Influence of Network Merger on Address Assignment Strategies for Mobile Ad Hoc Networks

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Abstract

For a mobile device to utilize routing to communicate with other nodes within an ad hoc network, it requires an address, which uniquely identifies the node within the network. A number of approaches have been proposed for the dynamic assignment of unique addresses within an ad hoc network. This paper presents a classification and a cumulative analysis of a number of these approaches through various simulation scenarios and suggestions are made as to improvement of performance based on the analysis. In particular we analyse how the various approaches tackle the problem of network merger and partitioning.

Introduction

A wireless ad hoc network is a collection of autonomous nodes or terminals that communicate with each other by forming a multi-hop radio network and maintaining connectivity in a decentralised manner. The network topology of such networks can be highly dynamic as the nodes may be mobile and their links may have to contend with the side effects of radio communication, such as noise, fading and interference. In an ad hoc network routing is used to find and maintain a path through the network. Routing requires each node to have a unique identifier, to ensure that packets sent to a particular node reach their intended destination.

Dynamic Address Assignment

In the wired environment a number of different methods can be used to dynamically assign an address. The Internet Protocol (IP) is the most popular network layer communication protocol used in the wired environment and requires each node in the network to be configured with a unique address. In the wired environment the Dynamic Host Configuration Protocol (DHCP) [1], Mobile IP [2,3], and IPv6 Stateless Address Auto-configuration [4] are often used to dynamically assign IP addresses. Problems however still exist when these approaches are applied to ad hoc network. One such problem is that these approaches fail to tackle the problem of network merger and partitioning, which can have an affect on address assignment in ad hoc networks. At any time, a network may split into multiple different partitions. A merger occurs when two or more separately configured networks are combined together to form one network. Network merger in particular can cause problems for address assignment, as address duplication can occur. If each partition has independently allocated or configured its own addresses, two nodes may end up sharing the same address. The problem is illustrated in Fig. 1.

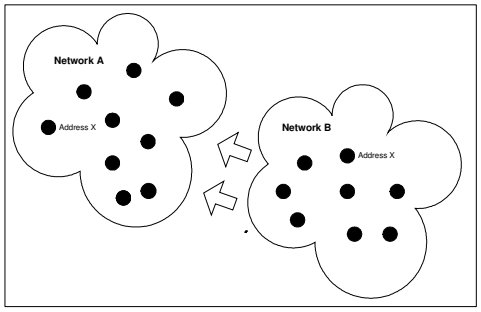

Figure 1: Network Merger

In Fig. 1 we have two networks A and B; each of which has a node with address X. If these two networks were to start moving towards each other and merge together into one network, address duplication would occur because two nodes in the merged network would share the same address. One of the nodes would have to relinquish their use of the address.

The peer-to-peer nature of ad hoc networks requires that a distributed approach to address assignment be used. Address assignment approaches for ad hoc networks can be classified into two different approaches.

A. Stateful Approach

In the stateful approach when a new node enters into the network and requires an address, it chooses one configured node to assist it in the selection of a unique address. This configured node may assist the new node in a number of ways. The configured node may for example choose an address and verify the uniqueness of this address on behalf of the un-configured node. It may also provide information to the un-configured node to assist it in the uniqueness verification process. Proposals based on this approach include [5-9].

B. Stateless Approach

In a stateless approach when a node enters into the network and requires an address, it creates and verifies the uniqueness of an address without any assistance from other nodes in the network. Two methods are generally used here, a MAC based approach and a random selection approach. In a random selection based approach, a node selects an address at random from a predefined pool of addresses and then performs a process to verify the uniqueness of this address within the network. Another approach is for a unique identifier such as a MAC address to be embedded into an address. The uniqueness of this address is then tested within the network. Examples of proposals based on this approach include the following [10-13].

Analysis

Simulations are carried out via a computer simulation of an ad hoc network. Performance metrics used to evaluate the performance of assignment approaches include the following.

- Latency for Address Assignment
  The average time taken for a node to be assigned a unique address.
- Address Assignment Overhead
  The average number of address assignment packets generated by each node during the simulation.
- Latency for Merger Detection
  The average time taken for a node to detect a network merger and resolve any possible address duplications.
- Merger Detection Overhead
  The average number of packets generated by each node in order to detect and resolve a network merger.

Various simulation parameters such as number of nodes, area size, mobility of nodes and number of available addresses will be varied in order to gain a comprehensive analysis.

Conclusion

The final version of this paper will present a classification and a comprehensive and comparative analysis through computer simulation of four of the above approaches to address assignment [5,6,9,11]. Suggestions will also be made as to the improvement of performance based on the analysis. In particular we will analyse how the various approaches tackle the problem of network merger and partitioning.

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