSTRACT

Mobile Ad Hoc Networks (MANETs) consist of a group of wireless nodes that do not need any fixed or established infrastructure. Due to their ease of establishment they and low cost they have found wide and varied uses. However, to have an efficient network, the backbone routing protocol should be very efficient. Reactive as well as proactive routing protocols alone may not provide the requisite facilities for the MANETs to work efficiently. In this way, various clustering schemes are discussed in detail that can help improve efficiency and quality of service in MANETs.

KEYWORDS: MANETs, Routing Protocols, Clustering

INTRODUCTION

Mobile Ad Hoc networks (MANETs) are a part of ad hoc networks that have the capability of self-configuration as well self-organization [1]. This results in low cost as well as ease of application for variety of purposes.. They can be also defined as a collection of mobile nodes that intercommunicate on shared wireless channels.

Routing in MANETs is quite difficult as the network topology of such systems is dynamic. Moreover, MANETs also support multihop transmission, hence having an idea about current position of the nodes is difficult. This makes routing all the more complex. Moreover, there are many other resource constraints like bandwidth limitation, low battery power etc. that puts additional pressure on the existing system and routing solutions. The nodes entering or leaving the network have routing capabilities which allow them to create multi hop paths connecting node which are not within radio range. Routing essentially implies selecting proper path or a set of nodes in a network for transmitting packets. More efficient the routing protocol, better will be the stability as well as the resulting parameters like throughput, scalability, lifetime of devices etc. Hence, the need for schemes to support and provide a capable routing protocol. The routing protocols can be subdivided into: proactive or table driven routing protocols, reactive or on-demand routing protocols and hybrid routing protocols [2].

In proactive routing protocols, every node maintains the network topology information in the form of routing tables. To find a path from source to destination, the node runs an appropriate path finding algorithm. The required routes are provided immediately but at the cost of high bandwidth consumption which is required for periodic updates of topology.

On the other hand, reactive routing protocols do not maintain any network topology information and are quite useful to reduce the overheads by maintaining information for active routes only. The necessary route from source to destination is acquired as and when required through a connection establishment process. Routes are usually discovered by flooding route request (RREQ) packets in the network. Ad hoc on demand Distance Vector (AODV) Routing Protocol and Dynamic Source Routing (DSR) Protocol are the most prominent examples of reactive routing protocols. They are the most widely used routing protocol.

Hybrid Routing Protocols (HRP) are a combination of proactive as well as reactive routing protocols. It combines the merits of proactive and reactive routing protocols to give the best possible result. HRP tries to reduce the

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routing overhead and increase scalability by making the neighbour nodes or nodes in close range with each other to work together.

Although reactive routing protocols consume less bandwidth than proactive and are more suitable for use in MANETs but they still have major drawbacks. When a path fails, it leads to packet loss in MANETs. Even though reactive routing protocols present many solutions like backup routing but efficient selection of routes and nodes remains difficult. To overcome this problem and to improve various parameters in MANETs like throughput, end to end delay etc., some other technique has to be considered. Clustering is one of the solutions that can be thought of and is discussed in this paper.

CLUSTERING AND PARTITIONING IN MANETS

The process of connecting the network into various substructures is called clustering. Clustering provides various benefits in MANETs. It facilitates spatial reuse of resources. Also for increased co-ordination of transmission activities, a cluster head is selected among the various nodes. Further, unnecessary retransmission of data to unrequired destinations is avoided by using cluster heads. The network is better organized as cluster heads interact with each other and manage transmission and reception of packets between nodes in different clusters. This is done with the help of gateway nodes [3].

Nodes are further categorized as cluster head nodes, standard nodes and gateway nodes. Standard or ordinary cluster members just transmit and receive data packets [4]. They do not perform any other function. Gateway nodes, on the other hand, help in performing inter cluster communication. Gateway nodes belong to more than one cluster. Since cluster heads are not adjacent to each other, gateway nodes participate in the task of inter cluster communication.

sCluster head nodes receive packets intended for a particular node. If the destination node lies within the cluster, packets are transmitted to it else packets are transmitted to the cluster head having the destination node. Since cluster heads play a crucial role in identifying the destination node and sending packets to it, cluster heads must also be selected optimally. Failure of a cluster head may lead to packet loss in many clusters. Clusters form backbone of the network by providing essential services like routing, bandwidth allocation, power management etc. Fig. 1 shows a simple clustering arrangement of nodes.

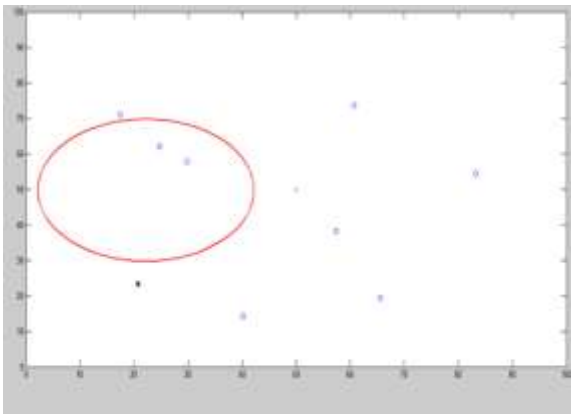

Fig.1 Clustering Arrangement of Nodes

Selection of cluster heads can be done through various techniques. Few of the techniques are discussed here[5][6]:

Highest Degree (HD) Algorithm

Location information is used here and node having highest degree in a neighbourhood is elected as cluster head.

Lowest Identifier Algorithm

Here, a node with minimum identifier is chosen as cluster head. Though this scheme is not very popular, as node having the lowest degree will have lowest stability which results in poor performance.

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Weighted Cluster Algorithm

It employs combined metric based clustering. Cluster heads are selected based on the weight. Node having the highest weight is selected. Node weight depends upon node speed, node degree etc.

CLASSIFYING CLUSTERING SCHEMES

Clustering schemes for MANET can be classify in two categories [7]

1. Single metric based clustering
2. Multiple metrics based clustering

Single Metric Based Clustering

In this scheme only one performance factor for clustering decisions is considered. A number of clustering algorithms have been proposed for the same. In Lowest ID cluster. Thus, the ids of the neighbors of the cluster head will be higher than that of the cluster head. Each node is assigned a distinct id. Periodically, the node broadcasts the list of nodes that it can hear. A node which only hears nodes with id higher than itself is a cluster head. One of the major shortcomings of lowest ID algorithm is that certain nodes are prone to power drainage.

Another example of this is Highest Connectivity Clustering algorithm (HCC). In HCC, each node broadcasts its ID to the nodes that are within its transmission range. The node with maximum number of neighbours (i.e., maximum degree) is chosen as a cluster head. This system has a low rate of cluster head change but the throughput is low. Each cluster is assigned certain resources that is shared among the nodes of that cluster. Here, as the number of nodes keep increasing, the throughput drops.

Multiple Metric Based Clustering

Combined metrics based clustering \or weight based clustering considers various suitable metrics like cluster configuration, node degree, energy capacity, moving speed, and so on. The selection of cluster heads is based on the parameters that directly affects network performance. Lowest attribute are not given any preference for selection as cluster head. Distributed clustering algorithm and weighted clustering algorithm are suitable examples of this scheme.

CONCLUSION

In this paper, the importance of routing protocols for efficient functioning of MANETs has been discussed. The roles as well as advantages and drawbacks of proactive and reactive routing protocols are discussed. Further, clustering technique is explained in detail with its benefits in selection of proper routes. Different clustering techniques are also analyzed. From the study and analysis it can be concluded that clustering technique especially weighted clustering technique, due to its efficient selection of cluster head nodes, provides an efficient way for transmission of packets.

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