Volume 6, Issue 9, September 2016 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Clustering Technique and its Advantages in Routing Protocols in MANETs

Meena Rao
Department of ECE, Maharaja Surajmal Institute of Technology,
C-4, Janakpuri, New Delhi, India

Abstract— A Mobile Ad Hoc Network is a collection of nodes that do not have fixed infrastructure. Nodes move randomly from one place to another. This random movement of nodes make implementation of any routing protocol very difficult. The problem becomes all the more pronounced when the routing protocol is based on clustering. However, clustering based routing algorithms also present several advantages over other routing protocols. So, a proper understanding of clustering based routing algorithm is necessary. In this paper, various clustering based routing algorithms for MANETs are studied.

Keywords— MANETs, Routing Protocols, Proactive Routing Protocol, Reactive Routing Protocol, Clustering,

I. INTRODUCTION

Mobile Ad Hoc Networks (MANETs) are characterized by multihop technology. They are based on wireless networks in which connections are established as and when necessary [1]. MANETs find various applications like in videoconferencing, emergency situations, military operations etc. However, the advent of MANETs beyond its traditional applications due to its ease of deployment and less cost has put more focus on improving the Quality of Service (QoS) parameters of the network. To improve the QoS parameters as well as other services in MANETS it is important to have an efficient routing protocol. Routing is the process of selecting a suitable path or route for sending the packets to the destination. Nodes in MANETs change their position very frequently, hence routing becomes a challenge in such systems.

Routing protocols in MANETs can be classified as proactive, reactive and hybrid [2]. In proactive routing protocols, routing information is maintained in the form of a routing table. The table needs to be updated as and when necessary. Since, the nodes change quite frequently in MANETs, maintaining such a table becomes very difficult. Moreover, limitations of resources as well as bandwidth make proactive routing protocols unsuitable for MANETs.

On the other hand reactive routing protocols establish routes as and when it is required. In literature Ad Hoc On Demand Distance Vector (AODV) as well as Dynamic Source Routing Protocol (DSR) protocols are most commonly used in MANETs. Although these reactive routing protocols consume less bandwidth but there are certain limitations with these routing protocols like establishment of backup routes or selection of an efficient node for routing based on position or energy efficiency of the nodes. Hence, an efficient technique should be thought of which leads to better management of MANETs. The paper is organized as follows: Section I is introduction to the work, in Section II clustering is explained along with how nodes are classified. In section III different algorithms for selection of cluster heads are described. Section IV describes optimal clustering. Finally the paper is summarized in section V.

II. CLUSTERING

Clustering means grouping or collecting nodes into groups. Groups are a part of the network or MANETs and are further known as clusters. Clusters are formed with an aim to achieve some purpose or overcome some limitations. Implementation of clustering leads to better performance of the routing protocols in Medium Access Control (MAC) layer. Implementation of routing protocols in conjunction with clustering leads to better throughput, scalability, power consumption etc.

Various nodes in MANETs are classified depending on how they are used in a cluster. Nodes in a cluster are classified as: Ordinary nodes, Gateway nodes and Cluster heads [3].

A. Ordinary Nodes

Ordinary nodes are those which do not have neighbours belonging to a different cluster.

B. Gateway Nodes

Gateway nodes are those nodes which lie at the boundary of a cluster. The reason these nodes are called gateways are because they can listen to transmissions from other nodes (that are part of a different cluster). However, this becomes possible only when there is at least one neighbour node that is a part of another cluster.

C. Cluster Heads

Clustering scheme results in a special type of node, called the Head Node (HD) to monitor traffic within a cluster If the number of nodes in a cluster are selected at random the it is called random clustering. A set of selected nodes in the network are called cluster heads (CH). Also, all the nodes in the network are linked with one such CH. Various CHs in MANETs or such networks are also connected with each other. They may be connected directly or through gateway nodes. Most of the functions like bandwidth allocation, routing control as well as other such functionalities are controlled with the help of connections between gateway nodes as well as various cluster heads in the network.

Packets that have to be transmitted are first sent to the CH. In case, the destination node is within the same cluster, packets are routed there. If the destination is located in some other cluster, the CH routes it to the CH of the cluster where the destination node lies. In this way routing protocols are implemented along with clustering technique for transmission of packets. Also, ordinary nodes in cluster can directly connect only to CH and gateways. In case the existing node wants to connect or send packets to some destination node then it has to be done via CH and existing gateway node.

III. SELECTION OF CLUSTER HEADS

CH must be efficient in the sense that they have to maintain all nodes within its cluster, interact or transfer packets from other nodes [4]. Hence, selection of a cluster head has to be done with utmost carefulness. Failure of the CH will result in failure of packet transmission, inability to transmit or forward packets to other nodes. Hence, nodes with high degree of stability or efficiency are selected as CHs. Different criteria based on which CH may be selected is given below [5]:

A. Highest Degree Algorithm

Any node in a neighbourhood that has the highest degree is made the CH. Location information for cluster formation is used here.

B. Lowest Identifier Algorithm

It is not a preferred method as here the lowest minimum identifier is elected as a CH. Since the lowest identifier is used, it results in high battery consumption. Since MANETs have limitations on battery usage, this algorithm results in short lifetime of devices of the system.

C. Distributed Clustering Algorithm

In this algorithm few modifications are made to the lowest identifier algorithm. In this algorithm every node can determine its cluster. However, here too each cluster selects its CH from its neighbouring nodes having the lowest ID.

D. Weighted Cluster Algorithm

It employs combined metrics-based clustering. Here, node degree, CH serving time and moving speed are taken into consideration.

Even though many techniques are available for selection of CHs, there are many associated problems especially in a dynamic system like MANETs. Here, the network topology changes very fast and dynamically. To update this many information, message exchanges are required. This results in consumption of more bandwidth which is not desirable. Moreover, change in cluster head of any part of the network may have an effect on the CHs of other clusters in the network effecting the entire network. Fig. 1 shows clustering arrangement for a MANET setup.

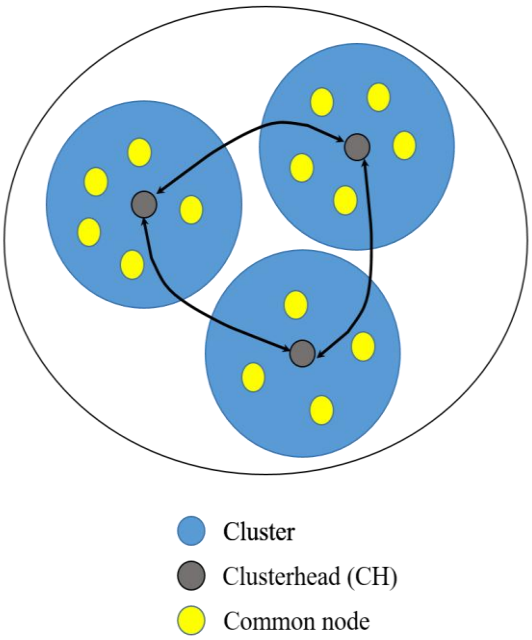

Fig. 1 Clustering Arrangement for a MANET Setup

IV. RADIO ENERGY MODEL FOR OPTIMAL CLUSTERING

Optimal clustering can be achieved if the energy consumption is well distributed over all nodes and in this way the total energy consumption is minimum. Such optimal clustering highly depends on the energy model that is used. A radio energy dissipation model shown in Fig. 2 is used in order to achieve an acceptable Signal-to-Noise Ratio (SNR) in transmitting an L-bit message over a distance d, the energy expended by the radio is given by [6][7]:

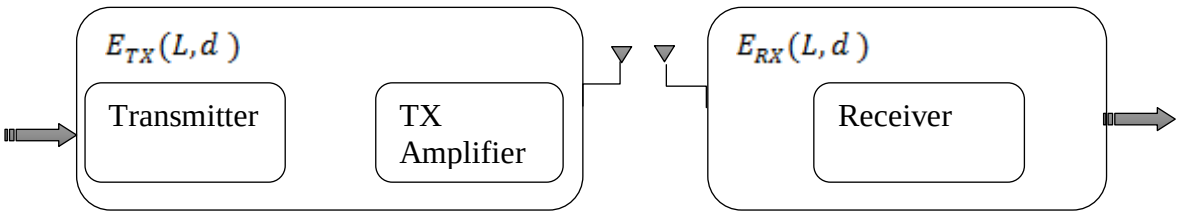

Fig. 2 Radio Energy Dissipation Model

Here E_{elec} is the energy dissipated per bit to run the transmitter or the receiver circuit, $\in_{fs}$ and $\in_{mp}$ depend on the transmitter amplifier model used and d is the distance between the sender and receiver.

To receive L-bit message the radio expends,

$$E_{Rx} = L.E_{elec} \quad (1)$$

It is assumed that every node can obtain the location of its neighbours. Then every node sends a hello message to all of its neighbours. To calculate the node speed difference, the following relation is used:

$$S_v = \sum_{i=1}^{d_v} |SP_v - SP_{vi}| \quad (2)$$

S_v is the node speed difference, SP_v is the average speed for node any *v* and SP_{vi} is the average speed of i^{th} neighbour of node *v*. Node density is also considered as a factor for deciding heads within the network environment. The expression for optimum probability is given in equation 5.5.

$$p(i) = \frac{p \times n \times current\ energy \times residual\ energy}{initial\ energy \times average\ energy} \quad (3)$$

p = Optimum election probability of a node to become a transmitting node or an active node.

By providing cluster based routing an optimum routing strategy can be achieved. Traditional routing protocols or any kind of backup routing consume much bandwidth and other resources. In case of multimedia transmission resource consumption is much more, so an optimum routing strategy is required that provides good results.

V. SUMMARY

In this paper it has been studied how the clustering techniques when applied optimally can result in an efficient routing technique. A study of functionalities of different nodes in the cluster has been done and it has been analysed how cluster heads are selected using different algorithms. Moreover, radio energy model has been elaborated and discussed. It can be observed from the discussions that radio energy model can also be applied for optimal clustering for packet transmission.

REFERENCES

[1] Chlamtac I., Conti M., Liu J.N., "Mobile Ad hoc Networking: Imperatives and Challenges", Ad hoc Networks, Elsevier, Vol. 1, Issue 1, pp. 13-64, 2003.

[2] Kumar M. and Rashmi M., "An Overview of MANET: History, Challenges and Applications", Indian Journal of Computer Science and Engineering, Vol. 3, pp. 121-125, 2012.

[3] Agarwal R. and Motwani M., "Survey of Clustering Algorithms for MANET" International Journal on Computer Science and Engineering" Vo.1, Issue 2, pp. 98-104, 2009.

[4] Anupama M. and Sathyanarayan P., "Survey of Cluster Based Routing Protocols in Mobile Ad Hoc Networks", International Journal of Computer Theory and Engineering, Vol. 6, No., 2011.

[5] Sharma A., Agarwal S., Rathore R.S., " Cluster based Routing in Mobile Ad Hoc Wireless Networks using Neuro-Genetic Paradigm", Vol.3, Issue 7, pp.1-5, 2012.

[6] Hossain A., "On the Impact of Energy Dissipation Model on Characteristic Distance in Wireless Networks", IEEE International Conference on Industrial and Communication Application, pp. 1-3, 2011.

[7] Gao Q., Blow K.J., Holding D.J., Marshall W., Peng X.H., "Radio Range Adjustment for Energy Efficient Wireless Sensor Networks", Ad hoc Networks Journal, Elsevier Science, Vol. 4, pp. 75-82, 2006.

