Chapter 88

Location Management in PCS Networks Using Base Areas (BAs) and 2 Level Paging (2LP) Schemes

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ABSTRACT

The main objective of PCS networks is to provide "anytime-anywhere" cellular services. Accordingly, lost calls as well as the network slow response have become the major problems that hardly degrade the network reliability. Those problems can be overcome by perfectly managing the Mobile Terminals (MTs) locations. In the existing location management (LM) scheme, Location Area (LA) is the smallest unit for registration. A MT must register itself when passing through its LA boundary to a neighboring one. Moreover, such registration takes place at the MTs' master HLR (even though currently managed by another HLR), which increases communication costs. As a result, existing LM scheme suffers from; (1) excessive location registrations by MTs located around LA boundaries (ping-pong effect) and (2) requiring the network to poll all LA cells to locate the callee MT. In this paper, a novel LM strategy is introduced by restructuring LAs into smaller areas called Base Areas (BAs), which impacts the paging cost. The proposed LM strategy uses caching to reduce unwanted updates and 2LP to reduce paging cost. Experimental results show that the proposed scheme introduces a distinct improvement in network response and tracing process.

INTRODUCTION

Providing a transparent cellular communication services all over the world is the most human aim over the past few years. Such services are the ones that guarantee a reliable exchange of information in any form (voice, data, video, image, etc.) with no worry about the real-time distribution of MTs. Hence, they should be independent of service time, user's location and the underlying network access arrangement. This aim is continuously promoted by the tremendous growth in wireless communications (Brown & Mohan, 1997; Fang, Chlamtac, & Lin, 2000; Fang, Chlamtac, & Fei, 2000).

A PCS network is the integration of cellular (Wireless) and conventional (wired) networks. It provides wireless communication services that enable Mobile Terminals (MTs) to communicate and exchange any form of information on the move "anytime-anywhere services". One of the key issues in the design of PCS networks is the efficient management of real-time locations for MTs. To efficiently establish any service in the PCS network, the location of the MT should be clearly identified. Consequently, when an MT moves, it should inform the system with its new location (Gibson, 1996; Wong & Leung, 2000, Zhang, 2002). There are two basic operations in location management (LM); Location Registration (Location Update) (LR) and Call Delivery (CD). Location registration is the process through which the cellular system tracks the continuously changed locations of its MTs. On the other hand, when an incoming call arrives, the system has to search for the callee MT. This process is defined as call delivery or paging (Li, Kameda, & Li, 2000; Lo, Wolff, & Bernhardt, 1992; Meier-Hellstern & Alonso, 1992). To the best of our knowledge, there are two standard schemes for PCS location management, which are; Interim Standard 41 (IS-41) for North America Digital Cellular system and Global System for Mobile (GSM) for Pan-European Digital Cellular. Both schemes use a two-tier infrastructure of Home Location Reg-

ister (HLR) and Visitor Location Register (VLR) databases. Moreover, in the existing LM schemes, only the master HLR for an MT is used for storing and updating any MT's data even though that MT moves to another Service Area (SA) served by another HLR. This increases the communication costs for accessing the master HLR for both LR and CD dramatically. Also, Location Area (LA) is considered as the smallest unit to make LR.

In this paper, we have introduced a novel strategy for LM in PCS networks by restructuring the LAs of PCS networks into smaller areas called Base Areas (BAs), which in turn minimizes the paging cost. Moreover, registration is done through the current HLR instead of the master HLR, which improves not only the network response but also the network quality of service (QoS). Also, the proposed scheme uses caching to reduce unwanted LRs (Location Updates), read/write from/to databases (accessing database), and signaling costs. While existing LM scheme locates any MT by polling all LA cells, the proposed scheme uses 2LP (2-level paging) scheme to reduce the paging cost. An analytical model is developed to study the performance of the proposed frameworks. Experimental results have shown that the proposed scheme introduces a distinct improvement in network response and tracing process as well as reducing LM costs.

The rest of this paper is organized as follows: Background and Basic Concepts and Related Works are presented first. Next we describe the existing Location Management scheme. We present the proposed framework and an analytical model is presented. The performance comparisons between the proposed location management scheme and the existing one are discussed and we conclude the paper.

Background and Basic Concepts

Figure 1 describes the PCS networks structure. As depicted in such figure, PCS network is divided into service areas (SAs), which in turn are sub-

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