A STATE OF ART OF VARIOUS CLUSTERING SCHEMES IN MANET

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ABSTRACT

Mobile Ad-hoc Networks (MANETs), are a specific kind of wireless networks that can be quickly deployed without any pre-existing infrastructures. They are used in different contexts such as collaborative, medical, military, embedded applications, etc. MANET has fully mobile nodes with limited energy and bandwidth. To provide better communication, the efficient utilization of energy and bandwidth is required. Due to this challenging approach, the mobile nodes can form groups for their stability and better bandwidth usage. The mobile nodes can be grouped using clustering approach. This approach involves with several clustering algorithms which allow the structuring of the network into groups of entities called clusters and creating a hierarchal structure. Each cluster contains a particular node called cluster head which is elected as according to a specific metric or a combination of metrics such as identity, degree, mobility weight, density, energy etc. This paper discusses clustering, its advantages and disadvantages, cluster head selection methods and various clustering schemes proposed in MANET.

Keywords: Mobile Ad-Hoc Network (MANET), Clustering, Cluster Head selection Technique, Clustering Scheme.

I. INTRODUCTION

Mobile Ad-hoc network (MANET) is the cooperative arrangement of a collection of wireless mobile nodes without any predefined infrastructure [1]. Each device in a MANET is free to move independently in any direction, and will therefore its links to other devices frequently. MANET is formed by a group of nodes that can transmit and receive data and also relay data among themselves. Communication between nodes can establish a wireless link among themselves only if they are within transmission range of each other.Clustering is one of the most popular techniques used to reduce traffic in routes and minimize energy consumption in large wireless networks by collecting the nodes into group called clusters. In a clustering the mobile nodes are divided into different virtual groups and they are allocated geographically adjacent into the same cluster according to some rules with different behaviours of nodes. Cluster structure makes ad-hoc networks appears to smaller and more stable. Every mobile node in the cluster broadcast the messages to establish connection in the network. If a node changes its cluster then only the nodes which are residing in corresponding clusters are ought to update the data, there is no need the changes to be done by the entire network.Figure 1 and Figure 2 shows the Ad-hoc network without clustering and ad-hoc network with clustering [2].

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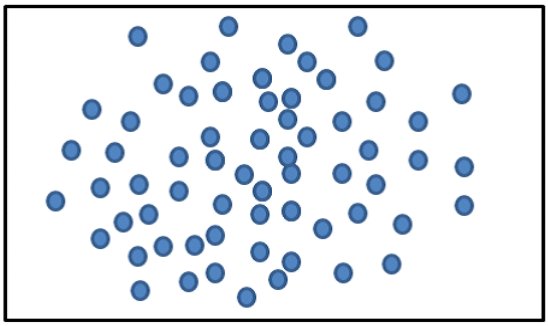

Figure 1: Ad –hoc network without clustering

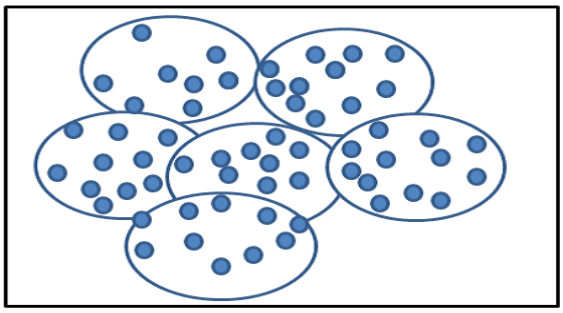

Figure 2: Ad-hoc network with clustering

There are two types of communications are possible in cluster which is shown in Figure3.

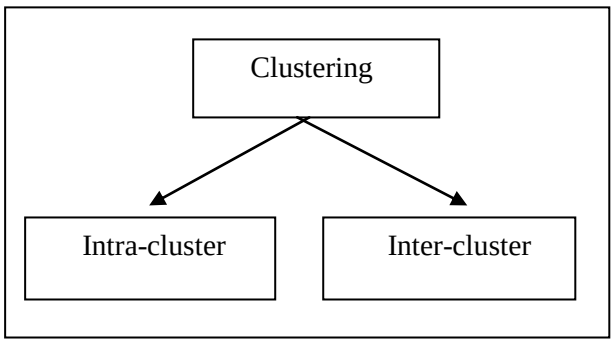

Figure 3:Types of clustering

A. Intra-cluster communication: In this type of communication [3], the cluster head has 1-hop connectivity with every member. Thus the cluster head can directly communicate with member nodes but the member nodes can communicate with each other only through the cluster head.

B. Inter-cluster communication: In this type of communication routing protocol plays a vital role. Inter-cluster communication routing protocol would be used for multi point relay concept and it selects the cluster head through which the data packets would be forwarded. This mechanism, minimize the congestion by reducing the number of forwarding nodes and saves the battery power of cluster head.

1.1. Advantages and Disadvantages of Clustering

1. Clustering in MANET networks has advantages compared to the conventional networks[4].
2. Well-organized handling of mobility management

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3. It helps to improve routing at the network layer by reducing the size of the routing table
4. It decreases broadcast overhead by updating the routing tables after topological changes
5. It helps to collective topological information as the nodes of a cluster are smaller when compared to the nodes of entire network.
6. It saves power and communication bandwidth in ad-hoc networks
7. It has the capability to adapt, depending on the policy management in the cognitive radio networks

1.2. Disadvantages of clustering

A large number of mobile terminals are managed by a MANET using a cluster topology. The organization and maintenance of a cluster construction requires additional cost comparing with a topology control without cluster.

1. The maintenance cost for a large and self-motivated mobile network requires explicit.
2. The main disadvantage of clustering is the high energy consumption during reclustering operation.
3. A current effect of re-clustering occurs if any local events take place like the movement or the death of a mobile nodes, as a result it may lead to the re-election of a new cluster head.
4. When a new cluster head is re-elected it may cause re-election in the whole of the cluster configuration.
5. As special node like a cluster head or a gateway node manage and forward all message of the local cluster their power expenditure will be high compared to ordinary nodes.

This paper is organized as follows: section 2 describes the Clustering Architecture Section 3 presents cluster head selection methods, section 4 discusses clustering schemes and section 5concludes the paper.

II. CLUSTERING ARCHITECTURE

The Architecture of clustering composedof three types of nodes such as Cluster Head, Cluster Gateway and Cluster Members[5].

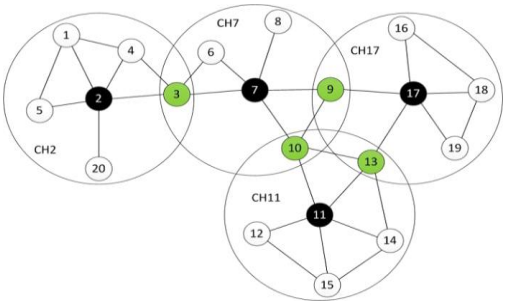

Figure 4: Clustering Architecture

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1. Cluster Head: Cluster Head serve as a leader node for its Cluster. Through cluster head any node can easily communicate with each other. It performs responsible duties like inter-clustering, intra-clustering, data packet forwarding and maintenance of the entire network.

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2. Cluster Gateway: It is a non-Cluster Head node and it provides link between two clusters. It is also called as Border node in Cluster. It can access neighbouring cluster and transfer data packet between clusters.

3. Cluster Members: Ordinary nodes in the Cluster are called cluster members. It is neither Cluster Head node nor Border nodes. It does not have any inter cluster links. The cluster head, and gateway plays an important role in clustering and acting as backbone nodes in hierarchical ad-hoc network

III. CLUSTER HEAD SELECTION METHODS

In MANET various clustering methods are used for the election of cluster head of each cluster. They are Highest-Degree (HCC), the Lowest-Id Clustering (LIC), Linked cluster (LCA), Distributed Clustering Algorithm (DCA), and Weighted Clustering Algorithm (WCA).

3.1Highest Degree Clustering (HCC):

This algorithm aims to reduce the number of clusters in the network. It uses location information for cluster formation. It elects the cluster head as the node which has amongthe neighbours.[6].

3.2 Lowest Id Clustering (LIC): The new version of Lowest ID Clustering is known as Linked Cluster Algorithm (LCA).In this clustering technique each node in the cluster is assigned with a unique identifier. All nodes discriminate its neighbours ID and CH is chosen according to node which has minimum ID, thus theneighbours ID of the CH will be higher than the CH ID. The main problem with this scheme is there is no limitation to the number of nodes attached to the same CH. Also CHs are prone to power drainage due to serving as cluster heads for the longer period of time[7].

3.3 Distributed Clustering Algorithm (DCA): The Distributed clustering algorithm is a modified version of the Lowest-Identifier algorithm. Each cluster selects its cluster head from its neighbours, the node which has the lowest ID[8].

3.4Weight Clustering Algorithm (WCA): Weight based clustering algorithm are the most popular clustering algorithm. This algorithm obtains one-hop diameter cluster with one cluster head. The selection of the cluster head depends on value of weight associated with each node. The four factors of calculating weight value are degree differences, summation of distance, mobility and cumulative time. Weight based clustering algorithm are the most popular clustering algorithm. They determines by using limited features of each node. As a result, the overhead induced by WCA is very high [9].

IV. CLUSTERING SCHEMES USED FOR ROUTING IN MANET

Table 1 summarises the various clustering schemes used for establishing an efficient route for forwarding the packets in MANET with its various clustering properties.

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4.1 Mobility Based Clustering

Javad Akbar et al [10] proposed a novel strategy in learning automate-based weighted cluster formation algorithm in MCFA, in which the mobility parameter of the hosts are assumed to the random variables with unknown distribution. In this method, each relative mobility host with respect to all neighbours is estimated by the sampling and its mobility parameters in various epochs. The proposed algorithm outperforms the others in terms of number of clusters, clusters lifetime,reaffiliationrate and control message overhead.

4.2 Mobility Based D-Hop Clustering

Seah W.K.Get al [11] proposed a mobility-based d-hop (Mob- DHop) clustering algorithm that partitions the mobile adhoc networks into variable-diameter clusters based only on the mobility information each host which is received from its onehop neighbours. The proposed algorithm improves the cluster stability by grouping the hosts with the similar mobility patterns together.The proposed algorithm used the three mobility metrics such as variation of estimated distance between nodes over time, local variability and group variability. In this method, all hosts periodically broadcast Hello messages. Each host then calculates the estimated distance based on the strength of the received signals. The variability of the estimated distance (VED) is computed for each host with respect to all its neighbours. In the proposed method, the host with the lowest VED among its neighbours has the most stability and so is selectedas cluster-head.

4.3Energy Efficient Clustering

Krishna Dalasaniya et al [12] proposed a method to maintain stability of clusters with less number of cluster formation and minimum number of invocation of clustering algorithm. This proposed clustering algorithm to select an efficient cluster head based on different performance such as degree of node, bandwidth requirement of the nodeetc. The proposed algorithm decreased the number of CHs reaffiliation, minimized the number of clusters and decreased the over head.

4.4 Energy Efficient Max-Heep TreeClustering

Madhvi Saxena et al proposed [13] a Max-Heap Tree algorithm is which based on energy efficient clustering. In proposed algorithm, small number of clusters is formed using Max-Heap Tree. The new improved mechanismis involved for the selection of cluster head. Cluster head is elected based on the energy level of nodes where the highest energy level of node becomes the CH. The proposed algorithm shows minimizing the power consumption and maximizing the network lifetime.

4.5Flexible Weight Based Clustering

Abdul Rah man et al [14] proposed the weight based clustering algorithm based on Battery Power. The proposed algorithm leads to high degree stability in the network which minimizes the number of clusters and the overhead of cluster formation. It shows the performance of the proposed enhancement clustering in terms of the average number of clusters formation, stability of clusters and minimum lifespan of a node.

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4.6Load Balancing Clustering

M .Kaliappan et al[15] uses the genetic algorithm such as Elitism based Immigrates Genetic Algorithm (EIGA) and Memory Enhanced Genetic Algorithm (MEGA) to solve Dynamic Load Balanced Clustering Problem(DLBCP). The proposed work usesthe EIGA to maintain the diversity level of the population and MEGA to store the old environments in the memory. The Load Balancing Clustering Mechanism (LBCM) produces the new load-balanced clusters and cluster heads to increase the network lifetime. The Proposed algorithm shows the network lifetime, energy consumption of a node, PDR, routing overhead and end- to-end delay.

4.7 Combined-Metrics Based Clustering

Adabi et al [16] proposed a Score Based Clustering Algorithm (SBCA), which aims to maximize the lifetime of mobile nodes and minimize the number of clusters. The proposed algorithm uses the Remaining battery power, Node edge, Number of nodes, and Node stability as the metrics to calculate the node score. The cluster formation each node calculates its score and broadcasts its message to all its neighbours. The proposed method generated the minimum number of clusters than WCA but has the same limitations.

Table 1:Summary of Various Proposed Clustering Schemes in MANET

Clustering Scheme	Clustering Metric	CHs Election	Cluster Radios	Overlapping clusters	No of Clusters	CH Change	Cluster Stability	Total Overhead
MOBIC [10]	Mobility	Lowest Mobility	One-Hop	Possible	Relatively High	Low	High	Relatively High
MOBIC [11]	Mobility	Lowest mobility	One-Hop	Possible	Relatively High	Low	High	Relatively High
EEC [12]	Energy	Node Stability	One-Hop	Possible	Relatively Low	Low	Relative High	Relatively Low
Max-Heap [13]	Energy	Roof Node	One-Hop	No	Low	Low	Relatively High	Relatively Low
FWCA [14]	Weight	A combined weight metrics	One-Hop	No	Low	Low	High	Relatively High
LBCM [15]	EIGA	A combined weight metrics	One-Hop	No	Low	Low	Very High	Relatively Low
CMBC [16]	Score	A Combined Metrics	One-Hop	No	Low	Low	High	Low

V. CONCLUSION

Clustering is one of the important research area in MANET. This paper discussed the fundamental concepts about clustering and reviewed the various clustering schemes which help to organize the network into hierarchical structure. In these clustering schemes, the clustering operation is carried out based on mobility, energy, weight, load or combination of some metrics. From the survey, it is observed that all the clustering schemes mainly focus on important issues such as cluster structure stability and overhead of the cluster formation and maintenance. The summary indicates that the combined metrics scheme provides better performance than the other schemes in MANET. Thus, in future the combined metrics scheme is further improved by implementing optimization technique.

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