Wireless Networks 8, 107–120, 2002

Analysis of a Metropolitan-Area Wireless Network

DIANE TANG
Stanford University, Gates 3A, Stanford, CA 94305-9030, USA

MARY BAKER
Stanford University, Gates 4A, Stanford, CA 94305-9040, USA

Abstract. We analyze a seven-week trace of the Metricom metropolitan-area packet radio wireless network to find how users take advantage of a mobile environment. Such understanding is critical for planning future large-scale mobile network infrastructures. Amongst other results, we find that users typically use the radios during the day and evening. Of the users who move around during the trace (over half), we find that the more locations a user visits on a daily basis, the closer together, on average, those locations are. While these results are only known to be valid for this particular network, we hope future analysis of other networks will add to a growing understanding of mobile network behavior.

Keywords: metropolitan-area wireless network, network analysis

1. Introduction

Currently, mobile and ad hoc networking is the topic of many research and development efforts. Much of this work focuses on providing future users with network resources and connectivity no matter where they are. Whether the work concentrates on adapting applications to changing user location or on devising new protocols to handle mobility, it is largely based on assumptions of how users will take advantage of a mobile environment. It is difficult to verify these assumptions since we are unaware of any publicly available studies of a sizeable metropolitan-area wireless network. Therefore, many research and development efforts must drive their simulations using assumed models of user movement not derived from observation.

In this paper, we analyze a network trace of the Metricom packet radio network, a metropolitan-area wireless network, to find answers to overall network questions such as when the mobile network is the most active, how active the network gets, where the network is active, as well as radio mobility questions such as how far, how often, and when users move. The answers to such questions are crucial in planning a future mobile network infrastructure, and in understanding how people actually take advantage of a mobile network. While these results are only known to be valid for this particular network, we hope future analysis of other networks will add to a growing understanding of mobile network behavior.

We present several results in this paper, including our finding that the more locations users visit on a daily basis, the closer together, on average, those locations are. In addition, the distance users move is a Gaussian distribution around the radius of the network. We also find that radios are used mostly during the day and evening hours.

In this paper, we first present some background information about the data before we present the actual results from the analysis. The analysis is divided into two parts: overall network behavior and radio mobility.

2. Background

In this section, we describe the network traced, how the data was collected, and some issues that arose in the data analysis.

2.1. Data collection

The traces we study here were obtained from Metricom [2,6]. Metricom has installed a Ricochet^{TM} packet radio network infrastructure in three major metropolitan areas (San Francisco Bay Area, Washington D.C., and Seattle), as well as in some airports, hotels, and college campuses scattered across the United States. This infrastructure consists of "poletop" repeaters distributed throughout the covered areas. Each poletop is one of two types:

- a wireless repeater, which just forwards packets on to another poletop via the radio interface, or
- a wired access point, which has both a radio interface and a wired interface. Typically, wired access points have 8, 16, or 24 radios on them, as they are the focal point of many other wireless repeaters.

The range of a repeater is normally about half a mile. This range may vary depending on external conditions, such as the weather or the location of buildings and hills.

When a subscriber radio is first turned on, it scans the network for poletops, and chooses one with which to register. This choice is usually based on signal strength, but may also be based on load-balancing considerations. This poletop is responsible for forwarding all packets to and from the Metricom network on behalf of that radio. Radio registrations also occur