Integrating Position Reporting, Routing and Mobility Management in Multihop Packet Radio Networks

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Abstract. In this paper we propose an integrated proactive routing and mobility management strategy that makes feasible the realization of a flat single-tier routing architecture in multihop packet radio networks. The integration of the routing and mobility management functions is achieved via the use of the geographic position reporting mechanism and the generalization of the zone routing concept. The underlying principle behind the proposed routing strategy is to reduce the network routing overhead by making the accuracy of the routing information in each node "inversely proportional" to its distance from any other node in the network. The proposed integrated scheme provides for a flat routing architecture with no hierarchical entry/exit points, where every node can act as a router, therefore increasing the network's routing flexibility and robustness. Finally we show through modeling and simulation that the proposed routing protocol is a bandwidth-efficient routing mechanism that can be applied across large-scale networks.

1 Introduction

Mobile wireless networking has enjoyed dramatic increase in popularity over the last few years. The advances in hardware design, the rapid growth in the communications infrastructure, and the increased user requirement for mobility and geographic dispersion, continue to generate a tremendous need for dynamic ad hoc networking. Multihop packet radio networks (or mobile ad-hoc networks) are an ideal technology to establish “instant” communication infrastructure for military and civilian [1,2] applications in which both hosts and routers are mobile. There are many existing military networking requirements for robust communications in a variety of potentially hostile environments that may require the rapid deployment of mobile radio networks (commonly referred to as packet radio networks) [3,4], as well as

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future military applications and requirements for IP-compliant data services within mobile wireless communication networks [5]. Moreover mobile ad hoc networking technology can provide extremely flexible method for establishing communications for operations in disaster areas resulting from flood, earthquake, fire, or other scenarios requiring rapidly deployable communications with survivable efficient dynamic networking. Some other applications of mobile ad hoc networking technology could include industrial and commercial applications involving cooperative mobile data exchange. In addition mesh-based mobile networks can be operated as robust, inexpensive alternatives or enhancements to cell-based mobile network infrastructures. In such mobile ad hoc networks there are no dedicated base stations as in conventional commercial cellular networks, and all nodes interact as peers for packet forwarding. This distributed nature eliminates single points of failure and makes those packet radio networks more robust and survivable that the commercial cellular networks. The vision of mobile ad hoc networking is to support robust and efficient operation in mobile wireless networks by incorporating routing functionality into mobile nodes. Such networks have dynamic, sometimes rapidly changing, random, multihop topologies. The goal of mobile ad hoc networking is to extend mobility into the realm of a set of wireless mobile nodes, where themselves form the network routing infrastructure in an ad hoc fashion.

A multihop packet radio network results from the fact that not every pair of nodes are within the transmission range of each other. In this case a packet must relayed over several hops before reaching its final destination, and therefore routing problems and issues emerge [6]. Choosing the proper routing strategies is very important for efficient network operation. Additional issues associated with the routing strategies in multihop packet radio networks stem from the fact that those networks are plagued with problems such as, variable quality of the links, the hidden terminal problem, and particularly the inaccuracies in the routing information due to the mobility of the nodes. In such mobile ad hoc networks a routing strategy (or system) can be defined as a set of several component functions including the following: monitoring network topology; locating end-points and performing mobility management; distributing this information for use in route construction; constructing and selecting routes. An efficient peer-to-peer mobile routing mechanism (protocol) in a purely mobile, wireless domain must: provide for effective operation over a wide range of mobile networking environment with its corresponding set of characteristics; provide algorithms and methods for allowing newly arrived nodes to be incorporated into the network and become an integral part of the network automatically, without manual intervention (self-organizing); react efficiently to topological changes and traffic demands while maintaining effective routing in a mobile networking environment; and address effectively the issue of scalability.

Implementing hierarchic routing in a highly dynamic network is complicated by the following issues: a) The hierarchy must be defined dynamically (because nodes that are now close together may later be far apart), b) Routing algorithms must adapt to changes in hierarchic connectivity, as well as to changes in radio connectivity, and c) Nodes must be able to determine the “hierarchical address” of a destination node. On the other hand some ad hoc mobile networks may be able to route messages using position (e.g. latitude and longitude) rather than topologically-derived information about nodes. Position based routing strategies, since they do not require the exchanges of routing tables, are especially attractive in highly mobile environments where topological changes are frequent and routing tables become obsolete very quickly [7].