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Evaluating the Performance of Wireless Ad-Hoc Networks with Low Forwarding Index

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ABSTRACT
Wireless ad-hoc networks have become an important area of research in wireless communication system. In particular, studying the capacity of wireless ad-hoc networks has been a key area of investigation in the research community. In this paper we shall attempt to remedy the situation to the extent that we shall seek efficient clustering algorithms and evaluate the performance of them. Our main objective is to study the problem of evenly distributed cluster formation in ad-hoc wireless environment. It is desirable to have these clusters as evenly distributed as possible over the network to avoid the congestion in the network. Clusterhead form a virtual backbone and are responsible to route packets (message) for nodes in their cluster. In our analysis we will discuss the concept of forwarding index for the clusterhead of the cluster to avoid the congestion in the network. The clusterhead-forwarding index of the network (cluster) is the minimum value of the largest load occurring at a clusterhead taken over all nodes in the cluster, where load of clusterhead is defined as the number of paths (routes) passing through that clusterhead..

Keywords
Ad-hoc Network, Routing, Performance, Protocols.

1. INTRODUCTION
Wireless ad-hoc networks have the advantage that deployment of networks does not require existing infrastructures. Ad-hoc networks have neither fixed topology nor centralized servers; it is assumed that, once deployed, the network nodes would self-configure to provide connectivity and form a communication network.

While the great flexibility of wireless ad-hoc networks is a highly desirable attribute, but it also presents considerable technical challenges in analyzing the behavior of such systems. In particular, studying the capacity of wireless ad-hoc networks has been a key area of investigation in the research community. For a network of n nodes, in the most general case, since each node can communicate with any other nodes, the capacity region has dimensions n (n−1).

The forwarding index is widely regarded as a good measure of routing to be evenly distributed over the network. Unfortunately in all the clustering algorithms that are designed thus far there has been no attempt to seek a good quality resultant network. By good quality we mean having low forwarding index and broadcasting radius. The first work on the subject works appeared in 1987 [1]. Since then, many studies from diverse points of view have been done. But previously the study was done on general communication network. Actually the forwarding index of a network provides the value of load in that network. So both the problems as the load-balancing problem and the problem of determining the forwarding index are same. In this paper we will define the problem of determining the Forwarding Index for the wireless ad-hoc networks.

Unfortunately, as shown in [2], the problem of determining the forwarding index of a network is NP – complete and it is also well known that optimal clustering is NP – complete. The election of clusterheads has been investigated in this paper. Leader election is a fundamental problem in distributed computing, and there has been a lot of research on this topic. Each of these employs different models of communication, and allows the passing of different types of messages between the nodes during cluster formation. Some work on Bluetooth network formation has also been done.

2. FORWARDING INDEX
Our main objective is to study the problem of evenly distributed cluster formation in ad-hoc wireless environment. It is desirable to have these clusters as evenly distributed as possible over the network to avoid congestion in the network. Clusterhead form a virtual backbone and are responsible to route packets (messages) for nodes in their cluster. Nodes are assumed to have non-deterministic mobility pattern. Diffusing node identities along the wireless links form clusters. Different heuristics employ different policies to elect clusterheads. Several of these policies are based in favor of some nodes. As a result, these nodes shoulder greater responsibility and may deplete their energy faster causing them to drop out of the network (i.e. there occurs a congestion in the network). Therefore, there is a need to minimize the load of clusterhead. Clusterheads maintain cluster databases for routing purposes.

This paper propose the concept of forwarding index [3,4,5] for the clusterhead of the cluster. The clusterhead-forwarding index of the network (cluster) is the minimum value of the largest load occurring at a clusterhead taken over all nodes in the cluster, where load of a clusterhead is defined as the number of paths (routes) passing through that clusterhead. This helps in the even distribution of the responsibility of acting as clusterheads among all nodes to avoid congestion in the network. This congestion is also bad from the fault-tolerance point of view for if clusterhead of such a cluster were to fail, a large part of the network comes to halt. Computing forwarding index of general network was shown to be NP-complete by Saad [1] and problem of optimal clustering is also NP-complete [6].

In a communication network data, message, etc. are transmitted from each node to any other node. A convenient way to achieve this is to have for every source node a designated route, a sequence of intermediate nodes for every destination. A set of nodes N (Which are processors or communicating centers), with link between some of them for the purpose of communicating data or message is usually represented by graphs [7]. Generally the nodes are to be

interpreted as computer/communication devices. Instead of nodes and links we speak of vertices and edges.

The network connecting the n nodes is designed by specifying first the bidirectional communication lines or channels, i.e., those pairs of nodes having direct communication. Interconnection is limited by a port constraint d ≥2 common to each node; i.e., at most d (where d is the degree of the graph) communication lines can be attached to any node. Since it follows in general that not every pair of nodes will have direct communication, the network design must also specify a set of n (n-1) paths called a routing, indicating for each x and y ≠ x the path or fixed sequence of lines which carries the data transmitted from node x to node y. Implicit here is that in addition of being data sources and sinks, the nodes also perform a forwarding function for the data being communicated between other nodes. Note that, generally the path from node x to node y need not be the reverse of the path from node y to node x.

3. WIRELESS AD-HOC NETWORK

Wireless communication network can be presented by an undirected graph G=(V,E), where V and E are the set of vertices and edges respectively for graph G. each node v □ V represents a wireless station and every undirected edge e □ E define a neighbor relationship between two nodes, that is to say it indicates two nodes at the end of the edge those can be communicate with each other, for any nodes u and v □ V, if v is an adjacent node of neighbor of u and if not neighbor of u we say v is two hop node of u.An ad-hoc wireless network [8, 9, 10] is a collection of wireless mobile hosts forming a temporary network without the aid of any established infrastructure or centralized administration. Ad-hoc networks are expected to play a significant role in future mobile computing. An ad-hoc network consists of a set of self organizing mobile nodes which require no fixed infrastructure, and which communicate with each other over wireless links. For efficient communication between nodes, ad-hoc networks are typically grouped into clusters [11, 12], where each cluster has a clusterhead. Clusterhead node is responsible for the formation of clusters. The set of clusterhead is known as a dominant set. A clusterhead does the resource allocation to all the nodes belonging to its cluster. Communication between nodes in different clusters is through gateway nodes, these are also known as bridge nodes. Bluetooth is an emerging technology for indoor wireless Pico-cellular environment and it employs a Master-Slave model for communication between nodes. In this model, each cluster has a star topology with a master of the star at the center and the Master controls the traffic to the Slaves.

Efficient clustering and topology construction algorithms play a very important role in the fast connection establishment of ad-hoc networks. The performance of these algorithms chiefly dependent on the device discovery time, i.e. the time taken by a node to discover and to connect to another node in its radio range (which is already part of the existing network). This device discovery time is also crucial in other situation for example, when large number of devices within radio range of each other is powered on time taken to complete the formation of the network is an important performance criterion.

The standard model that we shall use for wireless ad-hoc networks is derived from Bluetooth [13]. One can imagine receiving an e-mail from his/her phone into his/her mobile PC just by a voice command. A seemingly simple application but one that needs technology to connect devices link never before and this technology is Bluetooth. The Bluetooth SIG aims to provide solutions for short range wireless connectivity between pervasive devices, like PDAs, mobile phones, palmtops, laptops, pagers etc. It is meant to be cable replacement solution for desktop keyboards and other peripheral devices. The potential application range from smart home appliances to wireless connectivity to backbone data networks. Bluetooth is being considered for use by the top players in the consumer electronic market product would include wireless headsets cameras, watches and portable games, the automatic industry is also looking to use Bluetooth technology as the key solution for onboard wireless communication system, connecting vehicular and external networks. These and other applications in the office and classroom environments, like shared white boards would make it important for the devices to quickly self organize themselves into an ad-hoc network.

Basically Bluetooth is an asynchronous system in which each node has a unique ID, but does not know the ID of any other node. A node trying to discover other nodes broadcast generic messages and does not know which node it is replying to. Much more is ideally suited for frequency hopping system, where the device hop on sequences and the messages are repeated in order to read other nodes. This model has unique features, which cannot be solved using conventional techniques.

4. WIRELESS AD_HOC NETWORK AND FORWARDING INDEX

In an ad-hoc wireless environment it is desirable to have these clusters as evenly distributed as possible over the network to avoid congestion in the network. It will also be bad from the fault-tolerance point of view for if clusterhead of such a cluster were to fail a large part of network would come to halt. The clusterhead forwarding index of the network (cluster) is the minimum value of the largest load occurring at a clusterhead taken over all clusters, where load of a clusterhead is defined as the number of nodes connected to that clusterhead.

For wireless ad-hoc networks we have looked many papers [2, 14, 15, 16] that deal with the problem of load balancing in ad-hoc networks. Each of these papers attacks the problem of load balancing in different ways. The paper by S.K DAS et. al. [15] tries to devote the load balancing algorithm that would try to find the best node to share the load with while minimizing the communication overhead involved in load – balancing. Another paper by D. Turgut et. al. [16] deals with ad-hoc networks where mobile nodes have been loosely classified into clusters based on their current location. The authors proposed a load – balancing heuristic to extend the battery life of a clusterhead before allowing it to retire and allow another node to become the clusterhead.

A major drawback of all existing ad-hoc routing protocols is that they do not have provisions for conveying the load and/or quality of a path during route setup. Hence they cannot balance the load on different routes. Also, both proactive and reactive protocols choose a route based on the metric, the smallest number of hops to the destination. But it may not be the most significant route when there is congestion or bottleneck in the network. It may cause the packet drop rate, packet end-to-end delay, or routing overhead to be increased particularly in the cases when the traffic is concentrated on a special node like a gateway through which mobile nodes from ad hoc network can connect to Internet.

There are various algorithms available for load balancing that consider traffic load as a route selector, but these algorithms neither reflect burst traffic nor transient congestion [17]. While selecting the path set the following issues need due consideration [18]: i) the distribution of load should be even, ii) The traffic load in the medium surrounding the mobile nodes on the routes, should be light• iii) The paths should comprise of nodes with high residual battery power• iv) If a link is highly reliable, it is advantageous to allow it to be shared by more than one path.

5. REFERENCES

[1] R.Saad "Complexity of the Forwarding Index problem" LRI technical Report & SIAMS, Disc. Math., 6 (3), pp.418-427, to appear. 1993

[2] H.H. Abu Amara, "Fault – tolerance distributed algorithms for election in complete networks", IEEE Trans. Computers Vol.37, No.4, pp.449-453, Apr. 1998.

[3] F.Chung, E. Coffiman, M. Reiman and B.Smon "The forwarding index of Communications Networks ", IEEE trans, info. Theory, 331(1987), 224-232.

[4] A.Shastri and P. Zutshi, "Forwarding Index and connectivity of communication Networks" Proceeding of IEEE International Conference on Networking Indian and the World, Ahmedabad (1998).71-77.

[5] Y.Manoussakis and Zs. Tuza "The forwarding index of directed networks" technical report. L.R.I No. 482, University of Paris-XI (1989); Disc. Appl. Mathematics, 68, 1996, 279-291

[6] M. gray, Micheal R. , and Johnson., David S.; Freeman, Computers and Intractability: "A Guide to the theory of NP- completeness" NewYork,1979.

[7] A. Shastri and R. Dadhich, "Load Balancing in Wireless Ad-hoc Networks With Low Forwarding Index", Proceeding of IEEE International Conference on Information and Automation, held at COLOMBO, Sri Lanka, 14-18 Dec.2005.

[8] S. Sargento et al., "Mobile Ad-Hoc Networks Integration in the Daidalos Architecture", IST Mobile and Wireless Communications Summit 2003, June 2005.

[9] Uppsala University, Ad Hoc Implementation Portal website: http://core.it.uu.se/AdHoc/ImplementationPortal, as in February 2006.

[10] C. Jelger, T. Noel, "Gateway and address auto configuration for IPv6 adhoc networks", IETF Internet Draft, draft-jelger-manet-gatewayautoconf-v6-02.txt, Apr. 2004

[11] Statsoft: http://www.statsoftinc.com/textbook/stcluam.html, Cluster Analysis.

[12] Riot Applications: http://riot.ieor.berkeley.edu/riot/Applications/clustring/index.html, Clustring

[13] Bluethoot: http://www.bluetooth.com

[14] Turgut D., Turgut B. S.K.Das, R. Elamasri, "Balancing loads in mobile ad-hoc networks" telecommunications, 2003, ICT 2003, 10th International Conference Vol.1, 23 Feb.-1 march 2003.

[15] R. Prakash, A.D Amis, "Load Balancing in Wireless Ad-hoc Networks" Application Specific Systems and Software Engineering Technology, 2000, Proc. 3rd IEEE Symposium, 24-25 march 2000.

[16] F.Chung, E. Coffiman, M. Reiman and B.Smon "The forwarding index of Communications Networks ", IEEE trans, info. Theory, 331(1987), 224-232.

[17] Abolhasan, M., T. Wysocki and E. Dutkiewicz,. "A Review of Current On-demand Routing Protocols", ICN 2001, LNCS 2094, pp: 186-195. 2001.

[18] Murthy, S. and J. J. Garcia-Luna-Aceves,. "An Efficient Routing Protocol for Wireless Networks", ACM/Baltzer Mobile Networks and Applications, 1 (2): 183-197. 1996 July 2003.