Classification of MANET: A Review

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Abstract : In the past of few decades, we have seen the advancement in wireless networks. The emerging capabilities of mobile devices have given a new direction to the internet, which decreases the cost and allow us to use infrastructure wireless networks and infrastructure less wireless networks. MANET is one of the very important and actively searched topic of infrastructure less wireless networks. MANET is the science and technology which allows wireless nodes to dynamically form a network to exchange information without using any pre-existing fixed network infrastructure. This paper introduces the basic concept of MANET, and provides the understanding of various research models and related algorithms for clustering.

Keywords : MANET, Mobility Model, Clustering.

I. INTRODUCTION

A mobile ad hoc network (MANET) is a continuously self-configuring, infrastructure-less network of mobile devices connected without wires. Ad hoc is Latin and means "for this purpose". Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently.

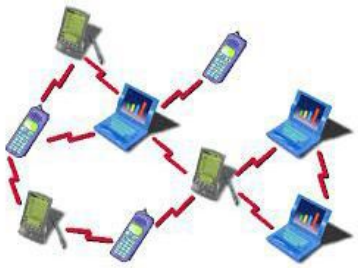

Fig 1: Mobile ad hoc network (MANET)

The primary challenge in building a MANET is equipping each device to continuously maintain the information required to properly route traffic. Such networks may operate by themselves or may be connected to the larger Internet. They may contain one or multiple and different transceivers between nodes. A mobile ad hoc network (MANET) is a self-directed, infrastructure-less, self-configuring and self-healing system of mobile nodes connected by wireless links. The nodes are free to move about randomly and may join or leave the network at their will. Due to its randomness, the network topology cannot be pointed and may change rapidly. The movement pattern of MANET nodes is differentiated by mobility models and each routing protocols shows specific characteristics for these models.

II.MANET MOBILITY MODELS

A mobility model shows the movement of real mobile nodes that change the speed and direction with time. The mobility model that accurately represents the characteristics of the mobile nodes in an ad hoc network is the key to examine whether a given protocol is useful in a particular type of mobile scenario. Based on mobility characteristics,

the classification of mobility models is also made primarily into four categories: random models, models with temporal dependency, models with spatial dependency, and models with geographical restrictions.

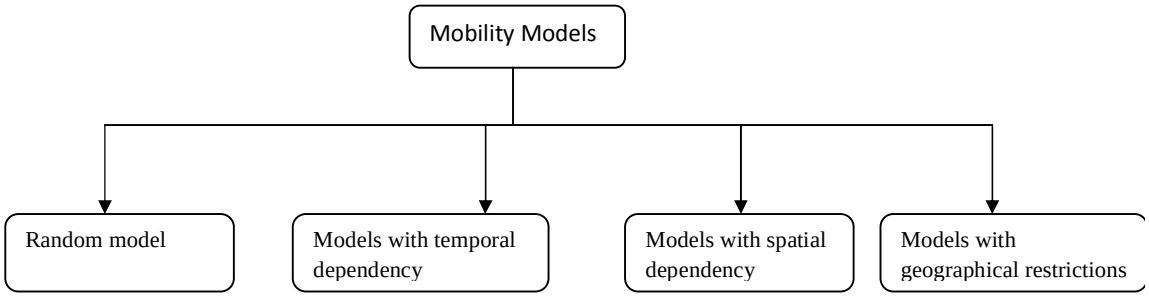

Fig 2: Different types of MANET Mobility model

A. Random model

In random models nodes move randomly and can be classified further based on the statistical properties of randomness, and random way-point, random direction, and random walk mobility model fall into this category.

Example: Random waypoint model

Random waypoint model is the most commonly used mobility model in research community today. At every instant, a node randomly chooses a destination and moves towards it with a velocity chosen randomly from a uniform distribution [0, V_max], where V_max is the maximum allowable velocity for every mobile node. After reaching the destination, the node stops for a duration defined by the 'pause time' parameter. After this duration, it again chooses a random destination and repeats the whole process until the simulation ends.

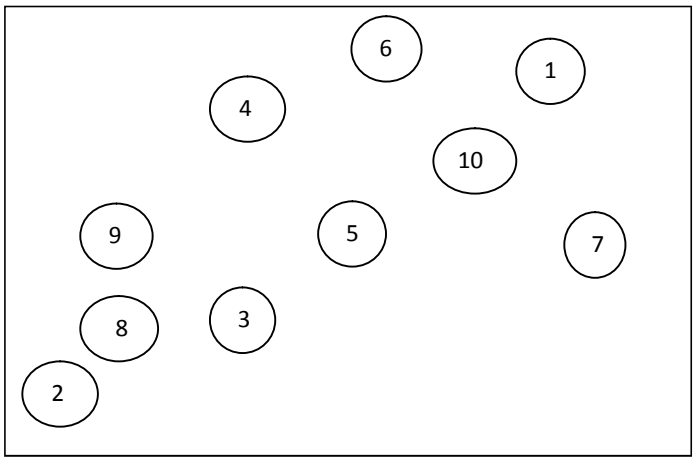

Fig 3: Topology showing the movement of nodes for random mobility model

B. Models with temporal dependency

The movement patterns of the mobility models with temporal dependency are likely to be influenced by their movement histories. Smooth random mobility is fall in this category.

Mobility of a node may be constrained and limited by the physical laws of acceleration, velocity and rate of change of direction. Hence, the current velocity of a mobile node may depend on its previous velocity. Thus the velocities of single node at different time slots are 'correlated'. We call this mobility characteristic the Temporal Dependency of velocity. However, the memory less nature of Random Walk model, Random Waypoint model and other variants render them inadequate to capture this temporal dependency behavior. As a result, various mobility models considering temporal dependency. Gauss-Markov Mobility Model and Smooth Random Mobility Model are examples of temporal dependency..

C. Models with spatial dependency

In some mobility scenarios, the mobile nodes tend to travel in a correlated manner. These mobility models are termed as mobility models with spatial dependency, and mobility models like reference point group mobility model and other spatially correlated mobility models belong to this category.

Example: Random Point Group Mobility (RPGM)

Random point group mobility can be used in military battlefield communication. Here each group has a logical centre (group leader) that determines the group's motion behavior. Initially each member of the group is uniformly distributed in the neighborhood of the group leader. Subsequently, at each instant, every node has speed and direction that is derived by randomly deviating from that of the group leader. Given below is example topography showing the movement of nodes for Random Point Group Mobility Model. The scenario contains ten nodes with Node 1 and Node 8 as group leaders.

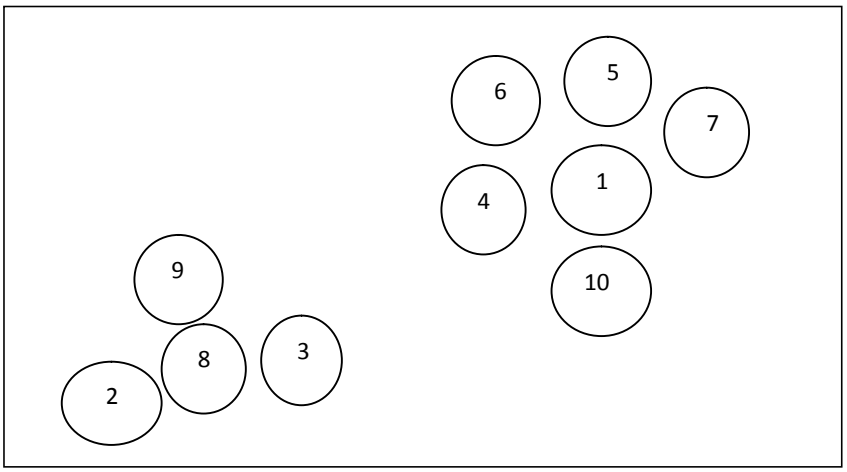

Figure 4: Topography showing the movement of nodes Random point group mobility

D. Models with geographical restrictions.

Another class is the mobility model with geographic restriction, same as the constrained topology-based model, where the movements of the mobile nodes are constrained by streets, freeways, and/or obstacles. Pathway,freeway and obstacle mobility model are examples of this mobility model.

Example: Freeway Mobility Model

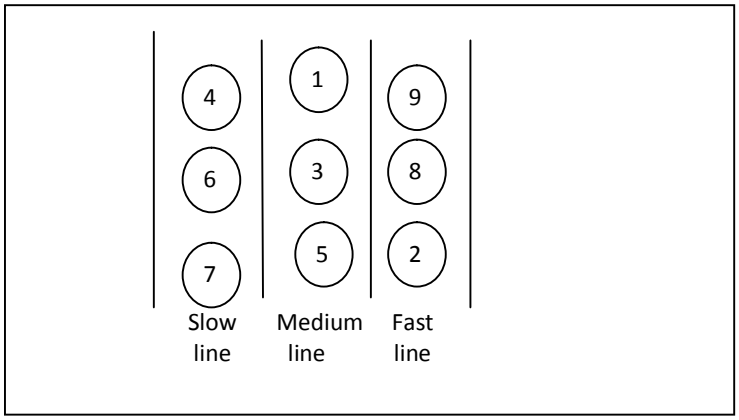

Figure 5. Topography showing the movement of nodes for Freeway mobility model.

This model emulates the motion behavior of mobile nodes on a freeway. It can be used in exchanging traffic status or tracking a vehicle on a freeway. Each mobile node is restricted to its lane on the freeway. The velocity of mobile node is temporally dependent on its previous velocity.

III. MANET ALGORITHMS

The field of wireless networking has been explored widely by a number of researchers who as a result have developed various algorithms. But an important challenge in the design of algorithms for a mobile ad hoc network is the fact that its topology is dynamic. Since the nodes are mobile, the network topology may change rapidly and unexpectedly, thereby affecting the availability of routing paths.

The design of algorithms for MANETs poses new and interesting research challenges. Algorithms for a MANET must self configure to adjust to environment and traffic where they run, and goal changes must be posed from the user and application.

Thus, in general before a node starts communicating, it must discover the set of nodes that are within its direct communication range. Once this information is gathered, the node keeps it in an internal data structure so it can be used in different network activities. After neighbor discovery the important part is packet forwarding. It is nothing but forward of data packet. The forwarding algorithm implements a forwarding goal that may be, for instance the shortest average hop distance from source to destination.

IV.CLUSTERING ALGORITHMS

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. In mobile ad hoc networks, the movement of the network nodes may quickly change the topology resulting in the increase of the overhead message in topology maintenance. Protocols try to keep the number of nodes in a cluster. The cluster head selection is invoked on-demand, and is aimed to reduce the computation and communication costs. A large variety of approaches for ad hoc clustering have been developed by researchers which focus on different performance metrics. .The most popular method that developed to provide resource management over mobile ad hoc networks is clustering. This technique based on partitioning the network in smaller and manageable groups each group called cluster. Clustering offers several benefits when it used with MANETs listed as following:

- Enhances routing process and mobility.
- Stabilizes dynamic network topology
- Helps to perform more efficient resource allocation
- Provides hierarchical routing architecture. This techniques dividing nodes of a self-organized network like MANET into a number of overlapped or disjointed clusters.

A cluster is therefore composed of a cluster head, gateways and members node. 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.
We classify the clustering algorithms based on their objectives, the cluster heads selection criteria and based on literature review as:

1. Identifier Neighbor Based Clustering:

In identifier neighbor based clustering, 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. There is a proposed clustering algorithm called Linked Cluster Algorithm (LCA) where each node is either, a cluster head, an ordinary node or a gateway node. 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.

2. Topology Based Clustering:

In the topology based clustering, the cluster head is chosen based on a metric computed from the network topology like node connectivity. High-Connectivity Clustering (HCC) based on the degree of connectivity to construct clusters. In this protocol the node with the highest number of neighbors is selected as the cluster head. If two nodes or more have the same degree of connectivity, the node with the lowest ID is elected as a cluster head. HCC generates a limited number of clusters. In mobile environment, this algorithm increases the number of re-affiliations of CHs because their degree changes very frequently.

3. Mobility Based Clustering:

Lowest Relative Mobility Clustering Algorithm (LRMCA) is based on the LCA algorithm but involves the relative mobility of nodes as a criterion in the cluster head selection. The idea is to choose nodes with low mobility as cluster heads because they provide more stability. This uses a similar clusters maintenance procedure as LCC with an additional rule to minimize the cost of clusters maintenance. This uses Cluster Contention Interval (CCI) to avoid unnecessary cluster head relinquishing. If two CHs are neighbors after the CCI time period has expired, then the one with the highest ID gives up the role of CH. This mechanism reduces the CHs maintenance.

4. Energy based Clustering:

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. A multicast power greedy clustering (MPGC) is based on heuristic to reduce the energy consumption. This algorithm runs in three consecutive phases: beacon phase, greedy phase and recruiting phase. During beacon phase, each node sends a beacon signal with the highest power in order to inform its neighbors of its presence and collects information about its neighbors of the beacons received. During the greedy phase, each node sends a cluster head declaration with necessary level of power required to reach its nearest neighbor, and then it increases its power level step by step until it reaches all its neighbors. During last phase, each node has the value of the residual power of its neighbors. If a node u has the highest residual power among all its neighbors, then u is selected as cluster head.

5. Weight based Clustering:

Weight based clustering techniques use a 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. A Flexible Weight Based Clustering Algorithm (FWCA) uses a combination of metrics (with different weights) to build clusters. Node degree, remaining battery power, transmission power, and node mobility are used in CHs selection process. The cluster size does not exceed a predefined threshold value. During cluster maintenance phase, FWCA uses the clusters capacity and the link lifetime instead of the node mobility because the link stability metric affects the election of a CH with the same weight as the node mobility metric.

V. CONCLUSION

It has always been difficult to decide which algorithm and which model is best in this field with least computational effort, least time and maximum and best results. In this review paper, various categories of Manet models and clustering algorithms are discussed.

Ad hoc network field has a wide range of applications in the field of classification, clustering and many other things among which this paper reviews the algorithms of the most applied field on Manet, i.e., clustering.

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