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Paging in Mobile Terminals using Mobility Management in Fixed and Mobile Networks

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Abstract— Terminal mobility(TM) and personal mobility (PM) should work together to provide mobility to mobile users in fixed and mobile networks. TM supports movement between different areas with in the same region. In mobility management, an MT (Mobile Terminal) updates its location when it changes its location and all calls are delivered to the MT by paging all cells within that registered location area (LA). In PM personal identifier (PID) is used to identify users at different terminals. In PM all users' information is registered at registrar and an incoming call is delivered to the registered terminal based on registered information. Since location management in TM generates a lot of signaling messages over radio interface and consumes scarce radio resources, it is essential to reduce the number of location registration and paging signaling messages, i.e., signaling load. We propose an efficient paging scheme for TM in fixed and mobile networks, by using registration information for PM management. In the proposed paging scheme, paging is firstly performed only to the cells containing terminals with which a user is registered for PM, instead of all cells within a registered LA. If the called user is not found in the first paging step, remaining cells within the registered LA are paged.

Indexing terms: ***Terminal mobility(TM),personal mobility (PM), MT (Mobile Terminal), personal identifier (PID)***

I. INTRODUCTION

In mobile communication networks, mobile users are communicated using the mobility management technique [1]. Terminal mobility, network mobility, session mobility, and personal mobility are different types which take place in the OSI layers at different level. By TM, a user can be reachable while it is moving around the network with a mobile terminal. Network mobility provides a collective mobility to an entire network of MTs riding on a transportation system. Session mobility allows a session to be maintained while a user changes a fixed terminal or an MT for the same service session. PM enables a user to use any fixed terminal or MT with personal identifier (PID), rather than terminal ID, based on registration information at either a fixed terminal or an MT.

TM management consists of location management and handoff management. Location management consists of location registration and paging, where a mobile user updates its location periodically and an incoming call is delivered to a mobile user by paging all cells within a registered. Location area (LA)[2][3]. Since location management generates a lot of signaling messages over the radio interface and consumes scarce radio resources, it is essential to reduce the number of location registration and paging signaling messages, i.e., signaling load. Handoff enables a mobile user to change its point of attachment when it moves across the cell boundaries. In handoff, minimizing delay to handover an ongoing call to a new base station is one of the most important requirements. TM handles mobility within mobile network while it does not cover mobility between fixed network and mobile network, and mobility between these networks is supported by PM. PM is realized by using unique PID and registration and deregistration at a terminal are needed by using PID[4]—[8]. Incoming call is delivered to an appropriate registered fixed or mobile terminal based on the registration information. PM can be classified as single registration and multiple registrations, depending on the number of terminals that can be registered at registrar simultaneously [9],[10]. In single registration, only one terminal can be registered at registrar and high registration signaling load is generated. On the other hand, multiple terminals can be registered at registrar simultaneously in multiple registrations and high searching signaling load is generated to find the called user.

In PM manual registration and deregistration are usually performed, and misrouted calls may occur if users forget to deregister when they move out from the area of the registered terminal. Radio frequency identification (RFID) technology has been used to register users at terminals with RFID readers automatically by detecting the movement of users with RFID tags. RFID reader is installed at terminals and users move with RFID tags[6]---[8]. Thus, if a user with RFID tag moves between different areas of terminals with RFID readers, the movement is detected automatically and registration can be performed at registrar. Both TM and PM are essential for providing seamless universal mobility services to mobile users. An

efficient pipelined search scheme is used for supporting PM in Session Initiation Protocol (SIP)-based voice over IP (VoIP) services in order to overcome the shortcomings of both sequential and parallel search schemes. RFID technology is used to register users automatically when they are moving into a new area and reduce the probability of call-miss. We propose a seamless mobility support mechanism between two access networks with RFID readers for users moving with RFID tags.

However, only PM was emphasized and there was little inter-working between TM and PM[9], from the aspect of performance improvement, to the best of our knowledge. However, information registered for PM management can be used efficiently in order to support TM[10] to mobile users. Thus, we propose an efficient paging scheme for TM using PM management information in inter-worked fixed and mobile networks in this paper. Paging is firstly performed only to the cells containing terminals with which users are registered for PM, instead of paging all cells within a registered LA. If the called mobile user is not found in the first paging step, remaining cells within the registered LA are paged and it is guaranteed that the called user is found within this two-step paging. The performance of the proposed paging scheme[4] is analyzed and compared with that of conventional scheme. We will show that the proposed scheme can achieve significant signaling load reduction at radio interface, and thus, save scarce radio resources.

II. RELATED WORKS ON PM

Two PM management schemes were proposed to manage PM information related [4]to universal personal telecommunication (UPT) service[5] in mobile networks, where the two proposed schemes differs from each other, based on the location information stored in the location register. The effect of introducing PM in mobile communication networks were analyzed, from the aspects of update or query cost, signaling delivery cost, and processing cost.

In [9] Single registration and multiple registration schemes were introduced and compared for PM. In multiple registrations, users are registered at multiple fixed terminals at the same time and PM is inherently supported by using sequential search or pure parallel search. Since there is a tradeoff between sequential search and pure parallel search, from the aspects of call setup delay and search cost, pipelined search scheme for Session Initiation Protocol (SIP)-based voice over IP (VoIP) services was proposed and the performance of the proposed scheme was analyzed. [9][10]

If a user forgot to register at a new terminal when he moves to a new location, the problem of call-miss is identified. In order to reduce the probability of call-miss, RFID technology is used to register users automatically when they are moving into a new area. We proposed an agent-based user mobility support mechanism to provide seamless mobility between two access networks with RFID readers for users moving with RFID tags and showed that seamless service could be provided according to a user movement by implementing a test bed for user mobility.[14] The utilization of enhanced user mobility support mechanism to minimize handover latency time in RFID networking environment shows that the proposed mechanism has lower handover latency time[9]. In these related works on PM, registration information is stored at location register or SIP registrar by manual registration by users or automatic registration using RFID technology. In this paper, the information managed for PM will be efficiently used to reduce signaling load for paging for MTs in inter-worked fixed and mobile network.

III. PROPOSED PAGING SCHEME

A. Fixed and Mobile Network Architecture

Fig. 1 shows a fixed and mobile network architecture considered in this paper. It consists of various fixed and mobile access networks, such as cellular network, office network, and home network. These networks are inter-worked based on common IP-based core network. Home location register (HLR), office gateway, and home gateway manage location information of mobile users residing at cellular network, office network, and home network, respectively. SIP registrar manages registration information for PM. [9][10]. It is assumed that terminals in fixed network are equipped with RFID readers and RFID tags are implemented within MTs. For PM, multiple registrations are assumed and thus, users can register all their terminals, i.e., office phone, home phone, etc., at SIP registrar simultaneously. In this paper, we assume a hierarchical registration approach for PM management. That is, within home or office network domain, PM registration update is automatically carried out at gateway when mobile users with RFID tags move around different terminals with RFID readers in the same domain[11][12]. The serving gateway information is managed at SIP registrar. Thus, incoming call or session to a called user for PM is delivered based on a combination of registered information at SIP registrar and gateway.

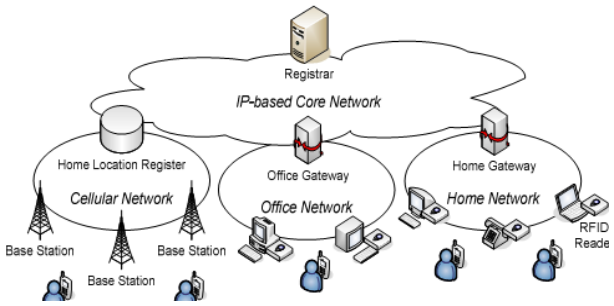

Fig 1 Interworked fixed and mobile network architecture [14]

Fig. 2 shows a PM registration procedure using RFID. In Fig. 2, RFID readers are implemented in terminals and RFID tag is implemented in an MT of a mobile user. We assume that mobile users carry their MTs with RFID tags[11][12. If mobile users do not carry MTs with RFID tags, it is additionally assumed that RFID. [9][10] tag is attached with a mobile user. Therefore, mobile users' movement can be detected automatically with RFID reader. [11][12]

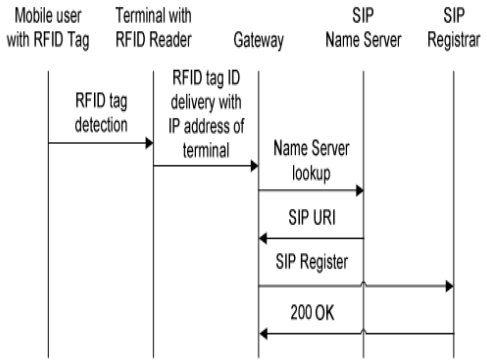

Fig 2: PM registration procedure using RFID[14]

When a RFID reader in fixed terminal detects a RFID tag of a mobile user, it sends the RFID tag ID with the IP address of the fixed terminal to its serving gateway. Then, the PM. [9][10] location information of the mobile user is registered at SIP registrar after name server lookup in SIP name server. Finally, incoming call or session to the registered terminal can be delivered based on the combination of registered information at SIP registrar and gateway.

B. Proposed Paging Scheme

In conventional cellular network, paging is needed to find the exact location of called MT and it is generally performed to all cells within a registered LA. Since paging signaling consumes scarce radio resources, reducing paging signaling load is one of the most important requirements of an efficient paging scheme.[14]

In the considered inter-worked fixed and mobile networks architecture supporting both PM and TM, PM management information is inherently registered at SIP registrar. In the proposed paging scheme, the PM management information registered at SIP registrar is efficiently used and reduces paging signaling load significantly. Since it is highly likely that mobile users reside at cells which contain registered gateways, the natural idea is to page only cells containing gateways managing fixed terminals with which users are registered[11]f the called user is not found in these cells, remaining cells are paged and it is guaranteed that the called user is found within this two-step paging.

If a mobile terminated call or session arrives at cellular network, HLR queries to SIP registrar about the location information[11][12 of registered fixed terminals. Since the obtained location information of gateways managing fixed terminals is a type of IP address, it should be converted to the geographical location information to find the cells which contain such registered fixed terminals. [9][10]. In this paper, it is assumed that the mapping between IP address and geographical location mapping is available. This converted geographical location information is delivered to visitor location register (VLR) of called MT. Then, the VLR maps the received geographical location information of registered gateways managing fixed terminals to cells within the registered LA which contain these gateways and paging is only performed to the mapped cells. If the called MT is not successfully found at the mapped cells due to stale PM registration information, the remaining cells are paged in the second paging step and it is guaranteed that the called MT can be found finally. By adopting this two-step paging approach based on PM management information at SIP registrar, paging signaling load can be reduced significantly, compared with conventional paging scheme, without increasing location registration signaling load for TM.[5]

Since registration signaling load for PM management inherently exists in inter-worked fixed and mobile networks, any significant additional signaling load for PM. [9][10] is not introduced in the proposed paging scheme, except the signaling load for the query at SIP registrar for the location information of registered fixed terminals from HLR. Also, since the signaling load for the query at SIP registrar from HLR only consumes network resources, which has sufficient resources compared to radio interface, it does not introduce any significant burden on the network. We also note that additional delay may be introduced for two staged paging approach, [11][12 but it is not significant for most applications since paging delay is limited to only two stages[4].

IV. CONCLUSIONS AND FURTHER WORKS

Here, we propose an efficient paging scheme for TM using PM [9][10]management information at registrar and showed that the proposed scheme can achieve significant signaling load reduction at radio interface. Although signaling load for the query at SIP registrar for the location information of registered fixed terminal from HLR is additionally generated and additional delay may be introduced for two staged paging approach in the proposed paging scheme, they are not considered as significant, compared with the significant signaling load reduction for scarce wireless resources at radio interface.[14]

In our further works, a more detailed analysis on signaling load at network and delay will be carried out based on a more detailed mobility and traffic modelling, in order to analyze the increase of network signaling load and delay quantitatively. Also, a more practical and elaborated algorithm for finding cells which contain terminals with which users are registered will be devised. Finally, an efficient handoff scheme in the interworked fixed and mobile networks will be investigated.[14]

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