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IPv6-GSM: An IPv6-based solution for GSM number portability

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This paper proposes an algorithm called IPv6-GSM. In IPv6-GSM, users own GSM Local Number Portability (LNP) capability and can communicate with VoIP terminals efficiently. Therefore, with the ample address space and embedded neat mobility mechanism than its ancestor, IPv6-GSM is demonstrated as an acceptable method for constructing future all-IP networks. Copyright © 2003 John Wiley & Sons, Ltd.

Introduction

The possibility of mobile subscribers changing their mobile network operator without changing their number may facilitate competition and offer new business opportunities in the telecommunications market. VoIP is another big benefit for the service providers. This should be another advantage for new service providers to combine local number portability and VoIP.

In Mobile IP[1], a Home Agent can be used to replace the Home Location Register. Under this condition, combining Local Number Portability with VoIP services is becoming feasible. Only one database is needed in these circumstances. However, using Mobile IP, every mobile station ISDN (MSISDN) must be assigned an IP address. This will consume available IPv4 addresses quickly. To avoid this outcome, IPv6 addresses are adopted.[2,3] This paper is the first to propose a system using Mobile IPv6 to combine LNP and VoIP services. We designate our system as IPv6-GSM. The proposed system has advantages in communicating with IP networks smoothly, saving cost (one database) and it is easy to manage (using IP). The simulations were processed using OPNET.

This paper is organized as follows. The next section introduces the IPv6-GSM network architecture. The third section describes the registration–deregistration–call delivery to the GSM Number Portality (NP) user and call delivery to the IP network message flows. The fourth section describes simulating the call setup time for IPv6-GSM and the traditional GSM LNP iGSM. The fifth section describes the simulation results. The final section presents our conclusions.

IPv6-GSM Network Architecture

Most parts of GSM are not modified. The Home Agent (HA) replaces the Home Location Register (HLR), hence all calls perform a look-up through a gateway to the HA. IPv6-GSM also provides VoIP service using the H.323 protocol. In IPv6-GSM, the gatekeeper can be omitted and the rest of the H.323 protocol remains the same.

The IPv6-GSM network architecture is described in Figure 1. The elements include a mobile station (MS), a basestation (BS), a Gateway Mobile

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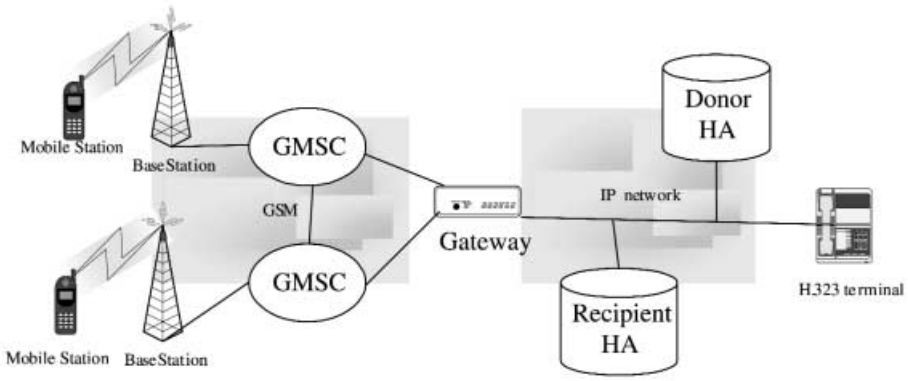

Figure 1. IPv6-GSM network architecture

Switching Center (GMSC), a HA and a H.323 terminal.

MSs, BSs and GMSCs are the same as those used in the traditional GSM.[4] The H.323 terminal is the same as in the traditional H.323. The VoIP architecture is described in references 5 and 6. IPv6-GSM contains a new element—the gateway. The functions of HA also must be modified.

—Gateway—

The Gateway includes a signaling gateway and a media gateway. To simplify our discussion, we assumed that both the signaling and media gateways are integrated into one IPv6-GSM gateway. The gateway functions are described as follows:

- Every gateway has a database that stores all of the MSISDN (Mobile Station ISDN number) and its corresponding IPv6 address.
- Calls are established and released.
- Transforming different signals. For example, the SS7 signal is transformed into the H.225 signal, or the SS7 signal is transformed into a Mobile IPv6 signal. This function may be divided into several gateways, but to simplify our discussion, we assume that it is integrated into an IPv6-GSM gateway.
- Transforming different voice codes. For example, the GSM code is transformed into the G726 or G728 code.
- VoIP terminal Authentication.

—HA—

In IPv6-GSM, if a user leaves his original service provider, we treat him as a mobile node leaving its' Home Link. After leaving his Home Link, the user will register his location with the home agent (HA). The user's last location and last address are stored in the HA database. If the user is in a GSM network, the HA sends the last IPv6 address to the gateway. The gateway subsequently translates the IPv6 address into a new MSISDN. The caller can then communicate with the user with a new MSIDSN. If the user is in an IP network and would like to switch to VoIP service, after the caller looks up the IPv6 address in the HA, the caller can use this IPv6 address to communicate with the user. Every service provider has a respective HA, and each HA only stores the service provider for its' own MSISDN and corresponding IPv6 address.

IPv6-GSM Message Flows

—Registration—

GSM (NP) registration—The message flow for GSM (NP) registration is illustrated in Figure 2 with the following steps:

Step 1 When a mobile station powers on or moves to a new service provider, the mobile station sends its' original MSISDN, original HA and other necessary information to the new GMSC.

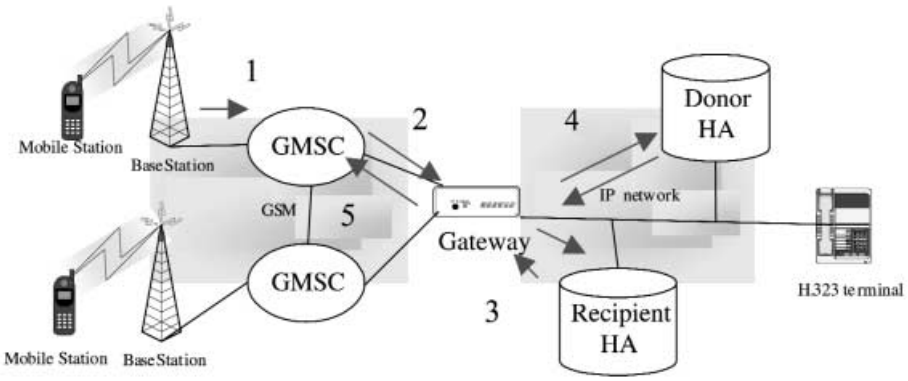

Figure 2. IPv6-GSM GSM (NP) registration

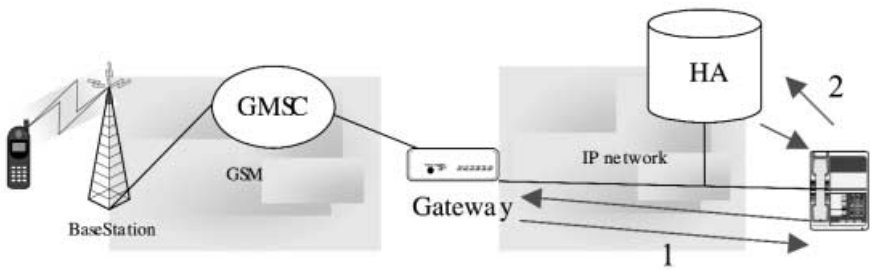

Figure 3. VoIP user registration

Step 2 The New GMSC sends registration information to the gateway. The registration information includes all of the necessary information.
Step 3 After receiving this SS7 message, the gateway transforms this SS7 message into an ICMPv6 message and asks the recipient HA to offer an IPv6 address. This IPv6 address has a corresponding MSISDN. If the recipient HA has available IPv6 addresses, it returns an IPv6 address to the gateway, otherwise it rejects the request.
Step 4 The Gateway registers with the donor HA using an IPv6 address obtained from the recipient HA. If the registration succeeds, the recipient HA renews the database and sets the Traffic Class option to GSM (This Traffic Class is different from the traffic class in the IPv6 header. It is a database field used to discriminate users belonging to a GSM network or IP network.) At the same time, the recipient HA returns a successful message to the gateway.
Step 5 The Gateway transforms the ICMPv6 message into a SS7 message and informs that the GMSC registration has succeeded. At this step, the registration is completed.

VoIP user registration—The message flow for VoIP registration is illustrated in Figure 3 with the following steps:

Step 1 When a user moves toward an IP network and has switched to VoIP service, the user enters a password and MSISDN into the terminal (in this paper, the terminal means an H.323 terminal). After the gateway confirms the password, the gateway returns the MSISDN corresponding IPv6 address to the terminal.
Step 2 The terminal assigns this IPv6 address as its own IP address. If the terminal is in a Foreign Link, the terminal will notify the HA of its care-of-address (the IPv6 address). After receiving the