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IP Paging Service for Mobile Hosts

RAMACHANDRAN RAMJEE *, LI LI, TOM LA PORTA and SNEHA KASERA
Lucent Bell Labs, 101 Crawfords Corner Road, Holmdel, NJ 07733, USA

Abstract. In wireless networks, mobile hosts must update the network with their current location in order to get packets delivered. Paging facilitates efficient power management at the mobile host by allowing the host to update the network less frequently at the cost of providing the network with only approximate location information. The network determines the exact location of a mobile host through paging before delivering packets destined to the mobile host. In this paper, we propose the concept of paging as an IP service. IP paging enables a common infrastructure and protocol to support the different wireless interfaces such as CDMA, GPRS, wireless LAN, avoiding the duplication of several application layer paging implementations and the inter-operability issues that exist today. We present the design, implementation, and detailed qualitative and quantitative evaluation, using measurements and simulation, of three IP-based paging protocols for mobile hosts.

Keywords: IP, paging, mobility, domain paging, Hawaii

1. Introduction

In networks that support mobility, the precise location of a mobile host must be known before data can be delivered. There is a tradeoff between how closely the network tracks the current location of a mobile host, versus the time and complexity required to locate a mobile host whose position is not precisely known.

Tracking the location of a mobile host is performed through *update* procedures in which a mobile host informs the network of its location at times triggered by movement, timer expiration, etc. Locating a mobile host is performed through search procedures which include *paging* the mobile host. Paging typically includes transmitting a request for a mobile host to a set of locations, in one of which the mobile host is expected to be. This set of locations is called a paging area and consists of a set of neighboring base stations.

A network that supports paging allows the mobile hosts to operate in two distinct states – an *active state* in which the mobile host is tracked at the finest granularity possible such as its current base station (resulting in no need for paging), and a *standby state* in which the host is tracked at a much coarser granularity such as a paging area. The network uses paging to locate the mobile host in standby state. The mobile host updates the network less frequently in standby state (every paging area change) than in active state (every base station change). Since the power spent in updating the network is an order of magnitude greater than the power spent in standby mode [18], battery power consumption at the mobile host is reduced significantly [17].

Thus, the main benefit of providing a paging service is to facilitate efficient power management at the mobile host. The cost of paging is the complexity of the algorithms and protocols required to implement the procedures, and the delay incurred in locating a mobile host before data can be delivered.

* Corresponding author.

Many research and standardization efforts are underway to integrate both indoor (LAN) and outdoor (WAN) wireless access technologies over a common IP-based access network [11,21,24]. These will allow more flexibility in deploying equipment which may greatly reduce network operations costs [20]. In addition, an IP-based access network will be able to support both voice and data services on a common infrastructure resulting in seamless support of services across wired and wireless networks. These IP-based networks are expected to be the basis for mature third and fourth generation wireless networks.

Paging service is available in wireless wide-area networks (WAN) such as General Packet Radio Service (GPRS) [2] and CDMA data [7]. Wireless local area network (LAN) protocols such as IEEE 802.11 [6], also have the notion of a power-save state [18]. Here the paging functionality is limited to waking the mobile host from power-save (standby) state to active state at a single base station. The paging architecture and protocols in each of these networks are defined independently and do not inter-operate. This precludes seamless movement between local-area and wide-area networks or between wide-area networks of different types. An IP-based paging architecture is a key element that would facilitate inter-operability between these different wireless networks.

Mobile IP [12], the mobility protocol for IP networks, currently does not support paging. The focus of this paper is on architectures and protocols for adding paging in IP networks that support mobility. Together, IP paging and IP mobility will support the full functionality present in current wide-area wireless networks, thereby serving as the basis for efficient and cost-effective all-IP third and fourth generation wireless networks.

An effective paging service should have the following characteristics. First, it should be simple to implement. Second, it should be flexible in terms of supporting various update and paging algorithms, and in terms of being compatible with existing IP mobility protocols. Third, it should be scal-