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ENHANCING THE CLUSTER HEAD NODE SELECTION REPRESENTATION IN MANET

[1] J. Radha, [2] P. Shanthi,
[1] M.Phil Resesarch Scholar, [2] Assistant Professor,
[1, 2] SRI JAYENDRA SARASWATHY MAHA VIDYALAYA COLLEGE OF ARTS AND SCIENCE,
[1, 2] Coimbatore, Tamilnadu, India

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.]

1. INTRODUCTION

With the exponential increase in the number of computing devices like mobile computers, net-books, PDA's, tablets, cellular phones and the increase in the need for connectivity at all times has magnified the importance of ad-hoc networks. Ad-hoc networks are short range networks which supposedly work without the presence of any central controller, access point or router, and provide connectivity through either single hops or multi-hops[1][2]. Example of ad-hoc networks is Bluetooth, infra-red connections, and other short distance communication. The big advantage of ad-hoc networks is that it operates without any extra circuitry other than the transmitting and receiving circuits.

Although access points are also used in ad-hoc networks but such topologies can be considered as hybrid ad-hoc networks and not pure ones [3].

Initial clustering creates the clusters in the ad hoc network at a time when the wireless capable nodes are discovering each other and the cluster management algorithm maintains the clustered architecture by continually adapting to the changing network topology.

1. **Cluster** - It refers to a collection of nodes, grouped for the functioning of the networks
2. **Master** - Every cluster is characterized by aunique node called its master. It has certain extra responsibilities.
3. **Bridge** - Bridge is a node which belongs to more than one cluster .It thus has more than one master.

4. **Slave** - All the cluster nodes other than bridges and master are called slaves. Each slave has only one master. And hence belongs to only one cluster.

5. **State** - A node's state describes whether the node is a slave, bridge, master or none (none means the node is uninitialized, i.e. it does not belong to any cluster).

In clustered network architecture, the whole network is divided into self-managed groups of nodes called clusters. All the nodes inside a cluster are at maximum two hops away from each other. These clusters continually adapt themselves to the changing network topology and new cluster configurations that are feasible with the current network topology, are created dynamically. Master (or Cluster head) is the node which is only one hop away from all the other nodes in the cluster, and brings positive additional tasks [4].

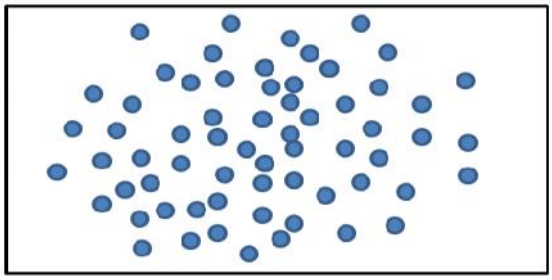

Figure 1- Ad hoc network without cluster

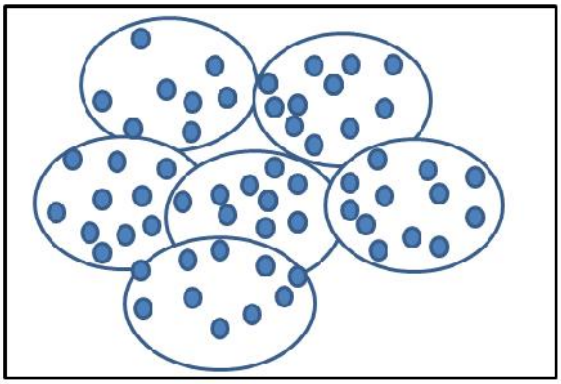

Figure 2- Ad hoc network with cluster

2. RELATED WORK

Clustering is a process that divides the network into interconnected substructures, called clusters. In a clustering scheme, all the mobile nodes in a MANET are grouped into different geographically distributed groups. Clustering in MANET guarantees many advantages when compared with traditional networks. But due to the unstable nature of MANET clustering in MANET is a difficult task. Cluster based routing protocols are used in clustering approach, but still there exists limitations besides the functionality of the Routing protocols. Clustering focuses on dividing the networks into clusters and to choose a particular node as a Cluster Head. Each cluster group will have a specific node elected as cluster head (CH).The Head node may be selected based on a specific metric or a combination of metrics. Some of the parameters may include the ID of a node, weight and density of a node, degree or mobility of a node etc. The other nodes in a group will communicate with the cluster Head. The cluster Head in a group may communicate with the Cluster Head of another cluster thereby decreasing the unnecessary traffic flow. If a node hears two or more Cluster Heads then it will be the gateway. A cluster is there-fore composed of a cluster head, gateways and member nodes. Clustering in MANET thus improves the efficiency and reduces the chances of interference thereby increasing the network throughput.

Jane Y.Yu and Peter H.J Chong [5] classified the clustering schemes of MANET under six categories as Dsbased,Low Maintenance, Mobility-aware, Energy Efficient, Load balancing and combined metrics based clustering. Cost comparison of the six clustering schemes and communication complexity are analyzed based on the ripple effect of re-clustering, stationary assumptions for cluster formation etc. Many researchers have focused the clustering schemes based on

different metrics. Effective and reliable cluster head selection based on different protocols areanalysed.

Roberto Carlos Hincapi´e, and Laura Ospin [6] classified the Clustering Techniques for Mobile AdHoc

Networks into eight categories as Lowest ID heuristic, Highest degree heuristic, k-CONID, Max-min heuristic

(α,t)cluster framework , MobDhop , DMAC and WCA and explained their advantages and disadvantages. Many related works focused on the clustering techniques and algorithms ,network scalability in clustering methods ,fairness of choosing a particular node as a cluster head, stability of head node based on different metrics such as Energy, mobility, weight etc. Some of the routing schemes in MANET are analyzed with clustering and scalability issues are considered. Cluster based protocol based on hierarchical routing strategies are focused for efficient routing. Some of the researchers focused mainly on the cost factor based on the scalability and performance of the cluster. In [7] authors classified the clustering approaches based on its objectives and tabulated the advantages and drawbacks of the algorithms. It is obvious that all the above metrics and analysis criteria is based on the efficient routing based on clustering. Since the cluster head is the main role in clustering, various surveys paid attention to the reliable cluster head selection techniques based on a specific parameter.

3. CLUSTERING IN MANET

Clustering is a technique for dividing the network into different group of nodes and manages the transmission of the data among the interacting nodes. Each group is known as cluster. In a cluster set of nodes gathered around a node known as cluster head. All cluster heads are interconnected with each other for reliable communication as limited energy resources are present[5,6]. Each cluster is a architecture in which the cluster head (CH) responsible for maintenance of cluster and communication between the cluster nodes.

Cluster head selection includes two variants-

i) Distance Constrained Selection-According to this selection process, every node in a cluster must be located at certain distance from the cluster head which is nearer to it.

ii) Size Constrained Selection-Acc. to this, each cluster in a network must have limited no. of members.

Basically 3 types of nodes are present in a cluster.

i) **Cluster Head**-It is a leader node that makes co-ordination among nodes, maintains list of nodes and path to every node in a cluster.

ii) **Cluster Member**-It is a part of a cluster that transmits information to their cluster heads which further compresses the information received from cluster member and forward it to the other cluster heads and base station.

iii) **Cluster Gateway**-Its main purpose is to connect one cluster with another cluster and forward the information among clusters. Gateways are basically non-cluster heads.

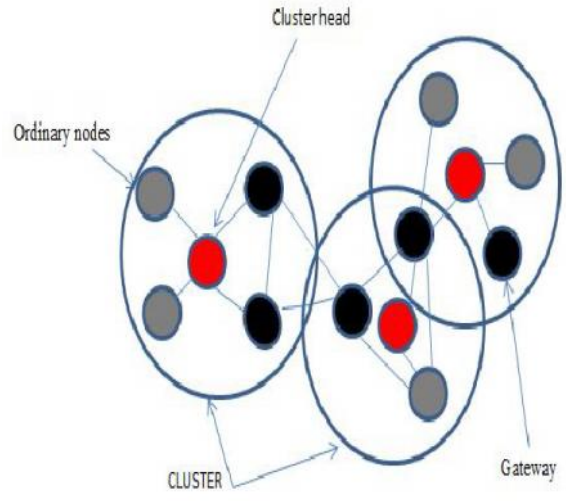

Figure 3- Clustering in MANET

4. CLUSTERING ALGORITHMS

4.1Lowest Id Cluster (LIC) algorithm

In this unique ids assigned to each node. Node with minimum id selected as cluster head. Ids of neighbor nodes are always greater than the cluster heads. A gateway node is a node which lies in between the two or more cluster heads transmission range. Gateway nodes are responsible for the routing between the clusters. LIC concerns only with lowest id nodes to which arbitrary numbers are assigned without taken into account the qualification of node and QoS parameters [7].

Drawbacks-

1. Power drainage occurs if certain node acts as a cluster head for a long time.
2. Security factors are not included.

It provides the balancing of load among the elected

4.2 Power Awareness Load Balancing Clustering (LBC) algorithm

In this algorithm each node assigned with a variable virtual ID (VID) and this value sets as its ID number. Node with a highest ID always selected as a cluster head node. Cluster head assigned with a specific time or budget for which the node acts as a cluster head. The budget is generally a restriction which is defined by the user in order to meet the characteristics of the system like battery life of the nodes. If the budget of a node exhausted then it sets it VID to 0.If two cluster head nodes budget get exhausted at the same time then the node with higher VID gets a cluster head role.

Drawbacks-

1. Cluster head serving time does not provide better utilization of energy.
2. Quality of Service parameters are not considered.

4.3 K-hop Connectivity ID Clustering Algorithm (KCONID)

In this cluster heads are selected on the basis of connectivity and the lowest id. The node with maximum connectivity selected as a cluster head .Here all other nodes are at distance of at most k-hops from the cluster head. If the connectivity of two nodes has same value then the node with lowest id selected as a cluster head. A pair did (d,id) is assigned to each node in the network where d represents the connectivity of node and id represents the identifier of the node. There is another approach for this algorithm which is based on the energy level. Here the node which has maximum energy level always selected as a cluster head.

Drawback-

As selection is done on the basis of energy then energy drainage of cluster head occurs if one node becomes cluster head for a long time.

4.4 Highest connectivity clustering algorithm (HCC)

Here each node transmits or broadcasts its ids to the nodes which are present within the transmission range of that node[8,9]. The node which has maximum number of neighboring nodes will be selected as cluster head node. The neighboring nodes which becomes the members of the cluster head do not participate in the election process .Here cluster heads are not directly connected with each other, only one cluster head is present per cluster. The nodes present in a cluster is either a cluster head or ordinary node.

Drawback-

Some resources are assigned to the cluster which are shared by the cluster members. Due to this, the throughput of the system decreases as the number of nodes increases.

4.5 Least Cluster Change (LCC) algorithm

This algorithm considers the cost for the maintenance of cluster and some issues like cluster re-clustering. LCC clustering algorithm has two parts-

- Cluster Formation
- Cluster Maintenance

Cluster formation phase follows the Lowest Id Cluster algorithm in which the node with lowest id is selected as cluster head. Re-clustering is done in two cases-

1. When two cluster heads must be reached within each other's transmission range then one leaves the cluster head role [10, 11].

2. When any mobile node does not access any cluster head or it does not come within the reach range of any cluster head then the structure of the cluster is reconstructed according to the LIC algorithm.

Drawback- Large communication overheads as the structure of the cluster can be rebuild due to the one mobile node which cannot access any cluster head.

4.6. Weighted Clustering Algorithm (WCA)

In this the cluster head is selected according to some parameters like the number of nodes which can be handled by the cluster head battery power, transmission power and mobility of the nodes. The selection of the cluster head must be done according to the weight value which is associated with each node. The weight value of the node k is defined as

$Wk = w1\ \Delta k + w2\ Dk + w3\ Mk + w4\ Pk$

The node which has minimum weight must be selected as the cluster head.

Mk -represents the mobility of the node which is the average running speed of every node within a specific time T.

Δk- represents the degree difference which is obtained by calculating the no of neighbors for each node. This calculation's result is defined by the dk. For the purpose of load balancing the degree difference must be calculated as $|dk-\delta|$ where δ represents the pre-defined threshold.

Dk- represents the sum of all distances of a given node to its neighbors.

Pk- measures the consumption of battery power.

Drawback- More consumption of battery power by the cluster head as it has many responsibilities.

5. SECURITY ISSUES IN CLUSTER MANETS

Security is a major issue in routing of information between clusters. There are no. of attackers present which finds the identity of the cluster nodes, drops the communication [12].The information collected by attacker is useful for making attack plans for the Certification authority node and disturbs the overall cluster process. So in order to provide security and protect the identity of individual node some techniques like threshold signature must be used. Threshold signature consists of basic operations like generation of pairing parameters, private keys. Algorithm like Trust based Cluster Head Selection is used for providing security by computing TRUST VALUE from the neighbor nodes. Each node collects the trust values which helps in the selection of cluster head and improves the authentication and confidentiality.

5.2 Energy Consumption

We have to reduce the energy consumption and interference of nodes or signals. A technique called topology control is used for reducing the energy consumption,

interference among signals and extend the lifetime of network by selecting accurate transmission power for each node[13,14]. Topology control includes parameters like energy efficiency, scalability, and k-connectivity and network lifetime.

5. CLUSTER HEAD SELECTION

In this we select a node as a leader node. Initially, all nodes act as cluster heads and they transmit hello messages .These messages are received by each of the nodes from its neighboring nodes. When any node receives hello message from neighboring nodes then it adds a new entry in the neighbor table[15],[16],[17]. When hello messages are received from all neighbor nodes then it assigns priority to each node according to energy level and total no. of nodes present. Then it compares the electing node with highest priority with itself ,if priority of electing node is greater than that node's priority then it acts as a cluster head else if priority is not greater then node itself acts as a cluster head[18].

Selection of node done on the basis of following factors:-

- Location of a node among other nodes.
- Mobility
- Energy
- Trust
- Throughput

Generally cluster head selection includes following steps-

1. Firstly we setup the threshold value and only those nodes will act as the cluster head whose value is greater than the threshold value.
2. Then measure the energy level of the nodes and the node with maximum energy level will acts as the cluster head.
3. When the node with is selected as the cluster head then the counter time must be setup for that node to stay as the cluster head for certain amount of time.
4. After timeout of the first node, next maximum energy level among the nodes will be checked and the next node with maximum energy level will be selected as the cluster head.
5. If in between new node arrived then the energy level for this node also be measured and compared with the threshold value.

CONCLUSION

We have reviewed various clustering algorithms on the basis of security and energy in the mobile adhoc networks in which cluster head is selected among various nodes present in the cluster by comparing their ID values. The main aim of every algorithm is to select the cluster head which increases the network lifetime and transmission rate. Selection of cluster head is a difficult task. As in these algorithms same node selected as cluster head next time due to the independent network topology which results in imbalanced energy consumption. Security problem arises because there is not any fixed infrastructure for the network. It is difficult to maintain the stability of the network. Many algorithms are developed for this purpose of which security and energy efficiency is a new area for research. So, there should be an efficient algorithm which taken into account the security, energy, trust, fault tolerance and checking black list of nodes.

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