行政院國家科學委員會補助專題研究計畫成果報告

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※　**整合無線區域網路與 GSM GPRS 之行動管理 (II)**　※
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計畫類別：■個別型計畫　　□整合型計畫
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執行期間： 89 **年** 8 **月** 1 **日至** 90 **年** 7 **月** 31 **日**

計畫主持人： 張明峰

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行政院國家科學委員會專題研究計畫成果報告

整合無線區域網路與 GPRS 之行動管理 (II)
Integrated Mobility Management of Mobile IP and GPRS

計畫編號：NSC 89-2213-E-009-201
執行期限：89 年 8 月 1 日至 90 年 7 月 31 日
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中文摘要

無線區域網路支援之行動計算是以行動式網際網路通訊協定(mobile IP- MIP)**為基礎，而現在蜂巢式行動電話系統可得的封包資料服務是** GPRS (General Packet Data Service)**。我們整合行動式網際網路通訊協定和** GPRS**。使用者優先考慮使用無線區域網路如果無法使用則連上** GPRS **網路。由於無線區域網路與行動通訊網路各有獨立的行動管理系統與通訊協定，兩系統的整合必須包含：兩個行動資料庫的合作或結合、行動式網際網路通訊協定的支援。我們設計以** MIP **為基礎的方式的整合架構：增進** GPRS **通訊協定的功能來支援** MIP **的系統架構，設計整合的位置資料庫的組織架構，及使用者手機定位策略。定位策略包含手機註冊（**registration**）程序，資料傳送程序。**

關鍵詞：無線區域網路、蜂巢式行動電話系統、雙階層通訊架構、行動管理

Abstract

A two-tier communication system integrating wireless LANs and cellular systems can provide the advantages of the individual systems and enable mobile users to access internet service at any time, at any place, and in any form. In wireless LANs, mobile IP (MIP) supports terminal mobility. On the other hand, the available packet data protocol for cellular systems is GPRS. In this paper, we integrate GPRS and MIP. The mobile users access the Internet through the MIP network if it is available; otherwise, the users switch to the GPRS automatically. The major task is to integrate the mobility management and communication protocols. The integrated system is based on MIP, i.e., the GPRS has to be extended to support the mobility management of the MIP.

Keywords: mobile IP, GPRS, mobility management

I. Introduction

Wireless LANs and cellular telephone systems are two existing communication media for wireless communication. Wireless LANs provide large data transmission bandwidth (1Mb/sec-11Mb/sec), but its service areas are small and zonal. On the other hand, cellular systems provide small data transmission bandwidth, but cover a large continuous area. A two-tier communication system integrating wireless LAN and cellular system can provide the advantages of the individual systems, and enable mobile users to access Internet service at any time, at any place and in any form. We design such a two-tier system where the users access the Internet through a wireless LAN if it is available; otherwise, the users switch to the data service of the cellular system automatically.

The major task in integrating the data communication service of wireless LAN and cellular systems is to integrate the mobility management and communication protocols of both systems. In wireless LANs, mobile IP (MIP) has been used to support terminal mobility [1]. Each mobile host has a permanent IP address and a home agent (HA) tunneling the datagrams addressed to the mobile host through a foreign agent (FA) to the mobile host. On the other hand, the available packet data protocol for cellular systems is General Packet Radio Service (GPRS) [2][3]. In the GPRS network, GSNs (GPRS support nodes) tunnel datagrams to the mobile host. Datagrams addressed to a mobile host are transmitted to a GGSN (Gateway GSN), and then the GGSN tunnels the datagrams to the SGSN (Serving GSN) where the mobile host is served. To integrate MIP and GPRS, it is necessary to integrate the location databases, to support mobile IP and to provide smooth tier-handover.

A. Mobile IP

Mobile IP (MIP) is a standard proposed by IETF to support terminal mobility [1]. A mobile host uses two IP addresses: a home address and a care-of address. The home address is fixed and used as the identification of an MS for TCP/UDP connections. The care-of address changes when the MS attaches to a new access point of another subnet.

To support terminal mobility, MIP uses a home agent (HA) and foreign agents (FA) for tunneling datagrams for an MS. The HA is a router in the MS's home network and the FA is a router in the visited domain.

The HA maintains the current location information (the home address and care-of address) of the MS. The HA receives all the datagrams for the MS and tunnels them to the MS's current point of attachment, i.e., the FA. The FA detunnels datagrams from the HA and delivers datagrams to the addressed MS. When an MS moves from the service area of an FA to another, a registration procedure should be performed. The MS sends a registration request to the new FA. Then the FA asks the HA to update the care-of address of the MS.

B. GPRS

GPRS (general packet radio service) [2][3] of GSM Phase 2+, which is led by ETSI, is the coming data communication services of cellular systems. GPRS consists of a number of projects including advance data transmission. GPRS shares GSM frequency bands and uses a packet-mode technique to transfer data. Hence, GPRS makes better use of network and radio resources. It allows data transmission speeds over 100 Kbps.

In a GPRS network, a GGSN is connected with SGSNs via an IP-based GPRS backbone network. The GGSN maintains the routing information of the MSs. Packet Data Units (PDUs) from the MS are sent to the current attached SGSN first. Then the SGSN tunnels the PDUs to the corresponding GGSN using GPRS Tunneling Protocol (GTP) [4]. On the other hand, the GGSN tunnels the PDUs addressed to the MS to the current attached SGSN. In addition, the GGSN interconnects the GPRS network and the extern packet data networks (e.g., IP and PSDN X.75) [5]. For the external packet data networks, the GGSN is a normal router. Datagrams from the external packet data networks to the MSs in the GPRS network are routed to the GGSN first.

II. An Architecture Based on MIP

In this section, we describe an integrated system based on MIP. This approach extends the registration defined in 3GPP. The GGSN is modified to emulate an FA to support MIP. In this way, the GPRS PLMN can be considered as a “big” service area of a special FA (the GGSN). This architecture is illustrated in Fig. 1.

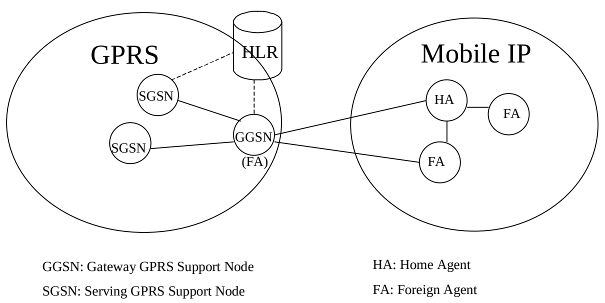

Fig. 1. The Architecture of the Two-tier System Based on MIP

A. The Assumptions

The assumptions of this architecture are described below:

1) The home address of an MS used in the MIP network is the static IP address used in the GPRS PLMN.
2) The HA keeps track of the MS. Datagrams addressed to the MS must be sent to the HA first.
3) The GGSN is the FA of a GPRS-registered MS. Hence the HA uses the GGSN address as the care-of address.
4) In the GPRS PLMN, only one GGSN is connected to the external IP network. The GGSN is the FA of all GPRS-registered MSs. Datagrams addressed to the GPRS-registered MS will be tunneled to the GGSN. Then, the GGSN tunnels the datagrams to the current attachment point of the MS, i.e., the attached SGSN address.

B. Registration

Since the integrated system is based on MIP, the HA maintains a location record for each MS, i.e., the MS should register to the HA. The MS performs the GPRS registration procedure when it accesses the network through the GPRS PLMN and performs the MIP registration procedure when it is in the MIP network. Only single registration is required.

When an MS can access only the GPRS PLMN, it performs the GPRS registration procedure. The procedure can be divided to two parts. The first part is the activation of IP context for the MS, i.e., the MS asks the SGSN and the corresponding GGSN to create a tunnel ID (TID) and the PDP context for it. The second part is similar to the MIP registration. The GGSN is the current FA and the MS registers to the GGSN.

If there is an FA nearby, the MS performs the MIP registration procedure. This procedure is a normal registration procedure defined in MIP.

C. Location Update

When an MS moves from a service area of one FA to another, location update procedure should be performed. Based on the source and destination, location update procedure can be classified into: intra-SGSN location update, inter-SGSN location update, inter-FA location update, inter-tier location update from FA to SGSN and inter-tier location update from SGSN to FA.

C.1 Intra-SGSN Location Update

An MS moves from a routing area to a new one served by the same SGSN. The GGSN is still the serving FA. It is unnecessary to update the location information of the MS at the HA and the GGSN. The GPRS intra-SGSN location update is illustrated in Fig. 2.

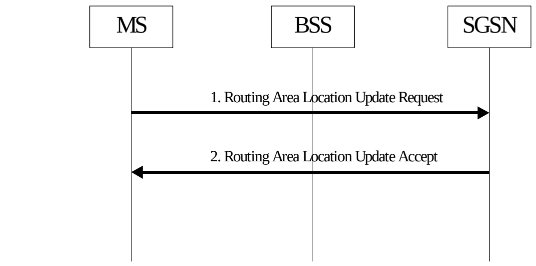

Fig. 2. The GPRS Inter-SGSN Location Update

C.2 Inter-SGSN Location Update

When an MS moves from a service area of one SGSN to another, the GPRS inter-SGSN location procedure is performed. The inter-SGSN location update procedure updates the location information at the HLR and routing information at the GGSN, as illustratedin Fig. 3.

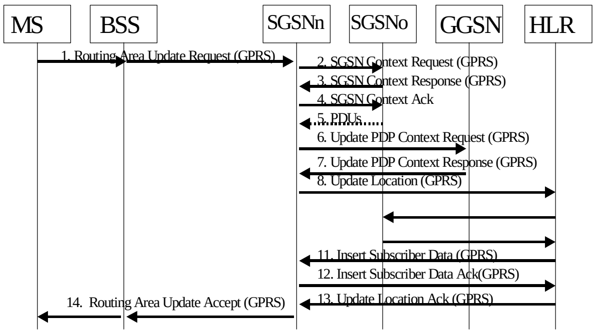

Fig. 3. Inter-tier Location from GFA to SGSN Based on GPRS

C.3 Inter-FA Location Update

When an MS moves from a service area of one FA to another, the MIP registration procedure is performed. In addition, the new FA should request the old FA to fowrad PDUs for the MS. The MIP registration procedure is illustrated in Fig. 4.

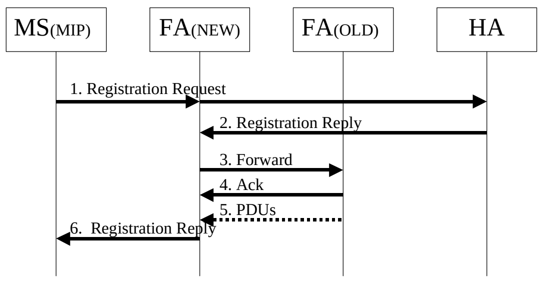

Fig.4. The MIP Registration Procedure

C.4 Inter-tier Location Update - from an FA to an SGSN

When an MS moves form a service area of one FA to a service area of one SGSN, an inter-tier location update, from an FA to an SGSN, is performed. The MS attaches to the current SGSN through the GSM BSS. Then the MS registers to the GGSN (the new FA). In addition, the GGSN should request the old FA to forward the PDUs for the MS. The update procedure is illustrated in Fig. 5.

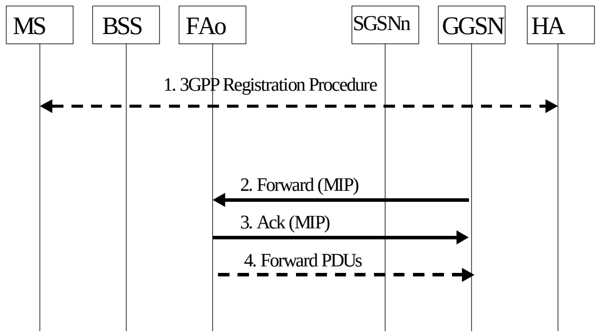

Fig. 5. Inter-tier Location Update from FA to SGSN Based on MIP

C.5 Inter-tier Location Update - from an SGSN to an FA

When an MS moves form a service area of one SGSN to a service area of one FA, an inter-tier location update is performed. The new FA will request the GGSN (the old FA) to forward PDUs for the MS. In addition, the GGSN must inform the old SGSN to forward buffered PDUs back. The update procedure is illustrated in Fig. 6.

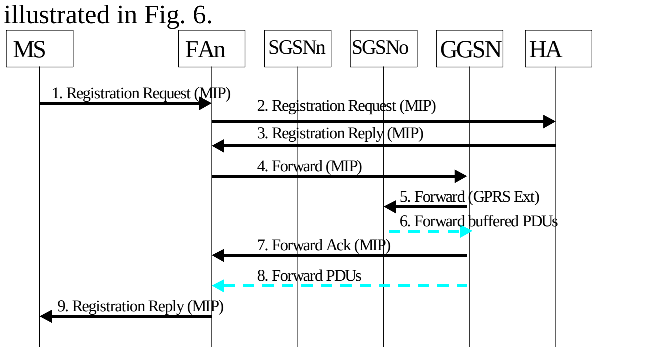

Fig. 6. Inter-tier Location Update from SGSN to FA Based on MIP

D. Data Transmission

We describe the PDU transmission in this session. For clarity, MS(MIP) denotes a MIP-registered MS and MS(GPRS) denotes a GPRS-registered MS. Data transmission from a fixed host to an MS(GPRS) is illustrated in Fig. 7.

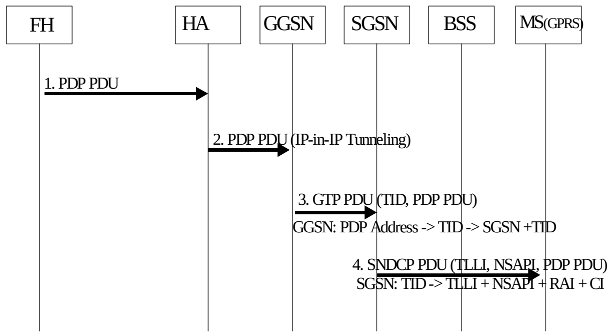

Fig. 7. Data Transmission from a Fixed Host to MS(GPRS)

1) The fixed host sends IP PDUs to the MS(GPRS) . The PDUs are routed to the HA first.
2) The HA uses the GGSN address as the care-of

address. Hence the HA tunnels (IP-in-IP) the PDUs to the GGSN.

3) The GGSN detunnels the PDUs sent from the HA and sends the PDUs to the MS(GPRS) through the GPRS backbone.

Data transmission from an MS(GPRS) to a fixed host follows the original GPRS mechanism. The PDUs from the MS are sent through the SGSN and GGSN. On the other hand, data transmission from MS1(GPRS) to MS2(GPRS) is illustrated in Fig. 8.

1) The MS1 sends PDUs to the MS2 through the GPRS backbone. The PDUs are sent to the attached SGSN (SGSN1) using SNDCP, and then tunneled from SGSN1 to the corresponding GGSN (GGSN1).
2) The GGSN1 detunnels the received GTP PDUs and routes the PDUs to the external IP network.
3) The PDUs will be routed to the HA of the MS2 (HA2).
4) The HA2 uses the GGSN2 address as the care-of address. Hence the HA2 tunnels (IP-in-IP) the PDUs to the GGSN2.
5) The GGSN2 detunnels the PDUs from the HA2 and sends the PDUs to the MS2 through the GPRS backbone.

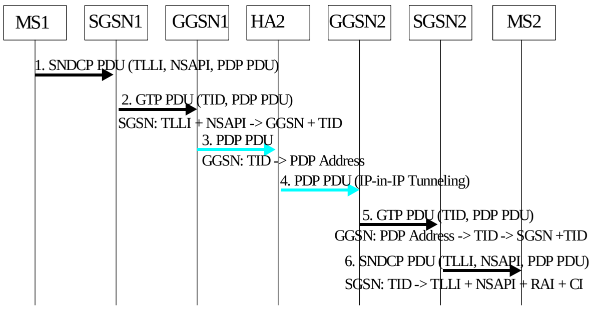

Fig. 8. Data Transmission from MS1(GPRS) to MS2(GPRS)

Data transmission from an MS(GPRS) to an MS(MIP) is illustrated in Fig. 9.

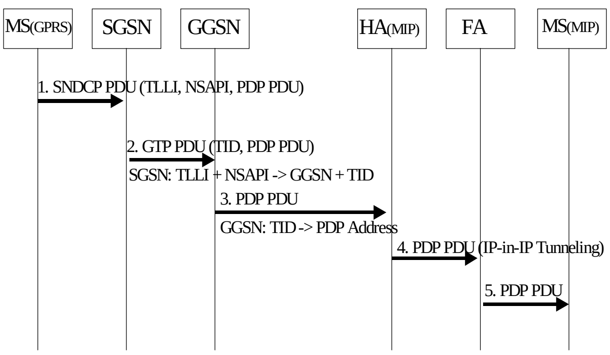

Fig. 9. Data Transmission from MS(GPRS)to MS(MIP)

1) The MS(GPRS) sends PDUs to the MS(MIP) through the GPRS backbone.
2) The GTP PDUs are decapsulated to IP PDUs by the GGSN and sent to the external IP network.
3) The IP PDUs are routed to the HA of the MS(MIP). Hence The HA tunnels (IP-in-IP) the PDUs to the FA.

Data transmission from MS(MIP) to MS(GPRS) is illustrated in Fig. 10.

1) The IP PDUs from the MS(MIP) are routed to the HA of the MS(GPRS) first.
2) The HA tunnels the PDUs to the GGSN because the HA uses the GGSN address as the care-of address.
3) The GGSN sends the PDUs to the MS(GPRS) through the GPRS backbone.

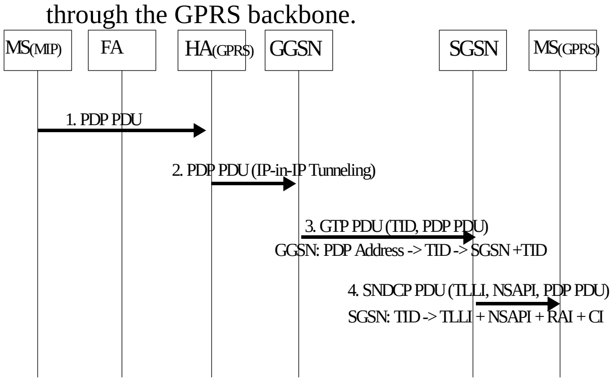

Fig. 10. Data Transmission from MS(MIP) to MS(GPRS)

III. Conclusion

We present a method based on MIP to integrate MIP and GPRS, i.e., the GPRS is extended to support the mobility management of MIP. The GGSN and SGSN of the GPRS system are modified. The GGSN emulates the function of an FA, and the PDU forwarding function of the SGSN is extended to support inter-tier location update. The HAs keep track of the location of MSs. In addition, we develop two inter-tier location update procedure since an MS may move across different tiers. Data transmission protocols are also developed for the integrated system.

IV. Reference

[1] C. Perkins, *IP Mobility Support*, RFC 2002, October 1996.

[2] ETSI, *Digital cellular telecommunications system (Phase 2+); General Packet Radio Service (GPRS); Service description; Stage 1*, Tech. Spec., GSM 02.60 version 7.0.0, Release 1998.

[3] ETSI, *Digital cellular telecommunications system (Phase 2+); General Packet Radio Service (GPRS); Service description; Stage 2*, Tech. Spec., GSM 03.60 version 7.0.0, Release 1998.

[4] ETSI, *Digital cellular telecommunications system (Phase 2+); General Packet Radio Service (GPRS); GPRS Tunneling Protocol (GTP) across the Gn and Gp inteface*, draft Tech. Spec., EN 301 347 GSM 03.60 version 6.1.0, Release 1998.

[5] ETSI, *Digital cellular telecommunications system (Phase 2+); General Packet Radio Service (GPRS); Interworking between the Public Land Mobile Network (PLMN) supporting GPRS and Packet Data Network (PDN)*, Tech. Spec., GSM 09.61 version 6.0.0, Release 1998.