Review on Cluster-head Election Mechanisms for Clustering Based Routing in Mobile Ad-hoc Network

Ms. Sujata Bhadoria, Ms. Lakshmi Nishad, Mrs. Lalita Tongue

Department of Computer Science, Rajiv Gandhi Technical University

Abstract- Wireless Ad hoc network is a set of wireless devices which move randomly and communicate with other node via radio signal. Ad-hoc networks may be logically represented as a set of clusters by grouping together nodes on the basis of different criteria such as 1-hop and k-hop that are in close boundary with one another. Clusters are formed by diffusing node identities along the wireless links. Different heuristics employ different policies to elect cluster heads. Several of these policies are biased in favour of some nodes. As a result, these nodes should greater responsibility and may deplete their energy faster, causing them to drop out of the network. Therefore, there is a need for load-balancing among cluster-heads to allow all nodes the opportunity to serve as a cluster-head. In this paper, different cluster head election mechanism are discussed in the one hop clustering approach.

Index Terms- Ad-hoc Network, Cluster-head, NWA, WCA, EWCA

I. INTRODUCTION

Mobile Ad Hoc Network (MANET) is a mobile, multi-hop wireless network, which does not need pre-existing infrastructure or centralized administration. Every node in the network is serving as a router, which means that every node is able to forward data to other nodes. There are many applications of ad hoc networks, for example meetings or conventions, electronic email and file transfer, and emergency disaster relief personnel coordinating efforts after a hurricane or earthquake [1, 2]. Dynamic routing is the most important issue in MANET's. In flat structure exclusively based on proactive and reactive routing algorithms cannot perform well in a large dynamic MANET. That means, with the increase in size of the networks, flat routing schemes do not scale well in terms of performance. In order to cope with these problems by grouping a number of nodes into an easily manageable set known as cluster [4, 3].The previous research on mobile ad-hoc network has heavily stressed the use of clustering algorithm because clustering simplifies routing and can improve the performance of flexibility and scalability in the network.

Several clustering algorithms have been proposed to increase scalability, improve bandwidth utilization, and reduce delays for routing strategies. In a clustering structure, the mobile nodes in a network are divided into several virtual zones (clusters). Every mobile node may be assigned a different status or function, such as cluster-head, cluster-gateway, or cluster-member. The cluster-head can be used as a repository for the knowledge of the cluster and as a coordinator of the cluster operations. Cluster-gateway is a boarder node in communication range for more than one cluster. Summarized cluster information is sent to the neighbouring cluster-heads via gateways [5, 6]

II. BACKGROUND

This section describes the basic cluster head selection mechanism for the one hop clustering.

A. Lowest-ID Algorithm

In this algorithm [11, 13] each node is assigned a distinct ID and the clusters are formed following the steps given below:

- Periodically a node broadcasts the list of nodes that it can hear (including itself).
- A node, which only hears nodes with ID higher than itself, becomes a Clusterhead (CH).
- The lowest-ID node that a node hears is its clusterhead, unless the lowest-ID specifically gives up its role as a clusterhead.
- A node, which can hear two or more clusterheads, is a Gateway.
- Otherwise the node is an ordinary node.

Major drawbacks of this algorithm are its bias towards nodes with smaller ids which may lead to the battery drainage of certain nodes, and it does not attempt to balance the load uniformly across all the nodes.

B. Highest-Degree Algorithm

The Highest-Degree Algorithm, also known as connectivity-based clustering algorithm, was originally proposed by Gerla and Parekh [12, 14], in which the degree of a node is computed based on its distance from others. A node x is considered to be a neighbor of another node y if x lies within the transmission range of y. The node with maximum number of neighbors (i.e., maximum degree) is chosen as a cluster-head. The neighbors of a cluster-head become members of that cluster and can no longer participate in the election process. Any two nodes in a cluster are at most two-hops away since the cluster-head is directly linked to each of its neighbors in the cluster. Basically, each node either becomes a cluster-head or remains an ordinary node (neighbor of a clusterhead).

Major drawbacks of this algorithm are the number of nodes in a cluster is increased, the throughput drops and hence a gradual degradation in the system performance is observed, and another limitation is the reaffiliation counts of nodes are high due to node movements and as a result, the highest- degree node (the current clusterhead) may not be re-elected to be a clusterhead

even if it loses one neighbor. All these drawbacks occur because this approach does not have any restriction on the upper bound on the number of nodes in a cluster.

C. Node-Weight Algorithm

Basagni et al. [15, 16] proposed two algorithms, namely distributed clustering algorithm (DCA) and distributed mobility adaptive clustering algorithm (DMAC). In this approach, each node is assigned weights (a real number above zero) based on its suitability of being a cluster-head. A node is chosen to be a cluster-head if its weight is higher than any of its neighbor's weight otherwise, it joins a neighboring cluster-head. The smaller ID node id is chosen in case of a tie. The DCA makes an assumption that the network topology does not change during the execution of the algorithm. To verify the performance of the system, the nodes were assigned weights which varied linearly with their speeds but with negative slope. Results proved that the number of updates required is smaller than the Highest-Degree and Lowest-ID heuristics. Since node weights were varied in each simulation cycle, computing the cluster-heads becomes very expensive and there are no optimizations on the system parameters such as throughput and power control.

D. Weighted Clustering Algorithm

The Weighted Clustering Algorithm (WCA) was originally proposed by M. Chatterjee et al. [7, 5,9]. It takes four factors into consideration and makes the selection of clusterhead and maintenance of cluster more reasonable. As is shown in equation (1), the four factors are node degree, distance summation to all its neighboring nodes, mobility and remaining battery power respectively. And their corresponding weights are w1 to w4. Besides, it converts the clustering problem into an optimization problem since an objective function is formed.

$$W_v = w1\,\Delta_v + w\,D_v + w\,M_v + w\,P_v \qquad (1)$$

Although WCA has proved better performance than all the previous algorithms, it lacks a drawback in knowing the weights of all the nodes before starting the clustering process and in draining the CHs rapidly. As a result, the overhead induced by WCA is very high.

III. RELATED WORK

A. Enhancement Weighted Clustering Algorithm (EWCA)

- Principles of Algorithm :

In proposed algorithm election, cluster-head is adaptive invoked based on moving of nodes or changing the relative distance between the nodes and cluster-head. Election is repeated until all of node must be as a member of any cluster or as a cluster-head. In Load-balancing, assume that there are a predefined threshold number of mobile nodes that a cluster can cover. When the number of cluster's members is too large, that may produce a small number of clusters which make bottleneck of a MANET and reduce system throughput. Moreover, too-small cluster's member may produce a large number of clusters and thus resulting in extra number of hops for sending a packet from source to destination, and longer end-to-end delay. When a cluster size exceeds its predefined limit, election procedure is repeated to adjust the number of mobile nodes in that cluster.If the distance between cluster-head and cluster member is within the transmission range, that with result a better communication.
The relative distance between nodes affects the consumption of the battery power. It is known that more power is required to communicate through a larger distance. Since cluster-heads have the extra responsibility to send packets to other nodes, they consume battery power more than ordinary nodes.
Mobility is one of the most important challenges of MANETs, and it is the main factor that would change network topology. A good electing cluster-head does not move very quickly, because when the cluster-head changes fast, the nodes may be moved out of a cluster and are joined to another existing cluster and thus resulting in reducing the stability of network .There are many mobility models known such as Random Way Point Model (RWP), Random Way Point on Border Model (RWBP), Random Gauss Markov (RGM) model, and Reference Point Group Mobility model (RPGM). In our algorithm we used Random Way Point Model [8,10].

B. An Adaptive Broadcast Period Approach

In this paper, an efficient distributed clustering algorithm is introduced which uses both location and energy metrics for cluster formation. Our proposed solution mainly addresses cluster stability, manageability and energy efficiency issues. Also, unlike existing active clustering methods, our algorithm relieves the network from the unnecessary burden of control messages broadcasting, especially for relatively static network topologies. This is achieved through adapting broadcast period according to mobile nodes mobility pattern. The efficiency, scalability and competence of our algorithm against alternative approaches have been demonstrated through simulation results.

C. Reliable Node Clustering for Mobile Ad Hoc Networks

In this paper, author use probabilistic analysis to guide proposed clustering algorithm towards more reliable clusters. We also use scatter search to perform clustering while considering various Performance metrics. Experiment results show that our clustering approach produces more reliable clusters than prior approaches.

D. Survey of Clustering Schemes in Mobile Ad hoc Networks

In this paper, author present a study and analysis of some existing clustering approaches for MANETs that recently appeared in literature, which we classify as: Identifier Neighbor based clustering, Topology based clustering, Mobility based clustering, Energy based clustering, and Weight based clustering. We also include clustering definition, review existing clustering approaches, evaluate their performance and cost, discuss their advantages, disadvantages, features and suggest a best clustering approach.

E. Efficient Flooding with Passive Clustering (PC) in Ad Hoc Networks

In this paper author introduced a novel clustering scheme, called Passive Clustering that can reduce the redundant rebroadcast effect in flooding. We demonstrate the efficiency of the proposed scheme in the AODV (Ad hoc On demand Distance Vector) routing scheme.

F. Inter-Domain Routing for Mobile Ad Hoc Networks

Inter-domain routing is an important component to allow interoperation among heterogeneous network domains operated by different organizations. Although inter-domain routing has been well supported in the Internet, there has been relatively little support to the Mobile Ad Hoc Networks (MANETs) space. In MANETs, the inter-domain routing problem is challenged by: (1) dynamic network topology due to mobility, and (2) diverse intra-domain ad hoc routing protocols.

In this paper, we discuss how to enable inter-domain routing among MANETs, and to handle the dynamic nature of MANET.

IV. CONCLUSION

Clustering is the best solution for reducing flooding routing packets in mobile ad hoc network to adapt itself for its dynamic nature. Selecting Coordinators for clusters is a research issue in the area of wireless ad hoc networks. Cluster-head can be selected by computing quality of nodes, which may depend on connectivity, mobility, battery power etc. Significant performance improvement can be achieved by combining the effect of several performance factors.

REFERENCES

[1] C. K. Toh, Ad Hoc Mobile Wireless Networks protocols and Systems, Prentice Hall PTR, New Jersey, 2002

[2] C. E. Perkins, Ad Hoc Networking, Addison-Wesley, 2001.

[3] P. Mohapatra, S. V. Krishnamurthy, AD HOC NETWORKS Technologies and Protocols, Springer Science + Business Media, 2005.

[4] R. Ramanathan and J. Redi. "A Brief Overview of Ad Hoc Networks: Challenges and Directions", IEEE Communication Magazine, 40(5), 2002.

[5] J. Y. YU and P. H. J. CHONG,"A Survey of Clustering Schemes for Mobile Ad hoc Networks," IEEE Communications Surveys and Tutorials, First Quarter 2005,Vol. 7, No. 1, pp. 32-48.

[6] T. Ohta, S. Inoue, and Y. Kakuda, "An Adaptive Multihop Clustering Scheme for Highly Mobile Ad Hoc Networks," in Proc. 6th ISADS'03, Apr. 2003.

[7] D.J. Baker and A. Ephremides, "A distributed algorithm for organizing mobile Radio telecommunication networks", in: Proceedings of the 2nd International Conference on Distributed Computer Systems, April 1981, pp. 476–483.

[8] A.K. Parekh, "Selecting routers in ad-hoc wireless networks", in: Proceedings of The SBT/IEEE International Telecommunications Symposium, August 1994.

[9] P. Basu, N. Khan, and T. D. C. Little, "A Mobility Based Metric for Clustering In Mobile Ad Hoc Networks," in Proc. IEEE ICDCSW' 01, Apr. 2001, pp. 413–18.

[10] M. Gerla and J.T.C. Tsai, Multicluster, mobile, multimedia radio network, Wireless Networks 1(3) (1995) 255–265.

[11] S. Basagni, "Distributed clustering for ad hoc networks", in: Proceedings of International Symposium on Parallel Architectures, Algorithms and Networks, June 1999, pp. 310–315.

[12] S. Basagni, "Distributed and mobility-adaptive clustering for multimedia support in Multi-hop wireless networks", in: Proceedings of Vehicular Technology Conference, VTC, Vol. 1999-Fall, pp. 889–893.

[13] A. D. Amis and R. Prakash, "Load-Balancing Clusters in Wireless Ad Hoc Networks," in Proc. 3rd IEEE ASSET'00, Mar. 2000, pp. 25–32

[14] T. Camp, J. Boleng, V. Davies, "A Survey of Mobility Models for Ad Hoc Network Research", Wireless Communications & Mobile Computing (WCMC), 2003.

[15] S.K. Dhurandher & G.V. Singh, 'Weight based adaptive clustering inwireless ad Hoc Networks", IEEE International Conference on Personal Wireless Communications, New Delhi, India, 2005, 95-100.

[16] Damianos Gavalas, Grammati Pantziou, Charalampos Konstantopoulos, Basilis Mamalis, " Clustering of Mobile Ad Hoc Networks: An Adaptive Broadcast Period Approach", Department of Cultural Technology and Communication, University of the Aegean, Greece.

[17] Tao Wang, William N. N. Hung, Reliable Node Clustering for Mobile Ad Hoc Networks, Hindawi Publishing Corporation Journal of Applied Mathematics Volume 2013

[18] Abdelhak Bentaleb, Abdelhak Boubetra, Saad Harous, Survey of Clustering Schemes in Mobile Ad hoc Networks, Communications and Network, 2013, 5, 8-14

[19] Taek Jin Kwon , Mario Gerla, Efficient Flooding with Passive Clustering (PC) in Ad Hoc Networks

[20] Chi-Kin Chau, Jon Crowcroft , Kang-Won Lee, Starsky H.Y. Wong , Inter-Domain Routing for Mobile Ad Hoc Networks , MobiArch'08, August 22, 2008, Seattle, Washington, USA.

AUTHORS

First Author – Ms. Sujata Bhadoria, M.Tech (Research Scholar), Indore Institute of Science and Technology, sujatabhadoria89@gmail.com.
Second Author – Ms. Lakshmi Nishad, Asst. Professor, Indore Institute Of Science and Technology.
Third Author – Mrs. Lalita Tongue, Asst. Professor, Indore Institute Of Science and Technology.

Correspondence Author – Ms. Sujata Bhadoria, sujatabhadoria89@gmail.com, Contact No. - 9826505733.