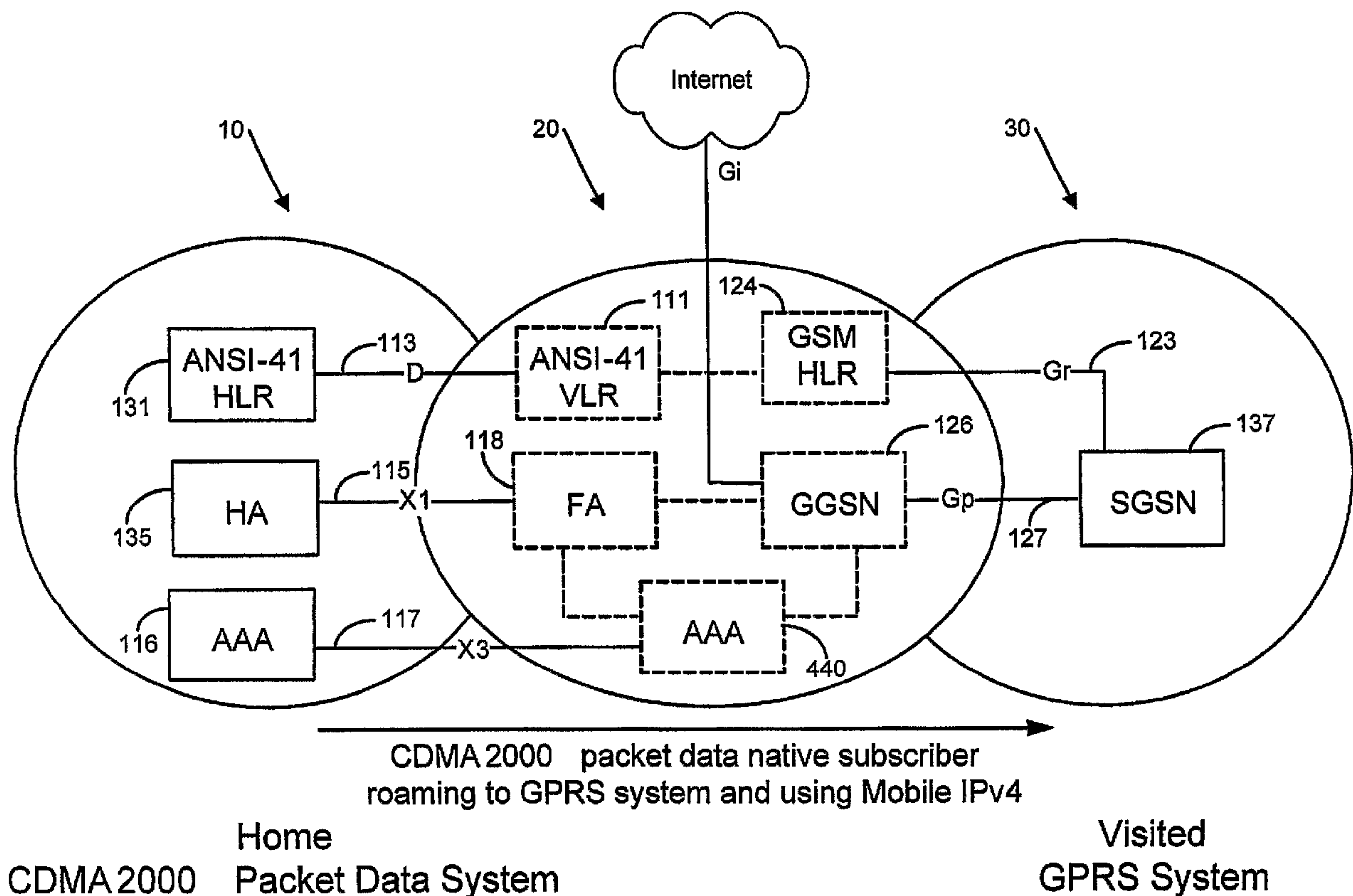




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(72) Inventeurs/Inventors:  
NASIELSKI, JOHN WALLACE, US;  
HSU, RAYMOND TAH-SHENG, US  
(73) Propriétaire/Owner:  
QUALCOMM INCORPORATED, US  
(74) Agent: SMART & BIGGAR

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(57) Abrégé/Abstract:

IIF architectures and corresponding call flows are provided for CDMA2000/GPRS roaming scenarios such as GPRS foreign mode with Mobile IPv4, GPRS foreign mode with Simple IPv4 or IPv6, CDMA2000 packet data foreign mode with Mobile IPv4, and CDMA2000 packet data foreign mode with Simple IPv4 or IPv6.



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The diagram illustrates a network architecture for a CDMA2000 packet data native subscriber roaming to a GPRS system and using Mobile IPv4. The architecture is divided into three main sections: 10 (Home CDMA2000 Packet Data System), 20 (Internet), and 30 (Visited GPRS System).

**Section 10 (Home CDMA2000 Packet Data System):** Contains three main components: ANSI-41 HLR (131), HA (135), and AAA (116). The AAA component is connected to the AAA component in Section 20 via interface X3 (117).

**Section 20 (Internet):** Contains three main components: ANSI-41 VLR (111), FA (118), and AAA (440). The FA component is connected to the GGSN component in Section 30 via interface Gp (127). The AAA component is connected to the GGSN component in Section 30 via interface Gp (127).

**Section 30 (Visited GPRS System):** Contains three main components: GSM HLR (124), GGSN (126), and SGSN (137). The GGSN component is connected to the SGSN component via interface Gp (127). The SGSN component is connected to the HA component in Section 10 via interface Gr (123).

**Interfaces and Connections:**

- Interface D (113) connects the ANSI-41 HLR (131) to the ANSI-41 VLR (111).
- Interface X1 (115) connects the HA (135) to the FA (118).
- Interface X3 (117) connects the AAA (116) to the AAA (440).
- Interface Gi connects the Internet (20) to the FA (118).
- Interface Gp (127) connects the FA (118) to the GGSN (126) and the GGSN (126) to the SGSN (137).
- Interface Gr (123) connects the SGSN (137) to the HA (135).

**Legend:**

- Home CDMA2000 Packet Data System (Section 10)
- Visited GPRS System (Section 30)

**Caption:** CDMA2000 packet data native subscriber roaming to GPRS system and using Mobile IPv4

**(57) Abstract:** IIF architectures and corresponding call flows are provided for CDMA2000/GPRS roaming scenarios such as GPRS foreign mode with Mobile IPv4, GPRS foreign mode with Simple IPv4 or IPv6, CDMA2000 packet data foreign mode with Mobile IPv4, and CDMA2000 packet data foreign mode with Simple IPv4 or IPv6.

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## METHODS AND APPARATUSES FOR CDMA2000/GPRS ROAMING

### BACKGROUND

#### Field

[0002] The present disclosed embodiments relate generally to wireless communications, and more specifically to roaming in the context of CDMA2000 and GPRS systems.

#### Background

[0003] Wireless subscribers may desire to use their wireless terminals in conjunction with wireless systems other than their home systems to obtain access to services using their existing subscriptions. Access to these services may be independent of their normal wireless terminals, through wireless systems other than their home systems. This may occur, for example, when the subscriber is roaming outside the service area of their home system. Accordingly, manufacturers and system operators desire to allow subscribers to receive services using their terminals and subscriptions via a system which may not be the subscriber's home system, provided that the terminal and the serving system are compatible.

[0004] Serving roaming subscribers can be difficult even when the serving system and home system employ identical technologies. When the serving system uses an air interface that differs from that used in the subscriber's home system, interworking between these systems is typically performed due to fundamental differences in message protocols, call models, et cetera. This interworking can be achieved via an Interworking and Interoperability Function (IIF).

[0005] One example of an IIF is described in US Patent Application 2002/094811 A1 to Bright et al. entitled "Interworking and Interoperability of GPRS Systems With Systems of Other Technology Families." US Patent Application 2002/094811 A1 provides a

GPRS interworking and interoperability function (IIF) interposed between a serving GSM/GPRS wireless system and a second wireless system of a different technology family. The IIF allows a mobile station homed to the second wireless system to operate in the GSM/GPRS system. According to US Patent Application 2002/094811 A1, telecommunications system components are provided that allow interworking and interoperability of a serving GSM and/or GPRS system with certain "domestic wireless" systems. For example, a mobile station homed on such a domestic wireless system, but registered with the serving system in a GPRS-only mode, may receive services from the serving system. US Patent Application 2002/094811 A1 mentions that the term "domestic wireless" (DW) is intended to refer to non-GSM systems compatible with ANSI or equivalent standards for TDMA, CDMA, and analog cellular systems, as generally used in North America, or compatible with other similar systems.

[0006] Although US Patent Application 2002/094811 A1 acknowledges the need for an IIF allows a mobile station homed to a CDMA wireless system to operate in the GSM/GPRS system, US Patent Application 2002/094811 A1 does not discuss an IIF adapted for CDMA2000/GPRS roaming scenarios when the terminal is using Mobile IP or Simple IP. US Patent Application 2002/094811 A1 fails to provide sufficient information, direction or guidance regarding how an IIF could be constructed that would allow a mobile station homed to a CDMA2000 wireless system could operate in the GSM/GPRS system, when the terminal is using Mobile IP or Simple IP. For example, US Patent Application 2002/094811 A1 fails to provide any details regarding what modules would be needed to implement such an IIF, how the modules would be interconnected, timed and controlled so as to obtain the specific operations needed to implement such an IIF.

[0007] Thus, there is a need in the art for a general architecture can be adapted for CDMA2000/GPRS roaming scenarios, such as, GPRS foreign mode with Mobile IPv4, GPRS foreign mode with Simple IPv4 or IPv6, CDMA2000 packet data foreign mode with Mobile IPv4, and CDMA2000 packet data foreign mode with Simple IP, Mobile IPv4 or Mobile IPv6. It would be desirable to enable communication between a CDMA 2000 packet data system and a GPRS system, when a CDMA 2000 packet data native subscriber using Simple IP, Mobile IPv4 or Mobile IPv6 roams to the GPRS system by supporting bearer connectivity between the GPRS and CDMA 2000 packet data system. Similarly, it would also be desirable to enable communication between a GPRS system

and a CDMA 2000 packet data system when a GPRS native subscriber roams from the GPRS system to the CDMA 2000 packet data system using Simple IP, Mobile IPv4 or Mobile IPv6 by supporting bearer connectivity between the GPRS system and the CDMA 2000 packet data system.

### SUMMARY

[0008] According to one aspect of the invention, an interface entity, interposed between a CDMA 2000 packet data system and a GPRS system, is provided that enables communication between the CDMA 2000 packet data system and the GPRS system when a CDMA 2000 packet data native subscriber roams to the GPRS system by supporting bearer connectivity between the GPRS and CDMA 2000 packet data system by providing a packet routing function.

[0009] According to one aspect of the invention, an interface entity is provided that enables communication between a home CDMA 2000 packet data system and a visited GPRS system comprising a Serving GPRS Support Node (SGSN), when a CDMA 2000 packet data native subscriber using Mobile IPv4 roams to a visited GPRS system.

[0010] For example, in an embodiment where a CDMA 2000 packet data native subscriber roams to a visited system and uses Mobile IPv4, an interface entity can be provided that couples the home system to the visited system to enable communication between the home system and the visited system. In this situation, the home system is a CDMA 2000 packet data system that can include a ANSI-41 home location register; an AAA entity; and a home agent, whereas the visited system can be a GPRS system that includes a SGSN.

[0011] According to one aspect of this embodiment, the interface comprises a GSM home location register emulation module, and an ANSI-41 visited location register emulation module. The GSM home location register emulation module can be coupled to the SGSN via a Gr interface, that allows a subscriber to register over a Gr interface, whereas the ANSI-41 visited location register emulation module can be coupled to the ANSI-41 home location register via a D interface that allows a subscriber to register over the D interface. According to one aspect of this embodiment, the interface further comprises a foreign agent emulation module and a GGSN emulation module. The foreign agent emulation module can be coupled to the home agent via an X1 interface, and supports bearer connectivity between the visited system and the home system such

that a foreign agent interface and an AAA interface are presented to the CDMA 2000 packet data system over the X1 interface. The GGSN emulation module can be coupled to the SGSN via a Gp interface, and can support bearer connectivity between the visited system and the home system such that a GGSN interface is presented to the visited system over the Gp interface. The interface can serve as an endpoint for a GTP tunnel and a Mobile IP tunnel. In this embodiment, the interface provides a packet routing function between the GGSN interface and the foreign agent interface. According to another aspect of this embodiment, the interface can also include an AAA emulation module that can be coupled to the AAA entity via an X3 interface. In this embodiment, the AAA emulation module provides an accounting function to interacting with a home network's AAA for Mobile IP Foreign Agent challenge authentication and 3GPP2 packet data accounting.

[0012] According to one aspect of the invention, an interface entity is provided that enables communication between a home CDMA 2000 packet data system and a visited GPRS system comprising a Serving GPRS Support Node (SGSN), when a CDMA 2000 packet data native subscriber using Simple IP roams to a visited GPRS system.

[0013] In an embodiment where a CDMA 2000 packet data native subscriber roams to a visited system and uses Simple IP, an interface entity can be provided that couples the home system to the visited system to enable communication between the home system and the visited system. In this situation, the home system is a CDMA 2000 packet data system that can include a ANSI-41 home location register; an AAA entity; and a LNS, whereas the visited system can be a GPRS system that includes a SGSN.

[0014] According to one aspect of this embodiment, the interface comprises an ANSI-41 visited location register, and a GSM home location register. The ANSI-41 visited location register can be coupled to the ANSI-41 home location register via a D interface, and allows a subscriber to register over the D interface. The GSM home location register can be coupled to the SGSN via a Gr interface and allows a subscriber to register over the Gr interface. According to another aspect of this embodiment, the interface may comprise a LAC emulation module and a GGSN emulation module. The LAC emulation module can be coupled to the LNS via an X2 interface, and supports bearer connectivity between the visited and home networks over the X2 interface. The GGSN emulation module can be coupled to the SGSN via a Gp interface, and supports bearer connectivity between the visited and home networks over the Gp interface by

presenting a GGSN interface to the visited system and presenting a normal routing interface to the CDMA 2000 packet data system to thereby provide a packet routing function between the GGSN interface and the home system. In this case, the interface serves as an endpoint for a GTP tunnel and an IPSec tunnel. According to yet another aspect of this embodiment, the interface can include an AAA emulation module that can be coupled to the AAA entity via an X3 interface. The AAA emulation module can provide an accounting function by interacting with the home network's AAA for L2TP authentication and 3GPP2 packet data accounting over the X3 interface.

[0015] According to another aspect of the invention, an interface entity, interposed between a GPRS system to a CDMA 2000 packet data system, is provided that enables communication between the GPRS system and the CDMA 2000 packet data system when a GPRS native subscriber roams from the GPRS system to a CDMA 2000 packet data system using one of Mobile IPv4 and Simple IP by supporting bearer connectivity between the GPRS system and the CDMA 2000 packet data system by providing a packet routing function.

[0016] According to yet another aspect of the invention, an interface entity is provided that enables communication between a home GPRS system comprising a GSM home location register, a GGSN, and an AAA entity, and a visited CDMA 2000 packet data system that comprises an ANSI-41 visited location register, an AAA entity, and a packet data serving node/ foreign agent, when a GPRS native subscriber using Mobile IPv4 roams to the visited CDMA 2000 packet data system.

[0017] In an embodiment where a GPRS native subscriber roams to a visited system and uses Mobile IPv4, an interface entity can be provided that couples the home system to the visited system to enable communication between the home system and the visited system. In this situation, the home system is a GPRS system comprising a GSM home location register; a GGSN; and an AAA entity, whereas the visited system can comprise a CDMA 2000 packet data system that includes a ANSI-41 visited location register; a AAA entity; and a packet data serving node/ foreign agent.

[0018] According to one aspect of this embodiment, the interface comprises a home agent emulation module and a SGSN emulation module. The home agent emulation module can be coupled to the packet data serving node/ foreign agent via an X1 interface, and presents a home agent interface to the visited system. The SGSN emulation module can be coupled to the GGSN via a Gp interface, and presents a SGSN

interface to the home system to support bearer connectivity between the visited and home networks by providing a packet routing function between the SGSN interface and the home agent interface. Here, the interface serves as an endpoint for a GTP tunnel and a Mobile IP tunnel. According to another aspect of this embodiment, the interface can also include an ANSI-41 home location register emulation module, and a GSM visited location register emulation module. The ANSI-41 home location register emulation module can be coupled to the ANSI-41 visited location register via a D interface, whereas the GSM visited location register emulation module can be coupled to the GSM home location register via a D interface, to allow a subscriber to register. According to yet another aspect of this embodiment, the interface may also include an AAA emulation module that can be coupled to the AAA entity via a Gi interface and coupled to the AAA entity via a X3 interface. The AAA emulation module interacts with the visited network's AAA for Mobile IP authentication and 3GPP2 packet data accounting, over the X3 interface, and the home network's AAA for 3GPP packet data accounting, over the Gi interface.

[0019] According to one aspect of the invention, an interface entity is provided that enables communication between a home GPRS system comprising a GSM home location register, a GGSN, and an AAA entity, and a visited CDMA 2000 packet data system that comprises an ANSI-41 visited location register, an AAA entity, and a packet data serving node/LAC entity, when a GPRS native subscriber using Simple IP roams to the visited CDMA 2000 packet data system.

[0020] In an embodiment where a GPRS native subscriber roams to a visited system and uses Simple IP, an interface entity can be provided that couples the home system to the visited system to enable communication between the home system and the visited system. In this situation, the home system is a GPRS system comprising a GSM home location register; a GGSN; and an AAA entity, whereas the visited system can comprise a CDMA 2000 packet data system that includes a ANSI-41 visited location register; a AAA entity; and a packet data serving node/LAC entity. According to one aspect of the invention, the interface supports bearer connectivity between the visited and home networks by providing a packet routing function. For example, the interface can include a SGSN emulation module, and a LNS emulation module. The SGSN emulation module can be coupled to the GGSN over a Gp interface, and presents a SGSN interface to the home system, whereas the LNS emulation module can be coupled to the packet

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data serving node/ LAC entity over an X2 interface, and presents a L2TP Network Server (LNS) interface to the visited system. As such, this interface provides the packet routing function between the SGSN emulation module and the LNS emulation module. Here, the interface serves as an endpoint for a GTP tunnel  
 5 and a Mobile L2TP tunnel.

**[0021]** According to another aspect of this embodiment, the interface comprises a ANSI-41 home location register emulation module and a GSM visited location register emulation module. The ANSI-41 home location register emulation module can be coupled to the ANSI-41 visited location register via a  
 10 D interface, whereas the GSM visited location register emulation module can be coupled to the GSM home location register via another D interface. This allows a subscriber to register. According to yet another aspect of this embodiment, the interface may also include an AAA emulation module that can be coupled to the AAA entity via a Y3 interface and coupled to the AAA entity via a X3 interface.  
 15 The AAA emulation module interacts with the visited network's AAA entity, over an X3 interface, for L2TP authentication and 3GPP2 packet data accounting, and with the home network's AAA entity, over an Gi interface, for 3GPP packet data accounting.

According to one aspect of the present invention, there is provided a  
 20 method in which a CDMA (Code Division Multiple Access) 2000 packet data native subscriber using Mobile IPv4 (Internet Protocol version 4) roams from a home CDMA 2000 packet data system to a visited GPRS (General Packet Radio Service) system comprising a SGSN (Serving GPRS Support Node), comprising:  
 coupling the home system to the visited system to enable communication between  
 25 the home system and the visited system, wherein the home CDMA 2000 packet data system comprises a ANSI (American National Standards Institute)-41 home location register, an AAA (Authentication, Authorization, and Accounting) entity, and a home agent; and providing a distinct interface for each of the ANSI-41 home Location register, the AAA entity, and the home agent.

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According to another aspect of the present invention, there is provided a method in which a CDMA(Code Division Multiple Access) 2000 packet data native subscriber using Simple IP roams from a home CDMA 2000 packet data system to a visited GPRS (General Packet Radio Service) system comprising  
5 a SOSM, (Serving GPRS Support Node) comprising: coupling the home system to the visited system to enable communication between the home system and the visited system, wherein the home CDMA 2000 packet data system comprises a ANSI-41 home location register, an AAA (Authentication, Authorization, and Accounting) entity, and a LNS (Layer 2 Tunneling Protocol Network Server); and  
10 providing a distinct interface for each of the ANSI-41 home location register, the AAA entity, and LNS.

According to still another aspect of the present invention, there is provided a method in which a GPRS (General Packet Radio Service) native subscriber using Mobile 1Pv4 (Internet Protocol version 4) roams from a home  
15 GPRS system to a visited CDMA (Code Division Multiple Access) 2000 packet data system that comprises an ANSI-41 visited location register, an AAA (Authentication, Authorization, and Accounting) entity, and a packet data serving node/foreign agent, comprising: coupling the home system to the visited system to enable communication between the home system and the visited system, wherein  
20 the home GPRS system comprises a GSM home location register, a GGSN, and an AAA entity; and providing a distinct interface for each of the GSM home location register, the GGSN, and the AAA entity.

According to yet another aspect of the present invention, there is provided a method in which a GPRS (General Packet Radio Service) native  
25 subscriber using Simple IP roams from home GPRS system to a visited CDMA 2000 packet data system that comprises a ANSI-41 visited location register, a AAA (Authentication, Authorization, and Accounting) entity, and a PDSN/LAC (Packet Data Serving Node/Layer 2 Tunneling Protocol Access Concentrator) entity, comprising: coupling the home system to the visited system  
30 to enable communication between the home system and the visited system, wherein the GPRS system comprises a GSM home location register, a GGSN,

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and an AAA entity; and providing a distinct interface for each of the GSM home location register, the GGSN, and the AAA entity.

According to a further aspect of the present invention, there is provided a system in which a CDMA (Code Division Multiple Access) 2000 packet data native subscriber using Mobile IPv4 (Internet Protocol version 4) roams to a visited GPRS (General Packet Radio Service) system comprising a SGSN (Serving GPRS Support Node), comprising: a home CDMA 2000 packet data system comprising a ANSI-41 home location register, an AAA (Authentication, Authorization, and Accounting) entity, and a home agent; and an interface entity that couples the home system to the visited system to enable communication between the home system and the visited system, wherein the interface entity includes a distinct interface for each of the ANSI-41 home location register, the AAA entity, and the home agent.

According to yet a further aspect of the present invention, there is provided a system in which a CDMA (Code Division Multiple Access) 2000 packet data native subscriber using Simple IP roams to a visited GPRS (General Packet Radio Service) system comprising a SGSN (Serving GPRS Support Node), comprising: a home CDMA 2000 packet data system that comprises: a ANSI-41 home location register, an AAA (Authentication, Authorization, and Accounting) entity, and a LNS; and an interface entity that couples the home system to the visited system to enable communication between the home system and the visited system, wherein the interface entity includes a distinct interface for each of the ANSI-41 home location register, the AAA entity, and the LNS.

According to still a further aspect of the present invention, there is provided a system in which a GPRS (General Packet Radio Service) native subscriber using Mobile IPv4 (Internet Protocol version 4) roams to a visited CDMA (Code Division Multiple Access) 2000 packet data system that comprises an ANSI-41 visited location register, an AAA entity, and a packet data serving node/foreign agent, comprising: a home GPRS system comprising a GSM home location register, a GGSN, and an AAA (Authentication, Authorization, and Accounting) entity; and an interface entity that couples the home system to the

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visited system, wherein the interface entity enables communication between the home system and the visited system, wherein the interface entity includes a distinct interface for each of the GSM home location register, the GGSN, and the AAA entity.

5                   According to another aspect of the present invention, there is provided a system in which a GPRS (General Packet Radio Service) native subscriber using Simple IP roams to a visited CDMA (Code Division Multiple Access) 2000 packet data system that comprises a ANSI-41 visited location register, a AAA (Authentication, Authorization, and Accounting) entity, and a PDSN/LAC entity,  
10 comprising: a home GPRS system comprising a GSM home location register, a GGSN (Gateway GPRS Support Node), and an AAA entity; and an interface entity that couples the home system to the visited system, wherein the interface entity enables communication between the home system and the visited system, and further wherein the interface entity includes a distinct interface for each of the GSM  
15 home location register, the GGSN, and the AAA entity.

                  According to yet another aspect of the present invention, there is provided an interface entity that enables communication between a home CDMA (Code Division Multiple Access) 2000 packet data system and a visited GPRS (General Packet Radio Service) system comprising a SGSN (Serving GPRS  
20 Support Node), when a CDMA 2000 packet data native subscriber using Mobile IPv4 (Internet Protocol version 4) roams to a visited GPRS system, wherein the home CDMA 2000 packet data system comprises an ANSI-41 home location register, an AAA (Authentication, Authorization, and Accounting) entity, and a home agent, and further wherein the interface entity includes a distinct  
25 interface for each of the ANSI-41 home location register, the AAA entity, and the home agent.

                  According to another aspect of the present invention, there is provided an interface entity that enables communication between a home CDMA (Code Division Multiple Access) 2000 packet data system and a visited GPRS  
30 (General Packet Radio Service) system comprising a SGSN (Serving GPRS Support Node), when a CDMA 2000 packet data native subscriber using Simple

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IP roams to a visited GPRS system, wherein the home CDMA 2000 packet data system comprises an ANSI-41 home location register, an AAA (Authentication, Authorization, and Accounting) entity, and a LNS, and farther wherein the interface entity comprises a distinct interface for each of the ANSI-41 home location register, the AAA entity, and the LNS.

According to another aspect of the present invention, there is provided an interface entity that enables communication between a home GPRS (General Packet Radio Service) system comprising a GSM home location register, a GGSN, and an AAA (Authentication, Authorization, and Accounting) entity, and a visited CDMA (Code Division Multiple Access) 2000 packet data system that comprises an ANSI-41 visited location register, an AAA entity, and a packet data serving node/foreign agent, when a GPRS native subscriber using Mobile IPv4 roams to the visited CDMA 2000 packet data system, wherein the interface entity includes a distinct interface for each of the GSM home location register, the GGSN, and the AAA entity.

According to still another aspect of the present invention, there is provided an interface entity that enables communication between a home GPRS (General Packet Radio Service) system comprising a GSM home location register, a GGSN, and an AAA (Authentication, Authorization, and Accounting) entity, and a visited CDMA 2000 packet data system that comprises an ANSI-41 visited location register, an AAA entity, and a packet data serving node/LAC entity, when a GPRS native subscriber using Simple IP roams to the visited CDMA 2000 packet data system, wherein the interface entity includes a distinct interface for each of the GSM home location register, the GGSN, and the AAA entity.

According to yet another aspect of the present invention, there is provided an apparatus for enabling communications between a CDMA (Code Division Multiple Access) packet data system and a GPRS (General Packet Radio Service) system, wherein a CDMA 2000 packet data native subscriber using Mobile IPv4 (Internet Protocol version 4) roams from a home CDMA 2000 packet data system to a visited GPRS system comprising a SGSN (Serving GPRS Support Node), comprising: means for coupling the home system to the visited

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system to enable communication between the home system and the visited system, wherein the home CDMA 2000 packet data system comprises a ANSI (American National Standards Institute)-41 home location register, an AAA (Authentication, Authorization, and Accounting) entity, and a home agent; and  
5 means for providing a distinct interface for each of the ANSI-41 home location register, the AAA entity, and the home agent.

According to a further aspect of the present invention, there is provided an apparatus for enabling communications between a CDMA (Code Division Multiple Access) packet data system and a GPRS (General Packet Radio  
10 Service) system, wherein a CDMA 2000 packet data native subscriber using Simple IP roams from a home CDMA 2000 packet data system to a visited GPRS system comprising a SGSN, (Serving GPRS Support Node) comprising: means for coupling the home system to the visited system to enable communication between the home system and the visited system, wherein the home CDMA 2000  
15 packet data system comprises a ANSI-41 home location register, an AAA (Authentication, Authorization, and Accounting) entity, and a LNS (Layer 2 Tunneling Protocol Network Server); and means for providing a distinct interface for each of the ANSI-41 home location register, the AAA entity, and LNS.

According to yet a further aspect of the present invention, there is  
20 provided an apparatus for enabling communications between a CDMA (Code Division Multiple Access) packet data system and a GPRS (General Packet Radio Service) system, wherein a GPRS native subscriber using Mobile IPv4 (Internet Protocol version 4) roams from a home GPRS system to a visited CDMA 2000 packet data system that comprises an ANSI-41 visited location register, an AAA  
25 (Authentication, Authorization, and Accounting) entity, and a packet data serving node/foreign agent, comprising: means for coupling the home system to the visited system to enable communication between the home system and the visited system, wherein the home GPRS system comprises a GSM home location register, a GGSN, and an AAA entity; and means for providing a distinct interface  
30 for each of the GSM home location register, the GGSN, and the AAA entity.

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According to still a further aspect of the present invention, there is provided an apparatus for enabling communications between a CDMA (Code Division Multiple Access) packet data system and a GPRS (General Packet Radio Service) system, wherein a GPRS native subscriber using Simple IP roams from home GPRS system to a visited CDMA 2000 packet data system that comprises a ANSI-41 visited location register, a AAA (Authentication, Authorization, and Accounting) entity, and a PDSN/LAC (Packet Data Serving Node/Layer 2 Tunneling Protocol Access Concentrator) entity, comprising: means for coupling the home system to the visited system to enable communication between the home system and the visited system, wherein the home GPRS system comprises a GSM home location register, a GGSN, and an AAA entity; and means for providing a distinct interface for each of the GSM home location register, the GGSN, and the AAA entity.

According to another aspect of the present invention, there is provided an apparatus for enabling communication between a home CDMA 2000 packet data system and a visited GPRS (General Packet Radio Service) system comprising a SGSN (Serving GPRS Support Node), when a CDMA 2000 packet data native subscriber using Mobile IPv4 roams to a visited GPRS system, the method comprising: means for allowing a subscriber to register over a first interface that couples a GSM home location register emulation module to the SGSN; and means for allowing the subscriber to register over a second interface that couples an ANSI-41 visited location register emulation module to a ANSI-41 home location register.

According to yet another aspect of the present invention, there is provided an apparatus that enables communication between a home CDMA (Code Division Multiple Access) 2000 packet data system and a visited GPRS (General Packet Radio Service) system comprising a SGSN (Serving GPRS Support Node), when a CDMA 2000 packet data native subscriber using Simple IP roams to a visited GPRS system, wherein the home CDMA2000 packet data system comprises a ANSI-41 home location register, an AAA entity, and a LNS, comprising: means for coupling an ANSI-41 visited location register to the

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ANSI-41 home location register via a first interface, wherein the ANSI-41 visited location register allows a subscriber to register over the first interface; and means for coupling a GSM home location register to the SGSN via a second interface, wherein the GSM home location register allows a subscriber to register over the  
5 second interface.

According to another aspect of the present invention, there is provided an apparatus that enables communication between a home GPRS (General Packet Radio Service) system comprising a GSM home location register, a GGSN, and an AAA (Authentication, Authorization, and Accounting) entity; and  
10 a visited CDMA 2000 packet data system that comprises an ANSI-41 visited location register, an AAA entity, and a packet data serving node/foreign agent, when a GPRS native subscriber using Mobile IPv4 (Internet Protocol version 4) roams to the visited CDMA 2000 packet data system, comprising: means for coupling a home agent emulation module to the packet data serving node/foreign  
15 agent via a first interface, wherein the home agent emulation module presents a home agent interface to the visited system; and means for coupling a SGSN emulation module to the GGSN via a second interface, wherein the SGSN emulation module presents a SGSN interface to the home system to support bearer connectivity between the visited and home networks by providing a packet  
20 routing function between the SGSN interface and the home agent interface.

According to another aspect of the present invention, there is provided an apparatus that enables communication between a home GPRS (General Packet Radio Service) system comprising a GSM home location register, a GGSN, and an AAA (Authentication, Authorization, and Accounting) entity, and  
25 a visited CDMA 2000 packet data system that comprises an ANSI-41 visited location register, an AAA entity, and a packet data serving node/LAC entity, when a GPRS native subscriber using Simple IP roams to the visited CDMA 2000 packet data system, comprising: means for coupling a SGSN emulation module to the GGSN over a first interface, wherein the SGSN emulation module presents a  
30 SGSN interface to the home system; and means for coupling a LNS emulation module to the packet data serving node/LAC entity over a second interface,

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wherein the LNS emulation module presents a L2TP Network Server (LNS) interface to the visited system, wherein the interface provides the packet routing function between the SGSN emulation module and the LNS emulation module.

According to still another aspect of the present invention, there is provided a method in which a user using Mobile IP roams from a home system to a visited system having a Serving GPRS Support Node (SGSN), comprising: coupling the home system to the visited system to enable communication between the home system and the visited system, wherein the home system comprises a home agent, a home location register, and an Access, Authorization, and Accounting (AAA) entity, by: providing a foreign agent emulation module to the home system over a third interface; providing a Gateway GPRS Support Node (GGSN) emulation module to the visited system over a fourth interface; providing an AAA emulation module to the home system; and providing an accounting function by interacting with the home system's AAA entity for Mobile IP Foreign Agent challenge authentication and 3GPP2 packet data accounting.

According to yet another aspect of the present invention, there is provided a method that enables communication between a home system comprising a home agent, and a visited system having a Serving GPRS Support Node (SGSN), when a user using Mobile IP roams to a visited system, comprising: coupling the home agent to a foreign agent emulation module via a third interface, wherein the foreign agent emulation module supports bearer connectivity between the visited system and the home system over the third interface, wherein the home system comprises a home location register, an Access, Authorization, and Accounting (AAA) entity; coupling a Gateway GPRS Support Node (GGSN) emulation module to the Serving GPRS Support Node (SGSN) via a fourth interface, wherein the Gateway GPRS Support Node (GGSN) emulation module supports bearer connectivity between the visited system and the home system over the fourth interface; allowing the user to register over a first interface that couples a Global System for Mobile communications home location register emulation module to the SGSN; allowing the user to register over a second interface that couples an visited location register emulation module to a

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home location register; and coupling an AAA emulation module to the AAA entity via a fifth interface, wherein the AAA emulation module provides an accounting function by interacting with the home system's AAA entity for Mobile IP Foreign Agent challenge authentication and 3GPP2 packet data accounting.

5                   According to a further aspect of the present invention, there is provided a system in which a user using Mobile IP roams to a visited system having a Serving GPRS Support Node (SGSN), comprising: a home system having a home agent, wherein the home system further comprising a home location register and an Access, Authorization, and Accounting (AAA) entity; an  
10 interface entity that couples the home system to the visited system to enable communication between the home system and the visited system, wherein the interface entity comprises: a foreign agent emulation module, coupled to the home agent via a third interface, that supports bearer connectivity between the visited system and the home system such that a foreign agent emulation module is  
15 presented to the home system over the third interface; a Global System for Mobile communications home location register emulation module, coupled to the Serving GPRS Support Node (SGSN) via a first interface, that allows a user to register over the first interface; an visited location register emulation module, coupled to the home location register via a second interface, that allows a user to register  
20 over the second interface; and an AAA emulation module, coupled to the AAA entity via a fifth interface, that provides an accounting function by to interacting with the home system's AAA entity for Mobile IP Foreign Agent challenge authentication and 3GPP2 packet data accounting.

                  According to yet a further aspect of the present invention, there is  
25 provided an interface entity that enables communication between a home system having a home agent, a home location register and an Access, Authorization and Accounting (AAA) entity, and a visited system comprising a Serving GPRS Support Node (SGSN), when a user using Mobile IP roams to a visited system, the interface entity comprising: a foreign agent emulation module, coupled to the  
30 home agent via an third interface, that supports bearer connectivity between the visited interface entity and the home interface entity such that a foreign agent

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emulation module and an AAA emulation module are presented to the interface entity over the third interface; a Gateway GPRS Support Node (GGSN) emulation module, coupled to the Serving GPRS Support Node (SGSN) via a fourth interface, that supports bearer connectivity between the visited system and the home system such that a Gateway GPRS Support Node (GGSN) emulation module is presented to the visited system over the fourth interface, wherein the interface entity provides a packet routing function between the Gateway GPRS Support Node (GGSN) emulation module and the foreign agent emulation module, and serves as an endpoint for a GPRS Tunneling Protocol (GTP) tunnel and a Mobile IP tunnel; a Global System for Mobile communications home location register emulation module, coupled to the Serving GPRS Support Node (SGSN) via a first interface, that allows a user to register over a first interface; an visited location register emulation module, coupled to the home location register via a second interface, that allows a user to register over the second interface; and an AAA emulation module, coupled to the AAA entity via an fifth interface, that provides an accounting function by to interacting with the home system's AAA entity for Mobile IP Foreign Agent challenge authentication and 3GPP2 packet data accounting.

According to still a further aspect of the present invention, there is provided a method in which a user using Simple IP roams from a home system comprising a L2TP Network Server (LNS) to a visited system comprising a Serving GPRS Support Node (SGSN), comprising: coupling the home system to the visited system to enable communication between the home system and the visited system, by: providing a Gateway GPRS Support Node (GGSN) emulation module to the visited system to support bearer connectivity between the visited and home networks over a third interface; and providing a Link Access Control (LAC) emulation module coupled to the L2TP Network Server via a third interface, wherein the Link Access Control (LAC) emulation module supports bearer connectivity between the visited and home system over the fourth interface thereby providing a normal routing interface to the home system.

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According to another aspect of the present invention, there is provided a method that enables communication between a home system comprising a L2TP Network Server (LNS) and a visited system comprising a Serving GPRS Support Node (SGSN), when a user using Simple IP roams to the visited system, comprising: coupling a Link Access Control (LAC) emulation module to the L2TP Network Server via a third interface, wherein the Link Access Control (LAC) emulation module supports bearer connectivity between the visited and home systems over the third interface; and coupling a Gateway GPRS Support Node (GGSN) emulation module to the Serving GPRS Support Node (SGSN) via a fourth interface to support bearer connectivity between the visited and home systems over the fourth interface.

According to yet another aspect of the present invention, there is provided a system in which a user using Simple IP roams to a visited system comprising a Serving GPRS Support Node (SGSN), comprising: a home system that comprises a L2TP Network Server (LNS); and an interface entity that couples the home system to the visited system to enable communication between the home system and the visited system, wherein the interface entity further comprises: a Link Access Control (LAC) emulation module, coupled to the L2TP Network Server via an third interface, that supports bearer connectivity between the visited and home networks over the third interface; and a Gateway GPRS Support Node (GGSN) emulation module, coupled to the Serving GPRS Support Node (SGSN) via a fourth interface, that supports bearer connectivity between the visited and home networks over the fourth interface by providing a Gateway GPRS Support Node (GGSN) emulation module to the visited system and providing a normal routing interface to the system to thereby provide a packet routing function between the Gateway GPRS Support Node (GGSN) emulation module and the home system.

According to one aspect of the present invention, there is provided an interface entity that enables communication between a home system and a visited system comprising a Serving GPRS Support Node (SGSN), when a user using Simple IP roams to a visited system, wherein the home system comprises a

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L2TP Network Server (LNS), and wherein the interface entity comprises: a Link Access Control (LAC) emulation module, coupled to the L2TP Network Server via an third interface, that supports bearer connectivity between the visited and home networks over the third interface; and a Gateway GPRS Support Node (GGSN) emulation module, coupled to the Serving GPRS Support Node (SGSN) via a fourth interface, that supports bearer connectivity between the visited and home networks over the fourth interface by providing a Gateway GPRS Support Node (GGSN) emulation module to the visited system and providing a normal routing interface to the home system to thereby provide a packet routing function between the Gateway GPRS Support Node (GGSN) emulation module and the home system.

According to another aspect of the present invention, there is provided a method in which a user using Mobile IP roams from a home system to a visited system comprising a Serving GPRS Support Node (SGSN), comprising: coupling the home system to the visited system to enable communication between the home system and the visited system, wherein the home system comprises a home location register, an Access, Authorization, and Accounting (AAA) entity, and a home agent; and providing an accounting function by interacting with a home system's Access, Authorization, and Accounting (AAA) for Mobile IP Foreign Agent challenge authentication and 3GPP2 packet data accounting.

According to still another aspect of the present invention, there is provided a method in which a user using Simple IP roams from a home system to a visited system comprising a Serving GPRS Support Node (SGSN), comprising: coupling the home system to the visited system to enable communication between the home system and the visited system, wherein the home system comprises a home location register, an Access, Authorization, and Accounting (AAA) entity, and a L2TP Network Server (LNS); providing endpoints for a GPRS Tunneling Protocol (GTP) tunnel and an IPSec tunnel; and providing an accounting function by interacting with the home system's Access, Authorization, and Accounting (AAA) for L2TP authentication and 3GPP2 packet data accounting over a fifth interface.

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According to yet another aspect of the present invention, there is provided a method that enables communication between a home system and a visited system comprising a Serving GPRS Support Node (SGSN), when a user using Mobile IP roams to a visited system, comprising: wherein the home system

5 comprises a home location register, an Access, Authorization, and Accounting (AAA) entity, and a home agent; coupling the home agent to a foreign agent emulation module via a third interface, wherein the foreign agent emulation module supports bearer connectivity between the visited system and the home system such that the foreign agent emulation module and an Access,

10 Authorization, and Accounting (AAA) emulation module are presented to the system over the third interface; and coupling a Gateway GPRS Support Node (GGSN) emulation module to the Serving GPRS Support Node (SGSN) via a fourth interface, wherein the Gateway GPRS Support Node (GGSN) emulation module supports bearer connectivity between the visited system and the home

15 system such that a Gateway GPRS Support Node (GGSN) emulation module is presented to the visited system over the fourth interface; allowing a user to register over a first interface that couples a Global System for Mobile communications home location register emulation module to the SGSN; and

20 allowing the user to register over a second interface that couples a visited location register emulation module to a home location register.

According to a further aspect of the present invention, there is provided a method that enables communication between a home system and a visited system comprising a Serving GPRS Support Node (SGSN), when a user using Simple IP roams to a visited system, wherein the home system comprises a

25 home location register, an Access, Authorization, and Accounting (AAA) entity, and a L2TP Network Server (LNS), comprising: coupling a Gateway GPRS Support Node (GGSN) emulation module to the Serving GPRS Support Node (SGSN) via a fourth interface to support bearer connectivity between the visited and home networks over the fourth interface; providing endpoints for a GPRS

30 Tunneling Protocol (GTP) tunnel and an IPSec tunnel; and coupling an Access, Authorization, and Accounting (AAA) emulation module to the Access, Authorization, and Accounting (AAA) entity via a fifth interface, wherein the

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Access, Authorization, and Accounting (AAA) emulation module provides an accounting function by interacting with the home system's Access, Authorization, and Accounting (AAA) for L2TP authentication and 3GPP2 packet data accounting over the fifth interface.

5                   According to yet a further aspect of the present invention, there is provided a method that enables communication between a home system and a visited system comprising a Serving GPRS Support Node (SGSN), when a user using Simple IP roams to a visited system, wherein the home system comprises a home location register, an Access, Authorization, and Accounting (AAA) entity,  
10   and a L2TP Network Server (LNS), comprising: coupling a Gateway GPRS Support Node (GGSN) emulation module to the Serving GPRS Support Node (SGSN) via a fourth interface to support bearer connectivity between the visited and home networks over the fourth interface; coupling a visited location register to the home location register via a first interface, wherein the visited location register  
15   allows a user to register over the first interface; coupling a Global System for Mobile communications home location register to the Serving GPRS Support Node (SGSN) via a second interface, wherein the Global System for Mobile communications home location register allows a user to register over the second interface; and coupling a Link Access Control (LAC) emulation module to the  
20   L2TP Network Server via an third interface, wherein the Link Access Control (LAC) emulation module supports bearer connectivity between the visited and home networks over the third interface.

                  According to still a further aspect of the present invention, there is provided a system in which a user using Mobile IP roams to a visited system  
25   comprising a Serving GPRS Support Node (SGSN), comprising: a home system comprising a home location register, an Access, Authorization, and Accounting (AAA) entity, and a home agent; and an interface entity that couples the home system to the visited system to enable communication between the home system and the visited system, and wherein the interface entity further comprises: a  
30   Global System for Mobile communications home location register emulation module, coupled to the Serving GPRS Support Node (SGSN) via a first interface,

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that allows a user to register over a first interface; and a visited location register emulation module, coupled to the home location register via a second interface, that allows a user to register over the second interface; a foreign agent emulation module, coupled to the home agent via an third interface, that supports bearer  
5 connectivity between the visited system and the home system such that a foreign agent emulation module and an Access, Authorization, and Accounting (AAA) emulation module are presented to the system over the third interface; and a Gateway GPRS Support Node (GGSN) emulation module, coupled to the Serving GPRS Support Node (SGSN) via a fourth interface, that supports bearer  
10 connectivity between the visited system and the home system such that a Gateway GPRS Support Node (GGSN) emulation module is presented to the visited system over the fourth interface.

According to another aspect of the present invention, there is provided a system in which a user using Simple IP roams to a visited system  
15 comprising a Serving GPRS Support Node (SGSN), comprising: a home system that comprises: a home location register; an Access, Authorization, and Accounting (AAA) entity; and a L2TP Network Server (LNS); and an interface entity that couples the home system to the visited system to enable communication between the home system and the visited system, wherein the  
20 interface entity further comprises: an visited location register, coupled to the home location register via a first interface, that allows a user to register over the first interface; and a Global System for Mobile communications home location register, coupled to the Serving GPRS Support Node (SGSN) via a second interface, that allows a user to register over the second interface; a Link Access Control (LAC)  
25 emulation module, coupled to the L2TP Network Server via an third interface, that supports bearer connectivity between the visited and home networks over the third interface; and a Gateway GPRS Support Node (GGSN) emulation module, coupled to the Serving GPRS Support Node (SGSN) via a fourth interface, that supports bearer connectivity between the visited and home networks over the  
30 fourth interface by presenting a Gateway GPRS Support Node (GGSN) emulation module to the visited system and presenting a normal routing interface to the

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system to thereby provide a packet routing function between the Gateway GPRS Support Node (GGSN) emulation module and the home system.

According to yet another aspect of the present invention, there is provided an interface entity that enables communication between a home system and a visited system comprising a Serving GPRS Support Node (SGSN), when a user using Mobile IP roams to a visited system, wherein the home system comprises a home location register, an Access, Authorization, and Accounting (AAA) entity, and a home agent, and wherein the interface entity comprises: a Global System for Mobile communications home location register emulation module, coupled to the Serving GPRS Support Node (SGSN) via a first interface, that allows a user to register over a first interface; and a visited location register emulation module, coupled to the home location register via a second interface, that allows a user to register over the second interface; a foreign agent emulation module, coupled to the home agent via an third interface, that supports bearer connectivity between the visited interface entity and the home interface entity such that a foreign agent emulation module and an Access, Authorization, and Accounting (AAA) emulation module are presented to the interface entity over the third interface; and a Gateway GPRS Support Node (GGSN) emulation module, coupled to the Serving GPRS Support Node (SGSN) via a fourth interface, that supports bearer connectivity between the visited system and the home system such that a Gateway GPRS Support Node (GGSN) emulation module is presented to the visited system over the fourth interface, wherein the interface entity provides a packet routing function between the Gateway GPRS Support Node (GGSN) emulation module and the foreign agent emulation module, and serves as an endpoint for a GPRS Tunneling Protocol (GTP) tunnel and a Mobile IP tunnel.

According to still another aspect of the present invention, there is provided an interface entity that enables communication between a home system and a visited system comprising a Serving GPRS Support Node (SGSN), when a user using Simple IP roams to a visited system, wherein the home system comprises a home location register, an Access, Authorization, and Accounting (AAA) entity, and a L2TP Network Server (LNS), and wherein the interface entity

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comprises: a visited location register, coupled to the home location register via a first interface, that allows a user to register over the first interface; a Global System for Mobile communications home location register, coupled to the SGSN via a second interface, that allows a user to register over the second interface; a

5 Link Access Control (LAC) emulation module, coupled to the L2TP Network Server via an third interface, that supports bearer connectivity between the visited and home networks over the third interface; and a Gateway GPRS Support Node (GGSN) emulation module, coupled to the Serving GPRS Support Node (SGSN) via a fourth interface, that supports bearer connectivity between the visited and

10 home networks over the fourth interface by presenting the GGSN emulation module to the visited system and presenting a normal routing interface to the home system to thereby provide a packet routing function between the GGSN emulation module and the home system.

### BRIEF DESCRIPTION OF THE DRAWINGS

15 **[0022]** FIG. 1 is a block diagram of a system that comprises a home system, a visited system, and an interface entity that enables communication between the home system and the visited system;

**[0023]** FIG. 2A is a block diagram of GPRS foreign mode with Mobile IPv4;

**[0024]** FIG. 2B is a call flow diagram that shows Mobile IPv4 operation in

20 the GPRS foreign mode;

**[0025]** FIG. 3A is a block diagram of GPRS foreign mode with Simple IP;

**[0026]** FIG. 3B is a call flow diagram that shows Simple IP operation in the GPRS foreign mode;

**[0027]** FIG. 4A is a block diagram of CDMA2000 packet data foreign mode

25 with Mobile IPv4;

**[0028]** FIG. 4B is a call flow diagram that shows Mobile IPv4 operation in the GDMA2000 packet data foreign mode;

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**[0029]** FIG. 5A is a block diagram of CDMA2000 packet data foreign mode with Simple IP; and

[0030] FIG. 5B is a call flow diagram that shows Simple IP operation in the CDMA2000 packet data foreign mode.

### DETAILED DESCRIPTION

[0031] The word “exemplary” can be used herein to mean “serving as an example, instance, or illustration.” Any embodiment described herein as “exemplary” can be not necessarily to be construed as preferred or advantageous over other embodiments.

[0032] As used herein, the term “agent advertisement” refers to the procedure by which a mobility agent becomes known to the mobile node.

[0033] As used herein, the term “agent discovery” refers to the process by which a mobile node can obtain the IP address of a home agent or foreign agent, depending upon whether the mobile node is home or away from home. Agent discovery occurs when a mobile node receives an agent advertisement, either as a result of periodic broadcast or in response to a solicitation. The term “discovery” is used interchangeably with the term “agent discovery.”

[0034] As used herein, the term “automatic home agent discovery” refers to the process by which a mobile node can obtain the IP address of a home agent on its home network, involving the transmission of a registration request to the subnet broadcast address of its home network.

[0035] As used herein, the term “care-of address” refers to an IP address at the mobile node’s current point of attachment to the Internet, when the mobile node is not attached to the home network.

[0036] As used herein, the term “collocated care-of address ” refers to a care-of address assigned to one of the mobile node’s network interfaces, instead of one being offered by a foreign agent.

[0037] As used herein, the term “correspondent node” refers to node that sends or receives a packet to a mobile node; the correspondent node may be another mobile node or a nonmobile Internet node.

[0038] As used herein, the term “encapsulation” refers to the process of incorporating an original IP packet inside another IP packet, making the fields within the original IP header temporarily lose their effect.

- [0039] As used herein, the term “foreign agent” refers to a mobility agent on the foreign network that can assist the mobile node in receiving datagrams delivered to the care-of address.
- [0040] As used herein, the term “foreign network” refers to the network to which the mobile node is attached when it is not attached to its home network, and on which the care-of address is reachable from the rest of the Internet.
- [0041] As used herein, the term “home address” refers to the IP address assigned to the mobile node, making it logically appear attached to its home network.
- [0042] As used herein, the term “home agent” refers to a node on the home network that effectively causes the mobile node to be reachable at its home address even when the mobile node is not attached to its home network.
- [0043] As used herein, the term “home network” refers to the network at which the mobile node seems reachable, to the rest of the Internet, by virtue of its assigned IP address.
- [0044] As used herein, the term “mobile node” refers to a node that changes its point of attachment to the Internet.
- [0045] As used herein, the term “mobility agent” refers to a node, such as a router, that offers support services to mobile nodes. A mobility agent can be either a home agent or a foreign agent.
- [0046] As used herein, the term “redirection” refers to a message that is intended to cause a change in the routing behavior of the node receiving it.
- [0047] As used herein, the term “registration” refers to the process by which the mobile node informs the home agent about its current care-of address.
- [0048] As used herein, the term “remote redirection” refers to a redirect sent from a source not present on the local network. The source can be located anywhere in the global Internet and may have malicious intent and be untraceable.
- [0049] As used herein, the term “route optimization” refers to a process that enables the delivery of packets directly to the care-of address from a correspondent node without having to detour through the home network.
- [0050] As used herein, the term “tunneling” has a meaning similar to the term “encapsulation”, but with additional connotations about changing the effects of Internet routing on the original IP packet.
- [0051] Acronyms

[0052] For each of the following terms, the description below uses the following acronyms:

Access, Authorization and Accounting (AAA)  
Challenge Handshake Authentication Protocol (CHAP)  
Domain Name System or Server (DNS)  
Foreign Agent (FA)  
Foreign Agent Challenge (FAC)  
General Packet Radio System (GPRS)  
Gateway GPRS Support Node (GGSN)  
Global System for Mobile communications (GSM)  
GPRS Tunneling Protocol (GTP)  
Home Agent (HA)  
Home Authentication, Authorization and Accounting (HAAA)  
Home Location Register (HLR)  
Internet Protocol Control Protocol (IPCP)  
Link Access Control (LAC)  
Link Control Protocol (LCP)  
L2TP Network Server (LNS)  
Mobile Station (MS)  
Mobile Switching Center (MSC)  
Mobile Station ID (MSID)  
Network Access Identifier (NAI)  
Network Access Server (NAS)  
PPP Authentication Protocol (PAP)  
Packet Control Function (PCF)  
Packet Data Serving Node (PDSN)  
Point to Point Protocol (PPP)  
Radio Access Network (RAN)  
Serving GPRS Support Node (SGSN)  
Visited Authentication, Authorization and Accounting (VAAA)  
Visited Location Register (VLR)

[0053] FIG. 1 is a block diagram of a system that comprises a home system 10, such as a CDMA 2000 packet data system or a GPRS system, a visited system 20, such as a GPRS system or a CDMA 2000 packet data system, and an interface entity 30 or "IIF" that couples the home system 10 to the visited system 20, and enables communication between the home system 10 and the visited system 20.

[0054] The following sections describe architectures that can be adapted for CDMA2000/GPRS roaming scenarios, such as, GPRS foreign mode with Mobile IPv4, GPRS foreign mode with Simple IPv4 or IPv6, CDMA2000 packet data foreign mode with Mobile IPv4, and CDMA2000 packet data foreign mode with Simple IPv4 or IPv6.

#### GPRS Foreign Mode with Mobile IPv4

[0055] FIG. 2A is an exemplary block diagram of a GPRS foreign mode with Mobile IPv4, and depicts the functions and control interface provided by an IIF in this embodiment. This roaming scenario occurs when a CDMA2000 packet data native subscriber operates Mobile IPv4 [IS-835-C] in GPRS foreign mode. In this embodiment, the home system 10 can be a CDMA 2000 packet data system wherein a CDMA 2000 packet data native subscriber roams to a GPRS system and uses Mobile IPv4. The home system 10 comprises a ANSI-41 home location register 131, an AAA entity 116, and a home agent 135. The visited system 20 can be a GPRS system that comprises a Serving GPRS Support Node (SGSN) 137. The Serving GPRS Support Node keeps track of the location of an individual mobile station and performs security functions and access control. The AAA entity can be used to securely determine the identity and privileges of a user and to track that user's activities.

[0056] The interface 30 or "IIF" comprises an ANSI-41 visited location register 111 coupled to the ANSI-41 home location register 131 via a D interface 113, a GSM home location register 124 coupled to the Serving GPRS Support Node (SGSN) 137 via a Gr interface 123, a Gateway GPRS Support Node (GGSN) 126 coupled to the Serving GPRS Support Node (SGSN) 137 via a Gp interface 127 and coupled to the Internet via a Gi interface, an AAA entity 140 coupled to the AAA entity 116 via an X3 interface 117, and a foreign agent 118 coupled to the home agent 135 via an X1 interface 115. The Gr interface is a GPRS interface which is located between the SGSN (Serving GPRS Support Node) and the HLR (Home Location Register). When the GGSN (Gateway GPRS Support Node) and the SGSN (Serving GPRS Support Node) are

located in different networks, they may be interconnected via the Gp interface which provides similar functionality to that of the Gn interface, however it usually includes extra security functionality which is based on mutual agreements between operators. The Gi Interface is a GPRS interface which is located between the GGSN (Gateway GPRS Support Node) and the external PDN (Public Data Network). The Gateway GPRS Support Node supports the edge routing function of the GPRS network. To external packet data networks the GGSN performs the task of an IP router. Firewall and filtering functionality, to protect the integrity of the GPRS core network, are also associated with the GGSN along with a billing function.

[0057] The IIF provides both GSM HLR and ANSI-41 VLR emulation to allow the subscriber to register. This interworking can be provided over the interface references "Gr" and "D." The Home Location Register (HLR) is a database found within cellular networks. It stores subscriber data relating to services and features in addition to location area based information. In the context of GSM, the Home Location Register is a database within the HPLMN (Home Public Land Mobile Network). It provides routing information for MT (Mobile Terminated) calls and SMS (Short Message Service). It is also responsible for the maintenance of user subscription information. This is distributed to the relevant VLR (Visitor Location Register) or SGSN (Serving GPRS Support Node) through the attach process and mobility management procedures such as Location Area and Routing Area updates. The Visitor Location Register (VLR) contains all subscriber data required for call handling and mobility management for mobile subscribers currently located in the area controlled by the VLR.

[0058] The IIF also provides Gateway GPRS Support Node (GGSN) and FA emulation to support bearer connectivity between the visited and home networks via the IIF. This interworking can be provided over the interface references "Gn" and "X1." The IIF provides AAA emulation to interact with the home network's AAA for Mobile IP Foreign Agent challenge authentication and 3GPP2 packet data accounting. This interworking can be provided over the interface reference "X3."

[0059] If bearer connectivity between from the GPRS system and the CDMA2000 packet data system is not required, then reverse tunneling on the X1 interface is not required. Rather, MS-terminated traffic traverses through the X1 and Gp interfaces. In the case where reverse tunneling is not required, the IIF routes MS-originated traffic, received on a Gp interface, to the Internet directly via a Gi interface.

[0060] Thus, for a user homed in a CDMA Mobile IP system roaming to a GSM system, the IIF may present a Gateway GPRS Support Node (GGSN) interface to GSM and a FA and AAA interfaces to the CDMA system. The IIF may serve as the endpoint for the GTP and Mobile IP tunnels, with a packet routing function between the Gateway GPRS Support Node (GGSN) and FA. GPRS Tunnelling Protocol is employed on the Gn interface in order to tunnel user data between different GGSN. The Gn interface is a GPRS interface which is located between the GSN (GPRS Support Nodes). Version zero of the protocol supports both signalling and user data under one generic header. It can be used with UDP User Datagram Protocol (UDP) or Transmission Control Protocol (TCP).

[0061] The IIF may also provide an accounting function so that operators can charge based on configurable measurements such as packet count, bandwidth, time of day, etc.

[0062] FIG. 2B is an exemplary call flow diagram that shows Mobile IPv4 operation in the GPRS foreign mode. FIG. 2B depicts a call flow example for the roaming scenario where a CDMA2000 packet data native subscriber operates Mobile IPv4 [IS-835-C] in the GPRS foreign mode. In this example, the MS has shared secrets with the home CDMA2000 system for Mobile IP authentication. The MS may request the home CDMA2000 system to assign a HA and/or an IP address. The reverse tunneling can be enabled so that all data traffic (MS-originated and -terminated) traverses through the IIF and home CDMA2000 system. The IIF generates 3GPP2 packet data accounting records and sends it to the home CDMA2000 system via RADIUS.

[0063] The MS performs GPRS attach with a SGSN. The authentication associated with the GPRS attach can be a SIM-based authentication requiring the Ki secret key. The IIF acts as the GSM HLR configured with the Ki secret. In any case, the IIF can be not required to communicate with the HLR in the home CDMA2000 system for the authentication. (Step 1) The MS sends the Activate PDP Context Request to the SGSN. The message includes the Access Point Name (APN). The APN has the format <Network ID>.<MNC>.<MCC>.gprs. The Network ID (e.g., CDMA2000carrier.com) indicates to which external network the MS wants to establish a logical connection. The Requested PDP Address can be omitted in the message. The MS has a static Mobile IP home address or obtains a new Mobile IP home address. (Step 2) The Serving GPRS Support Node (SGSN) selects a Gateway GPRS Support Node (GGSN) based on the APN. The Serving GPRS Support Node (SGSN) uses the APN as the lookup name to

query a DNS server (not shown in the figure) and obtains a list of available GGSNs that can be used to support the requested APN. A Domain Name Server maintains a database for resolving host names and IP addresses. Network devices query the DNS server by specifying a remote computers host name and receives in return, the hosts IP addresses.

[0064] The APN's Network ID indicates a CDMA2000 operator; thus, the DNS server returns with the IIF's IP address. (Step 3) The Serving GPRS Support Node (SGSN) sends the Activate PDP Context Request to the selected IIF to set up a PDP context for the MS. The message includes the APN, but the Requested PDP Address can be omitted. (Step 4) The IIF acts as the Gateway GPRS Support Node (GGSN) and sends the Create PDP Context Response to the Serving GPRS Support Node (SGSN) that in turn sends the Activate PDP Context Accept to the MS. The PDP Address in both messages can be set to 0.0.0.0 to indicate that the PDP address will be assigned later after successful Mobile IP registration. (Step 5) The IIF acts as the FA and sends one or more Mobile IP Agent Advertisements to the MS, because the omission of the Requested PDP Address in the Activate PDP Context Request can be the indication that the MS wishes to use Mobile IP. The Agent Advertisement can be sent over the established PDP context. The Agent Advertisement contains the FA Care-of Address and the FA Challenge (FAC). (Step 6)

[0065] The MS sends the Mobile IP Registration Request to the IIF over the PDP context. The following information can be contained in the Registration Request: MS's NAI [RFC 2794] has the format of <username>@<domain\_name>, where the domain\_name identifies the MS's home CDMA2000 system. MS-HA authenticator can be computed based on the content of the Registration Request and the secret shared between the MS and HA [RFC 2002]. MS-AAA authenticator can be computed based on the FAC and the secret shared between the MS and home AAA server [RFC 3012]. The HA Address field can be set to a known value if the MS uses a permanent HA, or to 0.0.0.0 if the MS wants a new HA assigned by the home network. Home Address field can be set to a known value if the MS uses a permanent address, or to 0.0.0.0 if the MS wants a new address assigned by the HA. The T-bit can be set to one to enable a reverse tunnel from the IIF to the MS's HA. (Step 7) The IIF acts as the RADIUS client and sends a RADIUS Access-Request to the home AAA server. The RADIUS Access-Request conveys MS's NAI, FAC authenticator, FAC, HA address, etc. [IS-835]. (Step

8) If the authentication is successful, the home AAA server responds with the RADIUS Access-Accept that includes the MS's HA address. (Step 9) The IIF acts as the FA and forwards the Mobile IP Registration Request to the HA address contained in the RADIUS Access-Accept. (Step 10) The HA verifies the MS-HA authenticator in the Mobile IP Registration Request. If the HA doesn't have the shared secret, as in the case of dynamically assigned HA, it communicates with the home AAA server for the shared secret. The HA responds to the Mobile IP Registration Request with the Mobile IP Registration Reply containing a registration result (e.g., successful or an error code). If the MS wishes for a new home address, a new address can be returned in the Registration Reply; otherwise, the MS's permanent address can be returned. (Step 11) The IIF acts as the FA and forwards the Mobile IP Registration Reply to the MS over the appropriate PDP context. The IIF FA functionality notes the assigned MS IP address and shares that address with the IIF Gateway GPRS Support Node (GGSN) functionality. (Step 12)

[0066] The IIF acts as the Gateway GPRS Support Node (GGSN) and updates its PDP context by setting the PDP address to the MS's home address (as indicated in the Registration Reply and shared by the FA functionality). The PDP address (hence the MS's home address) can be associated with a GTP tunnel identified by the Tunnel Endpoint ID (TEID). (Step 13) The IIF acts as the Gateway GPRS Support Node (GGSN) and triggers the GGSN-initiated PDP Context modification procedure in order to update the PDP address in the Serving GPRS Support Node (SGSN) and MS [3GPP TS 29.061]. The IIF sends the Update PDP Context Request to the Serving GPRS Support Node (SGSN) that forwards it to the MS. (Step 14) The MS responds with the Update PDP Context Response to the Serving GPRS Support Node (SGSN) that forwards it to the IIF. (Step 15) The IIF acts as the RADIUS client and sends the RADIUS Accounting-Request (Start) to the home AAA server [IS-835]. 3GPP2-vendor-specific attributes are used to convey accounting records, but some airlink record attributes (e.g., service option, mux option, etc.) are not applicable. (Step 16) The home AAA server responds with a RADIUS Accounting-Response (Start). (Step 17) Bearer traffic traverses through the IIF in both directions, if reverse tunneling from the IIF to HA is enabled. For routing MS-originated packets, the IIF routes packets received from the MS's GTP tunnel (identified by a TEID) to the MS's HA via a Mobile IP reverse tunnel. For routing MS-terminated packets, the IIF routes packets

received from the HA-to-FA tunnel to the MS's GTP tunnel. IPsec can be used to protect the Mobile IP tunnels between HA and IIF, and the GTP tunnels between IIF and SGSN. (Step 18)

### GPRS Foreign Mode with Simple IP

[0067] FIG. 3A is an exemplary block diagram of a GPRS foreign mode with Simple IP that shows a roaming scenario where a CDMA2000 packet data native subscriber operates IPv4 or IPv6 in the GPRS foreign mode. FIG. 3A also depicts the functions and control interface provided by an interface or IIF in this case. In this embodiment, the home system 10 can be a CDMA 2000 packet data system wherein a CDMA 2000 packet data native subscriber roams to a GPRS system and uses Simple IP. The home system 10 comprises a ANSI-41 home location register 131, an AAA entity 116, and a LNS 139. The visited system 20 can be a GPRS system that comprises a Serving GPRS Support Node (SGSN) 137.

[0068] The interface 30 or "IIF" comprises an ANSI-41 visited location register 111 coupled to the ANSI-41 home location register 131 via a D interface 113, a GSM home location register 124 coupled to the Serving GPRS Support Node (SGSN) 137 via a Gr interface 123, a Gateway GPRS Support Node (GGSN) 126 coupled to the Serving GPRS Support Node (SGSN) 137 via a Gp interface 127 and coupled to the Internet via a Gi interface, an AAA entity 140 coupled to the AAA entity 116 via an X3 interface 117, and a LAC entity 109 coupled to the LNS 139 via an X2 interface 119. The IIF provides both GSM HLR and ANSI-41 VLR emulation to allow the subscriber to register. This interworking can be provided over the interface references "Gr" and "D." The IIF provides Gateway GPRS Support Node (GGSN) and LAC emulation to support bearer connectivity between the visited and home networks via the IIF. This interworking can be provided over the interface references "Gn" and "X2." The Link Access Control sublayer is the upper sublayer of Layer 2, and provides a mechanism for the correct transport and delivery of signaling messages which have been generated at Layer 3.

[0069] The IIF also provides AAA emulation to interact with the home network's AAA for L2TP authentication and 3GPP2 packet data accounting. This interworking can be provided over the interface reference "X3." The L2TP uses features of PPTP (Point to Point Tunneling Protocol) and L2F (Layer 2 Forwarding). It has the ability to

encapsulate PPP frames so they can be sent over IP, X.25, Frame Relay, or ATM (Asynchronous Transfer Mode) networks. When using L2TP on an IP based network, the IP datagram supporting the L2TP payload employs the services of UDP (User Datagram Protocol).

[0070] If bearer connectivity between the CDMA2000 packet data system and GPRS system is not required, then the X2 interface is not required. The IIF still supports a Gp interface to the Serving GPRS Support Node (SGSN) and provides Internet access via a Gi interface (not shown in the figure).

[0071] Thus, for a user homed in a CDMA Simple IP system roaming to a GSM system, the IIF may present a Gateway GPRS Support Node (GGSN) interface to GSM and a normal routing interface to the CDMA system. The IIF may serve as the endpoint for the GTP and IPsec tunnels, with a packet routing function between the Gateway GPRS Support Node (GGSN) and the CDMA system. The IIF may also provide an accounting function so that operators can charge based on configurable measurements such as packet count, bandwidth, time of day, etc.

[0072] FIG. 3B is an exemplary call flow diagram that shows Simple IP operation in the GPRS foreign mode, and explains a roaming scenario where a CDMA2000 packet data native subscriber operates Simple IP in the GPRS foreign mode. In this example, the MS has shared secrets with the home CDMA2000 system for Simple IP authentication (i.e., CHAP). The MS establishes a PPP session, via L2TP, to the home CDMA2000 system. During the PPP establishment, the home CDMA2000 system assigns an IP address to the MS dynamically. All the MS's data traffic (MS-originated and – MS terminated) traverses through the IIF and home CDMA2000 system. The IIF generates 3GPP2 packet data accounting records and sends it to the home CDMA2000 system via RADIUS.

[0073] The MS performs GPRS attach with a SGSN. The authentication associated with the GPRS attach can be a SIM-based authentication requiring the Ki secret. The IIF acts as the GSM HLR configured with the Ki secret or the GSM VLR. In any case, the IIF can be not required to communicate with the HLR in the home CDMA2000 system for the authentication. (Step 1) The MS sends the Activate PDP Context Request to the SGSN. The message includes the APN (Access Point Name). The APN has the format <Network ID>.<MNC>.<MCC>.gprs. The Network ID (e.g., CDMA2000carrier.com) indicates to which external network the MS wants to establish

a logical connection. The Requested PDP Address can be omitted in the message so that the IIF (acting as a GGSN) later will not assign an IP address to the MS; instead, the address will be assigned by the LNS. (Step 2) The Serving GPRS Support Node (SGSN) selects a Gateway GPRS Support Node (GGSN) based on the APN. The Serving GPRS Support Node (SGSN) queries a DNS server (not shown in the figure) and obtains a list of available GGSNs that can be used to support the requested APN. In this case, the APN's Network ID indicates a CDMA2000 operator; thus, the DNS server returns with the IIF's IP address. (Step 3)

[0074] The Serving GPRS Support Node (SGSN) sends the Activate PDP Context Request to the selected IIF to set up a PDP context for the MS. The message includes the APN, but the Requested PDP Address can be omitted. (Step 4) The IIF acts as the Gateway GPRS Support Node (GGSN) and sends the Create PDP Context Response to the Serving GPRS Support Node (SGSN) that in turn sends the Activate PDP Context Accept to the MS. The PDP Address in both messages can be set to 0.0.0.0 to indicate that the PDP address will be reset later. (Step 5)

[0075] After the PDP context can be established, the MS and IIF perform PPP LCP negotiation. The IIF LAC functionality establishes L2TP tunnels with a LNS. The IIF determines which LNS based on the requested APN. The IIF is configured with the LNS information (e.g., LNS's IP address) corresponding to an APN. After the L2TP tunnel establishment, the IIF LAC functionality forwards LCP information between the LNS and MS. During the LCP negotiation, the LNS and MS negotiate PAP or CHAP as the protocol for PPP authentication. (Step 6) PPP authentication (PAP or CHAP) is performed. The MS's credential is authenticated by the home AAA in the CDMA2000 system. The RADIUS interaction between the LNS and home AAA is not shown in the figure. (Step 7) The LNS and MS perform PPP IPCP negotiation. The IIF LAC functionality relays IPCP messages between the L2TP tunnel and PDP context. During the negotiation, the LNS assigns an IP address to the MS. The IIF monitors for this address and uses it as the MS's PDP address. (Step 8)

[0076] The IIF also needs to notify the Serving GPRS Support Node (SGSN) and MS about the updated PDP address. Recall that the PDP address can be set to 0.0.0.0 initially. Therefore, the IIF sends the Update PDP Context Request to the Serving GPRS Support Node (SGSN) that forwards it to the MS. (Step 9) The MS responds

with the Update PDP Context Response to the Serving GPRS Support Node (SGSN) that forwards it to the IIF. (Step 10)

[0077] The IIF acts as the RADIUS client and sends the RADIUS Accounting-Request (Start) to the home AAA server [IS-835]. 3GPP2-vendor-specific attributes are used to convey accounting records, but some airlink record attributes (e.g., service option, mux option, etc.) are not applicable. (Step 11) The home AAA server responds with the RADIUS Accounting-Response (Start). (Step 12) Bearer traffic traverses through the IIF in both directions. For routing MS-originated packets, the IIF routes packets received from the MS's GTP tunnel (identified by a TEID) to the MS's L2TP tunnel/session. For routing MS-terminated packets, the IIF routes packets received from the MS's L2TP tunnel/session to the MS's GTP tunnel. IPsec can be used to protect the L2TP tunnel/session between LNS and IIF, and the GTP tunnels between IIF and SGSN. (Step 13)

#### CDMA2000 Packet Data Foreign Mode with Mobile IPv4

[0078] FIG. 4A is an exemplary block diagram of a CDMA2000 packet data foreign mode with Mobile IPv4. This section describes the roaming scenario where a GPRS native subscriber operates Mobile IPv4 [IS-835-C] in the CDMA2000 packet data foreign mode. FIG. 4A also depicts the functions and control interface provided by the IIF in this case. In this embodiment, the home system 10 can be a GPRS system. A GPRS native subscriber roams to a CDMA 2000 packet data system and uses Simple IP. The home system 10 comprises a GSM home location register 124, a Gateway GPRS Support Node (GGSN) 126, and an AAA entity 128. The visited system 20 can be a CDMA 2000 packet data system that comprises a ANSI-41 visited location register 111, an AAA entity 116, and a packet data serving node/ foreign agent 118.

[0079] The interface 30 or "IIF" comprises an ANSI-41 home location register 131 coupled to the ANSI-41 visited location register 111 via a D interface 113, a GSM visited location register 133 coupled to the GSM home location register 124 via a D interface 121, a Serving GPRS Support Node (SGSN) 137 coupled to the Gateway GPRS Support Node (GGSN) 126 via a Gp interface 127, an AAA entity 140 coupled to the AAA entity 128 via a X4 interface 129 and coupled to the AAA entity 116 via a X3 interface 117, and a home agent 135 coupled to the packet data serving node/ foreign agent 118 via a X1 interface 115. The IIF provides both GSM VLR and ANSI-41 HLR

emulation to allow the subscriber to register. This interworking can be provided over the interface reference "D." The IIF provides HA and Serving GPRS Support Node (SGSN) emulation to support bearer connectivity between the visited and home networks via the IIF. This interworking can be provided over the interface reference "X1" and "Gn." The IIF provides AAA emulation to interact with the visited network's AAA for Mobile IP authentication and 3GPP2 packet data accounting. The IIF also may interact with the home network's AAA for 3GPP packet data accounting. This interworking can be provided over the interface reference "X3" and "X4." The IIF/AAA requirements for CDMA2000 packet data foreign mode with mobile IP will be described below in greater detail.

[0080] If bearer connectivity between the visited CDMA2000 packet data system and home GPRS system is not required, the Gp interface is not required. In this case, mobile-originated data traffic can be routed directly to the Internet via the Packet Data Serving Node (PDSN)/FA in the visited system, or via the IIF/HA if reverse tunneling is enabled. Mobile-terminated data traffic is routed to the Packet Data Serving Node (PDSN)/FA via the IIF/HA. The interface X3 and X4 are required for the IIF to interwork AAA messages between the CDMA2000 AAA server and GPRS AAA server.

[0081] Thus, for a user homed in a GSM system roaming to a CDMA Mobile IP system, the IIF may present a HA interface to the CDMA system and a Serving GPRS Support Node (SGSN) interface to the GSM system. A subset of Serving GPRS Support Node (SGSN) functions is required including APN resolution. The IIF may serve as the endpoint for the Mobile IP and GTP tunnels, with a packet routing function between the HA and Serving GPRS Support Node (SGSN) functions.

[0082] FIG. 4B is an exemplary call flow diagram that shows Mobile IPv4 operation in the CDMA2000 packet data foreign mode. This call flow example shows a roaming scenario where a GPRS native subscriber operates Mobile IPv4 [IS-835-C] in the CDMA2000 packet data foreign mode. In this example, the home GPRS system doesn't support HA; thus, the MS has shared secrets with the IIF for Mobile IP authentication. The home GPRS system dynamically assigns an IP address to the MS. All MS's data traffic (MS-originated and MS-terminated) traverses through the IIF and home GPRS system. The IIF receives 3GPP2 accounting records from the visited

CDMA2000 system and may map them to 3GPP accounting records and forward them to the home GPRS system via RADIUS.

[0083] The MS originates SO 33 and establishes a PPP session with the Packet Data Serving Node (PDSN)/FA. (Step 1) The Packet Data Serving Node (PDSN)/FA sends one or more Mobile IP Agent Advertisements to the MS, because the omission of the IP-Address Configuration Option during the PPP IPCP negotiation indicates that the MS wishes to use Mobile IP. The Agent Advertisement contains the FA Care-of Address and the FA Challenge (FAC). (Step 2)

[0084] The MS sends the Mobile IP Registration Request to the Packet Data Serving Node (PDSN)/FA. The following information can be contained in the Registration Request: MS's NAI [RFC 2794] has the format of <username>@<domain\_name>, where the domain\_name identifies the MS's home GPRS system. MS-HA authenticator can be computed based on the content of the Registration Request and the secret shared between the MS and HA [RFC 2002]. MS-AAA authenticator can be computed based on the FAC and the secret shared between the MS and home AAA server [RFC 3012]. The HA Address field can be set to a known value if the MS uses a permanent HA, or to 0.0.0.0 if the MS wants a new HA assigned by the home network. The HA field can be set to 0.0.0.0 to request a new address assigned by the HA. The T-bit can be set to one to request the Packet Data Serving Node (PDSN)/FA to establish a reverse tunnel to the MS's HA. (Step 3)

[0085] The Packet Data Serving Node (PDSN)/FA generates a RADIUS Access-Request conveying MS's NAI, FAC authenticator, FAC, HA address, etc. [IS-835]. Because the domain name of the MS's NAI indicates a GPRS system, the Packet Data Serving Node (PDSN)/FA sends a RADIUS Access-Request to the IIF via the AAA in the CDMA2000 system. The IIF may modify the message in accordance with [3GPP TS 29.061]. (Step 4) If the authentication is successful, the home AAA server responds with the RADIUS Access-Accept. The message is routed back to the Packet Data Serving Node (PDSN) via IIF and visited AAA. The IIF may modify the message in accordance with [P.S0001-A V3.0]. (Step 5) The Packet Data Serving Node (PDSN)/FA forwards the Mobile IP Registration Request to the HA function in the IIF. The IIF verifies the MS-HA authenticator in the Mobile IP Registration Request. (Step 6)

[0086] If the authentication is successful, the IIF Serving GPRS Support Node (SGSN) functionality establishes GTP tunnels with a Gateway GPRS Support Node (GGSN) in the home GPRS system and can request an IP address from the GGSN. The IIF Serving GPRS Support Node (SGSN) functionality derives an APN that has the format <Network ID>.mnc<MNC>.mcc<MCC>.gprs [TS 23.003]. The <Network ID> is the realm portion of the MS's NAI and indicates which Gateway GPRS Support Node (GGSN) the MS wants to access for the requested service. The <MNC> and <MCC> are derived from the MS's IMSI. The MS's NAI and IMSI are available from the RADIUS Access-Request in step 4. The Serving GPRS Support Node (SGSN) functionality uses the derived APN as the lookup name to query GPRS DNS server (not shown in the figure) and from it obtains a list of available GGSNs that can be used to support the requested service. The IIF Serving GPRS Support Node (SGSN) functionality sends the Create PDP Context Request to the selected GGSN. The Requested PDP Address in the message is set to 0.0.0.0 to request a new IP address. (Step 7) The Gateway GPRS Support Node (GGSN) responds with the Create PDP Context Response including the new IP address assigned to the MS. (Step 8) The IIF acts as the HA and sends the Mobile IP Registration Reply to the MS via the Packet Data Serving Node (PDSN)/FA. The Home Address field in the Mobile IP Registration Reply can be set to the IP address assigned by the GGSN. (Step 9) The Packet Data Serving Node (PDSN) sends the RADIUS Accounting-Request (Start) containing 3GPP2 packet data accounting information [P.S0001-A V3.0]. Because the domain name of the MS's NAI indicates a GPRS system, the RADIUS Accounting-Request (Start) is routed to the home AAA in the GPRS system via the visited AAA and IIF. The IIF may modify the message in accordance with [3GPP TS 29.061]. (Step 10) The IIF acts as the RADIUS server and replies with the RADIUS Accounting-Response (Start). (Step 11)

[0087] Bearer traffic traverses through the IIF in both directions. For routing MS-originated packets, the IIF routes packets received from the Mobile IP reverse tunnel to the MS's GTP tunnel (identified by a TEID). For routing MS-terminated packets, the IIF routes packets received from the GTP tunnel to a HA-to-FA tunnel. IPsec can be used to protect the Mobile IP tunnels between Packet Data Serving Node (PDSN)/FA and IIF, and the GTP tunnels between IIF and GGSN. (Step 12)

IIF/AAA Requirements for CDMA2000 Packet Data Foreign Mode with Mobile IP

- [0088] The IIF requirements to process the RADIUS Access-Request received from the visited CDMA2000 packet data system will now be described.
- [0089] The IIF proxies all IETF RADIUS attributes without modification, except the Calling-Station-ID attribute, Called-Station-ID attribute, and Framed-Protocol attribute. The processing of these three attributes is described below. If the Calling-Station-ID attribute in the received RADIUS Access-Request contains IMSI, the IIF copies the IMSI into the 3GPP-IMSI attribute [3GPP TS 29.061] and include it in the RADIUS Access-Request destined for the MS's home GPRS system. The IIF does not include the Calling-Station-ID attribute in the RADIUS Access-Request sent to the home AAA in the GPRS system. If the Calling-Station-ID attribute in the received RADIUS Access-Request contains MIN or IRM, the IIF maps it to the MS's IMSI used in the home GPRS system and include it in the 3GPP-IMSI attribute of the RADIUS Access-Request destined for the home GPRS system. The IIF does not include the Calling-Station-ID attribute in the RADIUS Access-Request sent to the home AAA in the GPRS system.
- [0090] The IIF includes the Called-Station-ID attribute in the RADIUS Access-Request destined for the MS's home GPRS system. The Value field of the Called-Station-ID attribute is set to the APN (see section 8.3.4). If the Framed-Protocol attribute is included in the received RADIUS Access-Request, the IIF overrides the value to 7 [3GPP TS 29.061]. The IIF removes all 3GPP2 VSAs from the received RADIUS Access-Request. The IIF is not required to include any 3GPP VSAs, except the 3GPP-IMSI attribute, in the transmitted RADIUS Access-Request destined for the MS's home GPRS system.
- [0091] The IIF requirements to process the RADIUS Access-Accept received from the MS's home GPRS system will now be described.
- [0092] The IIF proxies all IETF RADIUS attributes without modification. The IIF removes all 3GPP VSAs from the received RADIUS Access-Accept, before transmitting the RADIUS Access-Accept to the visited CDMA2000 packet data system.
- [0093] If the policy of the home GPRS system requires the roaming MS's data traffic to traverse through the home GPRS system via the IIF, and the HA-Address VSA was included in the corresponding RADIUS Access-Request received earlier from the

visited CDMA2000 packet data system, the IIF includes the Reverse-Tunnel-Specification VSA in the transmitted RADIUS Access-Accept destined for the visited CDMA2000 packet data system. The value field of the VSA is set to 1 indicating that reverse tunneling is required.

[0094] The IIF requirements to process the RADIUS Accounting-Request START and Accounting-Request INTERIM are the same as the requirements to process the RADIUS Access-Request.

[0095] The IIF requirements to process the RADIUS Accounting-Request STOP are the same as the requirements to process the RADIUS Access-Request with the following additional requirements: If the Session-Continue VSA is set to FALSE in the received RADIUS Accounting-Request STOP, and if the IIF has not previously received an Accounting-Request (Start) from another Packet Data Serving Node (PDSN) with the same IP Address (for the case of inter-PDSN handoff with Mobile IP), the IIF inserts the 3GPP-Session-Stop-Indicator VSA to indicate that the PDP session has been terminated.

#### CDMA2000 Packet Data Foreign Mode with Simple IP

[0096] FIG. 5A is an exemplary block diagram of a CDMA2000 packet data foreign mode with Simple IP. This section describes the roaming scenario where a GPRS native subscriber operates IPv4 or IPv6 in the CDMA2000 packet data foreign mode. FIG. 5A also depicts the functions and control interface provided by the interface 30 or "IIF" in this case. In this embodiment, the home system 10 can be a GPRS system wherein a GPRS native subscriber roams to a CDMA 2000 packet data system and uses Mobile IPv4. The home system 10 comprises a GSM home location register 124, a Gateway GPRS Support Node (GGSN) 126, and an AAA entity 128. The visited system 20 can be a CDMA 2000 packet data system that comprises a ANSI-41 visited location register 111, an AAA entity 116, and a home system 109.

[0097] The interface 30 or "IIF" comprises an ANSI-41 home location register 131 coupled to the ANSI-41 visited location register 111 via a D interface 113, a GSM visited location register 133 coupled to the GSM home location register 124 via a D interface 121, a Serving GPRS Support Node (SGSN) 137 coupled to the Gateway GPRS Support Node (GGSN) 126 via a Gp interface 127, an AAA entity 140 coupled to the AAA entity 128 via a X4 interface 129 and coupled to the AAA entity 116 via a X3

interface 117, and a LCS entity 139 coupled to the packet data serving node/ LAC entity 109 via an X2 interface 119. The IIF provides both GSM VLR and ANSI-41 HLR emulation to allow the subscriber to register. This interworking can be provided over the interface reference "D." The IIF provides LNS and Serving GPRS Support Node (SGSN) emulation to support bearer connectivity between the visited and home networks via the IIF. This interworking can be provided over the interface reference "X2" and "Gn." The IIF provides AAA emulation to interact with the visited network's AAA for L2TP authentication and 3GPP2 packet data accounting. The IIF also may interact with the home network's AAA for 3GPP packet data accounting. This interworking can be provided over the interface reference "X3" and "X4." The IIF/AAA requirements for CDMA2000 packet data foreign mode with Simple IP will be described below in greater detail.

[0098] If bearer connectivity between the visited CDMA2000 packet data system and home GPRS system is not required, the X2 and Gp interface are not required. In this case, both mobile-originated and mobile-terminated data traffic is routed to/from the Internet via the Packet Data Serving Node (PDSN) in the visited system. The interface X3 and X4 are required for the IIF to interwork AAA messages between the CDMA2000 AAA server and GPRS AAA server.

[0099] Thus, for a user homed in a GSM system roaming to a CDMA Simple IP system, the IIF may present a L2TP Network Server (LNS) interface to the CDMA system and a Serving GPRS Support Node (SGSN) interface to the GSM system. A subset of Serving GPRS Support Node (SGSN) functions is required including APN resolution. The IIF may serve as the endpoint for the Mobile L2TP and GTP tunnels, with a packet routing function between the LNS and Serving GPRS Support Node (SGSN) functions.

[00100] FIG. 5B is an exemplary call flow diagram that shows Simple IP operation in the CDMA2000 packet data foreign mode. This call flow example illustrates a roaming scenario where a GPRS native subscriber operates Simple IP in the CDMA2000 packet data foreign mode. In this example, the MS has shared secrets with the home AAA in the GPRS system for CHAP authentication. The home GPRS system dynamically assigns an IP address to the MS. All MS's data traffic (MS-originated and mobile-terminated) traverses through the IIF and home GPRS system. The IIF receives 3GPP2

accounting records from the visited CDMA2000 system and maps it to 3GPP accounting records and forward it to the home GPRS system via RADIUS.

[00101] The MS originates SO 33 and initiates PPP LCP negotiation with the Packet Data Serving Node (PDSN)/LAC. CHAP can be negotiated as the protocol for PPP authentication. (Step 1) Packet Data Serving Node (PDSN)/LAC sends a CHAP challenge to the MS. (Step 2) The MS replies with its NAI and a challenge response computed based on the challenge and the secret shared with the home AAA in the GPRS system. The Packet Data Serving Node (PDSN)/LAC sends RADIUS Access-Request. Because the domain name of the MS's NAI indicates a GPRS system, the RADIUS Access-Request can be routed through the visited AAA and IIF that proxies the message to the home AAA in the GPRS system. The IIF may modify the message in accordance with [3GPP TS 29.061]. (Step 3) If the authentication is successful, the home AAA responds with the RADIUS Access-Accept. The message can be routed back to the Packet Data Serving Node (PDSN)/LAC via the IIF and visited AAA. The IIF inserts the Tunnel-Server-Endpoint attribute in the RADIUS Access-Accept. This attribute informs the Packet Data Serving Node (PDSN)/LAC to establish a L2TP tunnel with the IIF that acts as the LNS. The Packet Data Serving Node (PDSN)/LAC sends the CHAP Success to inform the MS about the successful authentication. (Step 4)

[00102] The Packet Data Serving Node (PDSN)/LAC establishes a L2TP tunnel/session with the IIF that acts as the LNS. During the L2TP tunnel/session establishment, the Packet Data Serving Node (PDSN)/LAC forwards the LCP information (exchanged between the MS and Packet Data Serving Node (PDSN)/LAC) to the IIF. The IIF LNS functionality may initiate CHAP challenge (not shown in the figure) to authenticate the MS before IPCP negotiation. (Step 5) The IIF Serving GPRS Support Node (SGSN) functionality establishes GTP tunnels with a Gateway GPRS Support Node (GGSN) in the home GPRS system and can request an IP address from the GGSN. The IIF derives an APN that has the format <Network ID>.mnc<MNC>.mcc<MCC>.gprs. The <Network ID> is the realm portion of the MS's NAI and is used to indicate which Gateway GPRS Support Node (GGSN) the MS wants to access for the requested service. The <MNC> and <MCC> are derived from the MS's IMSI. The MS's NAI and IMSI are available from the RADIUS Access-Request in step 3. The IIF Serving GPRS Support Node (SGSN) functionality uses the derived APN as the lookup name to query GPRS DNS server (not shown in the figure) and obtains a list of available

GGSNs that can be used to support the requested service. The IIF Serving GPRS Support Node (SGSN) functionality sends the Create PDP Context Request to the selected GGSN. The Requested PDP Address in the message is set to 0.0.0.0 to request a new IP address. (Step 6) The Gateway GPRS Support Node (GGSN) responds with the Create PDP Context Response including the new IP address assigned to the MS. (Step 7)

[00103] This new IP address can be assigned to the MS during the PPP IPCP negotiation between the IIF and MS. (Step 8) The Packet Data Serving Node (PDSN)/FA sends the RADIUS Accounting-Request (Start) containing 3GPP2 packet data accounting information [IS-835]. The Packet Data Serving Node (PDSN) sends the RADIUS Accounting-Request (Start) containing 3GPP2 packet data accounting information [P.S0001-A V3.0]. Because the domain name of the MS's NAI indicates a GPRS system, the RADIUS Accounting-Request (Start) is routed to the home AAA in the GPRS system via the visited AAA and IIF. The IIF may modify the message in accordance with [3GPP TS 29.061]. (Step 9) The home AAA replies with the RADIUS Accounting-Response (Start) that is routed back to the Packet Data Serving Node (PDSN) via IIF and visited AAA. (Step 10)

[00104] Bearer traffic traverses through the IIF in both directions. For routing MS-originated packets, the IIF routes packets received from the MS's L2TP tunnel/session to the MS's GTP tunnel (identified by a TEID). For routing MS-terminated packets, the IIF routes packets received from the MS's GTP tunnel to the MS's L2TP tunnel/session. IPsec can be used to protect the L2TP tunnel/session between Packet Data Serving Node (PDSN)/LAC and IIF, and the GTP tunnels between IIF and GGSN. (Step 11)

#### IIF/AAA Requirements for CDMA2000 Packet Data Foreign Mode with Simple IP

[00105] The IIF requirements to process the RADIUS Access-Request are the same as the requirements to process the RADIUS Access-Request for the CDMA2000 Packet Data Foreign Mode with Mobile IP, described above.

[00106] The IIF requirements to process the RADIUS Access-Accept are similar to the requirements for processing the RADIUS Access-Accept for the CDMA2000 Packet Data Foreign Mode with Mobile IP, however, if the policy of the home GPRS system requires the roaming MS's data traffic to traverse through the home GPRS system via

the IIF, and the HA-Address VSA was not included in the corresponding RADIUS Access-Request received earlier from the visited CDMA2000 packet data system, the IIF inserts the Tunnel-Server-Endpoint, Tunnel-Type, and Tunnel-Medium-Type attributes in the transmitted RADIUS Access-Accept destined for the visited CDMA2000 packet data system. The Tunnel-Server-Endpoint attribute indicates the IIF/LNS address. The Tunnel-Type attribute indicates L2TP. The Tunnel-Medium-Type attribute indicate IPv4.

[00107] The IIF requirements to process the RADIUS Accounting-Request START and Accounting-Request INTERIM are the same as the requirements to process the RADIUS Accounting-Request START and Accounting-Request INTERIM for the CDMA2000 Packet Data Foreign Mode with Mobile IP, described above.

[00108] The IIF requirements to process the RADIUS Accounting-Request STOP are the substantially the same as the requirements to process the RADIUS Accounting-Request STOP for the CDMA2000 Packet Data Foreign Mode with Mobile IP, however, if the Session-Continue VSA is set to FALSE in the received RADIUS Accounting-Request STOP, and the IP-Technology VSA indicates Simple IP, the IIF inserts the 3GPP-Session-Stop-Indicator VSA to indicate that the PDP session has been terminated.

[00109] Those of skill in the art would understand that information and signals may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the above description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

[00110] Those of skill would further appreciate that the various illustrative logical blocks, modules, circuits, and algorithm steps described in connection with the embodiments disclosed herein may be implemented as electronic hardware, computer software, or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality can be implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application,

but such implementation decisions should not be interpreted as causing a departure from the scope of the present invention.

[00111] The various illustrative logical blocks, modules, and circuits described in connection with the embodiments disclosed herein may be implemented or performed with a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

[00112] The steps of a method or algorithm described in connection with the embodiments disclosed herein may be embodied directly in hardware, in a software module executed by a processor, or in a combination of the two. A software module may reside in RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, hard disk, a removable disk, a CD-ROM, or any other form of storage medium known in the art. An exemplary storage medium can be coupled to the processor such the processor can read information from, and write information to, the storage medium. In the alternative, the storage medium may be integral to the processor. The processor and the storage medium may reside in an ASIC. The ASIC may reside in a user terminal. In the alternative, the processor and the storage medium may reside as discrete components in a user terminal.

[00113] The previous description of the disclosed embodiments can be provided to enable any person skilled in the art to make or use the present invention. Various modifications to these embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments without departing from the spirit or scope of the invention. Thus, the present invention can be not intended to be limited to the embodiments shown herein but can be to be accorded the widest scope consistent with the principles and novel features disclosed herein.

**WHAT IS CLAIMED IS:**

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CLAIMS:

1. A method in which a CDMA (Code Division Multiple Access) 2000 packet data native subscriber using Mobile IPv4 (Internet Protocol version 4) roams from a home CDMA 2000 packet data system to a visited GPRS (General  
5 Packet Radio Service) system comprising a SGSN (Serving GPRS Support Node), comprising:  
  
coupling the home system to the visited system to enable communication between the home system and the visited system,  
  
wherein the home CDMA 2000 packet data system comprises a  
10 ANSI (American National Standards Institute)-41 home location register, an AAA (Authentication, Authorization, and Accounting) entity, and a home agent; and  
  
providing a distinct interface for each of the ANSI-41 home Location register, the AAA entity, and the home agent.
2. A method according to claim 1, wherein the home CDMA 2000  
15 packet data system comprises a ANSI-41 home location register, an AAA entity, and a home agent, further comprising:  
  
allowing a subscriber to register over a first interface; and  
  
allowing the subscriber to register over a second interface.
3. A method according to claim 1, further comprising:  
20 supporting bearer connectivity between the visited system and the home system such that a foreign agent interface and an AAA interface are presented to the CDMA 2000 packet data system over a third interface; and  
  
supporting bearer connectivity between the visited system and the home system such that a GGSN (Gateway GPRS Support Node) interface is  
25 presented to the visited system over a fourth interface.

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4. A method according to claim 3, further comprising:  
providing an endpoint for a GTP (GPRS Tunneling Protocol) tunnel and a Mobile IP tunnel.
5. A method according to claim 4, further comprising:  
5 providing a packet routing function between the GGSN interface and a foreign agent interface.
6. A method according to claim 1, further comprising:  
providing an accounting function by interacting with a home network's AAA for Mobile IP Foreign Agent challenge authentication and 3GPP2 (3rd  
10 Generation Partnership Project 2) packet data accounting.
7. A method in which a CDMA(Code Division Multiple Access) 2000 packet data native subscriber using Simple IP roams from a home CDMA 2000 packet data system to a visited GPRS (General Packet Radio Service) system comprising a SGSN, (Serving GPRS Support Node) comprising:  
15 coupling the home system to the visited system to enable communication between the home system and the visited system,  
wherein the home CDMA 2000 packet data system comprises a ANSI-41 home location register, an AAA (Authentication, Authorization, and Accounting)  
entity, and a LNS (Layer 2 Tunneling Protocol Network Server); and  
20 providing a distinct interface for each of the ANSI-41 home location register, the AAA entity, and LNS.
8. A method according to claim 7, further comprising:  
allowing a subscriber to register over a first interface; and  
allowing the subscriber to register over a second interface.

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9. A method according to claim 8, further comprising:

supporting bearer connectivity between the visited and home networks over a third interface; and

5 supporting bearer connectivity between the visited and home networks over a fourth interface by presenting a GGSN interface to the visited system and presenting a normal routing interface to the CDMA 2000 packet data system to thereby provide a packet routing function between the GGSN interface and the home system.

10. A method according to claim 9, further comprising:

10 providing an endpoint for a GTP tunnel and an IPSec tunnel.

11. A method according to claim 10, further comprising:

providing an accounting function by interacting with the home network's AAA for L2TP (Layer 2 Tunneling Protocol) authentication and 3GPP2 packet data accounting over a fifth interface.

15 12. A method in which a GPRS (General Packet Radio Service) native subscriber using Mobile IPv4 (Internet Protocol version 4) roams from a home GPRS system to a visited CDMA (Code Division Multiple Access) 2000 packet data system that comprises an ANSI-41 visited location register, an AAA (Authentication, Authorization, and Accounting) entity, and a packet data serving  
20 node/foreign agent, comprising:

coupling the home system to the visited system to enable communication between the home system and the visited system,

wherein the home GPRS system comprises a GSM home location register, a GGSN, and an AAA entity; and

25 providing a distinct interface for each of the GSM home location register, the GGSN, and the AAA entity.

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13. A method according to claim 12, further comprising:

presenting a home agent interface to the visited system; and

presenting a SGSN interface to the home system to support bearer connectivity between the visited and home networks by providing a packet routing  
5 function between the SGSN interface and the home agent interface.

14. A method according to claim 13, further comprising:

providing endpoints for a GTP tunnel and a Mobile IP tunnel.

15. A method according to claim 13, further comprising:

allowing a subscriber to register.

10 16. A method according to claim 15, further comprising:

interacting with the visited network's AAA for Mobile IP authentication and 3GPP2 packet data accounting over a fifth interface; and

interacting with the home network's AAA for 3GPP packet data accounting over a fourth interface.

15 17. A method in which a GPRS (General Packet Radio Service) native subscriber using Simple IP roams from home GPRS system to a visited CDMA 2000 packet data system that comprises a ANSI-41 visited location register, a AAA (Authentication, Authorization, and Accounting) entity, and a PDSN/LAC (Packet Data Serving Node/Layer 2 Tunneling Protocol Access Concentrator)  
20 entity, comprising:

coupling the home system to the visited system to enable communication between the home system and the visited system,

wherein the GPRS system comprises a GSM home location register, a GGSN, and an AAA entity; and

25 providing a distinct interface for each of the GSM home location register, the GGSN, and the AAA entity.

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18. A method according to claim 17, further comprising:

supporting bearer connectivity between the visited and home networks by providing a packet routing function.

19. A method according to claim 18, further comprising:

5 presenting a SGSN interface to the home system;

presenting a L2TP Network Server (LNS) interface to the visited system; and

providing the packet routing function between a SGSN emulation module and a LNS emulation module.

10 20. A method according to claim 19, further comprising:

providing endpoints for a GTP tunnel and a Mobile L2TP tunnel.

21. A method according to claim 20, further comprising:

allowing a subscriber to register.

22. A method according to claim 21, further comprising:

15 interacting with the visited network's AAA entity, over a fifth interface, for L2TP authentication and 3GPP2 packet data accounting; and

interacting with the home network's AAA entity, over a sixth interface, for 3GPP packet data accounting.

23. A system in which a CDMA (Code Division Multiple Access) 2000

20 packet data native subscriber using Mobile IPv4 (Internet Protocol version 4) roams to a visited GPRS (General Packet Radio Service) system comprising a SGSN (Serving GPRS Support Node), comprising:

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a home CDMA 2000 packet data system comprising a ANSI-41 home location register, an AAA (Authentication, Authorization, and Accounting) entity, and a home agent; and

an interface entity that couples the home system to the visited system to enable communication between the home system and the visited system,

wherein the interface entity includes a distinct interface for each of the ANSI-41 home location register, the AAA entity, and the home agent.

24. A system according to claim 23, wherein the home CDMA 2000 packet data system comprises a ANSI-41 home location register, an AAA entity, and a home agent, and wherein the interface entity further comprises:

a GSM home location register emulation module, coupled to the SGSN via a first interface, that allows a subscriber to register over a first interface; and

an ANSI-41 visited location register emulation module, coupled to the ANSI-41 home location register via a second interface, that allows a subscriber to register over the second interface.

25. A system according to claim 23, wherein the interface entity further comprises:

a foreign agent emulation module, coupled to the home agent via a third interface, that supports bearer connectivity between the visited system and the home system such that a foreign agent interface and an AAA interface are presented to the CDMA 2000 packet data system over the third interface; and

a GGSN emulation module, coupled to the SGSN via a fourth interface, that supports bearer connectivity between the visited system and the home system such that a GGSN interface is presented to the visited system over the fourth interface.

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26. A system according to claim 25, wherein the interface entity serves as an endpoint for a GTP tunnel and a Mobile IP tunnel.

27. A system according to claim 26, wherein the interface entity provides a packet routing function between the GGSN interface and the foreign agent  
5 interface.

28. A system according to claim 23, wherein the interface entity further comprises:

an AAA emulation module, coupled to the AAA entity via a fifth interface, that provides an accounting function by to interacting with a home  
10 network's AAA for Mobile IP Foreign Agent challenge authentication and 3GPP2 packet data accounting.

29 A system in which a CDMA (Code Division Multiple Access) 2000 packet data native subscriber using Simple IP roams to a visited GPRS (General Packet Radio Service) system comprising a SGSN (Serving GPRS Support  
15 Node), comprising:

a home CDMA 2000 packet data system that comprises: a ANSI-41 home location register, an AAA (Authentication, Authorization, and Accounting) entity, and a LNS; and

an interface entity that couples the home system to the visited  
20 system to enable communication between the home system and the visited system,

wherein the interface entity includes a distinct interface for each of the ANSI-41 home location register, the AAA entity, and the LNS.

30. A system according to claim 29, wherein the interface entity further  
25 comprises:

an ANSI-41 visited location register, coupled to the ANSI-41 home location register via a first interface, that allows a subscriber to register over the first interface, and

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a GSM home location register, coupled to the SGSN via a second interface, that allows a subscriber to register over the second interface.

31. A system according to claim 30, wherein the interface entity further comprises:

5 a LAC emulation module, coupled to the LNS via a third interface, that supports bearer connectivity between the visited and home networks over the third interface; and

a GGSN emulation module, coupled to the SGSN via a fourth interface, that supports bearer connectivity between the visited and home  
10 networks over the fourth interface by presenting a GGSN interface to the visited system and presenting a normal routing interface to the CDMA 2000 packet data system to thereby provide a packet routing function between the GGSN interface and the home system.

32. A system according to claim 31, wherein the interface serves as an  
15 endpoint for a GTP tunnel and an IPSec tunnel.

33. A system according to claim 32, wherein the interface further comprises:

an AAA emulation module, coupled to the AAA entity via a fifth interface, that provides an accounting function by interacting with the home  
20 network's AAA for L2TP authentication and 3GPP2 packet data accounting over the fifth interface.

34. A system in which a GPRS (General Packet Radio Service) native subscriber using Mobile IPv4 (Internet Protocol version 4) roams to a visited CDMA (Code Division Multiple Access) 2000 packet data system that comprises  
25 an ANSI-41 visited location register, an AAA entity, and a packet data serving node/foreign agent, comprising:

a home GPRS system comprising a GSM home location register, a GGSN, and an AAA (Authentication, Authorization, and Accounting) entity; and

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an interface entity that couples the home system to the visited system, wherein the interface entity enables communication between the home system and the visited system,

wherein the interface entity includes a distinct interface for each of  
5 the GSM home location register, the GGSN, and the AAA entity.

35. A system according to claim 34, wherein the interface entity further comprises:

a home agent emulation module, coupled to the packet data serving node/foreign agent via an first interface, that presents a home agent interface to  
10 the visited system;

and a SGSN emulation module, coupled to the GGSN via a second interface, that presents a SGSN interface to the home system to support bearer connectivity between the visited and home networks by providing a packet routing function between the SGSN interface and the home agent interface.

15 36. A system according to claim 35, wherein the interface entity serves as an endpoint for a GTP tunnel and a Mobile IP tunnel.

37. A system according to claim 35, wherein the interface entity further comprises:

a ANSI-41 home location register emulation module, coupled to the  
20 ANSI-41 visited location register via a third interface; and

a GSM visited location register emulation module, coupled to the GSM home location register via a third interface, to allow a subscriber to register.

38. A system according to claim 37, wherein the interface entity further comprises:

25 a AAA emulation module, coupled to the AAA entity via a fourth interface and coupled to the AAA entity via a fifth interface, that interacts with:

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the visited network's AAA for Mobile IP authentication and 3GPP2 packet data accounting, over the fifth interface, and

the home network's AAA for 3GPR packet data accounting, over the fourth interface.

5 39. A system in which a GPRS (General Packet Radio Service) native subscriber using Simple IP roams to a visited CDMA (Code Division Multiple Access) 2000 packet data system that comprises a ANSI-41 visited location register, a AAA (Authentication, Authorization, and Accounting) entity, and a PDSN/LAC entity, comprising:

10 a home GPRS system comprising a GSM home location register, a GGSN (Gateway GPRS Support Node), and an AAA entity; and

an interface entity that couples the home system to the visited system, wherein the interface entity enables communication between the home system and the visited system, and

15 further wherein the interface entity includes a distinct interface for each of the GSM home location register, the GGSN, and the AAA entity.

40. A system according to claim 39, wherein the interface entity supports bearer connectivity between the visited and home networks by providing a packet routing function.

20 41. A system according to claim 40, wherein the interface entity further comprises:

a SGSN emulation module, coupled to the GGSN over a first interface, that presents a SGSN interface to the home system; and

25 a LNS emulation module, coupled to the packet data serving node/LAG entity over a second interface, that presents a L2TP Network Server (LNS) interface to the visited system,

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wherein the interface provides the packet routing function between the SGSN emulation module and the LNS emulation module.

42. A system according to claim 41, wherein the interface entity serves as an endpoint for a GTP tunnel and a Mobile L2TP tunnel

5 43. A system according to claim 42, wherein the interface entity further comprises:

a ANSI-41 home location register emulation module, coupled to the ANSI-41 visited location register via a third interface, that allows a subscriber to register; and

10 a GSM visited location register emulation module, coupled to the GSM home location register via another third interface, that allows the subscriber to register.

44. A system according to claim 43, wherein the interface entity further comprises:

15 an AAA emulation module, coupled to the AAA entity via a fourth interface and coupled to the AAA entity via a fifth interface, that interacts with:

the visited network's AAA entity, over a fifth interface, for L2TP authentication and 3GPP2 packet data accounting, and

20 the home network's AAA entity, over a sixth interface, for 3GPP packet data accounting.

45. An interface entity that enables communication between a home CDMA (Code Division Multiple Access) 2000 packet data system and a visited GPRS (General Packet Radio Service) system comprising a SGSN (Serving GPRS Support Node), when a CDMA 2000 packet data native subscriber using  
25 Mobile IPv4 (Internet Protocol version 4) roams to a visited GPRS system, wherein the home CDMA 2000 packet data system comprises an ANSI-41 home location register, an AAA (Authentication, Authorization, and Accounting) entity,

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and a home agent, and further wherein the interface entity includes a distinct interface for each of the ANSI-41 home location register, the AAA entity, and the home agent.

46. An interface entity according to claim 45, wherein the interface entity  
5 further comprises:

a GSM home location register emulation module, coupled to the SGSN via a first interface, that allows a subscriber to register over a first interface; and

10 an ANSI-41 visited location register emulation module, coupled to the ANSI-41 home location register via a second interface, that allows a subscriber to register over the second interface.

47. An interface entity according to claim 45, wherein the interface entity further comprises:

15 a foreign agent emulation module, coupled to the home agent via a third interface, that supports bearer connectivity between the visited interface entity and the home interface entity such that a foreign agent interface and an AAA interface are presented to the CDMA 2000 packet data system over the third interface; and

20 a GGSN emulation module, coupled to the SGSN via a fourth interface, that supports bearer connectivity between the visited interface entity and the home interface entity such that a GGSN interface is presented to the visited interface entity over the fourth interface.

48. An interface entity according to claim 47, wherein the interface entity serves as an endpoint for a GTP tunnel and a Mobile IP tunnel

25 49. An interface entity according to claim 48, wherein the interface entity provides a packet routing function between the GGSN interface and the foreign agent interface.

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50. An interface entity according to claim 45, wherein the interface entity further comprises:

an AAA emulation module, coupled to the AAA entity via a fifth interface, that provides an accounting function by to interacting with a home network's AAA for Mobile IP Foreign Agent challenge authentication and 3GPP2 packet data accounting.

51. An interface entity that enables communication between a home CDMA (Code Division Multiple Access) 2000 packet data system and a visited GPRS (General Packet Radio Service) system comprising a SGSN (Serving GPRS Support Node), when a CDMA 2000 packet data native subscriber using Simple IP roams to a visited GPRS system, wherein the home CDMA 2000 packet data system comprises an ANSI-41 home location register, an AAA (Authentication, Authorization, and Accounting) entity, and a LNS, and farther wherein the interface entity comprises a distinct interface for each of the ANSI-41 home location register, the AAA entity, and the LNS.

52. An interface entity according to claim 51, wherein the interface entity further comprises:

an ANSI-41 visited location register, coupled to the ANSI-41 home location register via a first interface, that allows a subscriber to register over the first interface: and

a GSM home location register, coupled to the SGSN via a second interface, that allows a subscriber to register over the second interface.

53. An interface entity according to claim 52, wherein the interface entity further comprises:

a LAC emulation module, coupled to the LNS via a third interface, that supports bearer connectivity between the visited and home networks over the third interface; and

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a GGSN emulation module, coupled to the SGSN via a fourth interface, that supports bearer connectivity between the visited and home networks over the fourth interface by presenting a GGSN interface to the visited system and presenting a normal routing interface to the CDMA 2000 packet data system to thereby provide a packet routing function between the GGSN interface and the home system.

54. An interface entity according to claim 53, wherein the interface entity serves as an endpoint for a GTP tunnel and an IPSec tunnel.

55. An interface entity according to claim 54, wherein the interface entity further comprises:

an AAA emulation module, coupled to the AAA entity via a fifth interface, that provides an accounting function by interacting with the home network's AAA for L2TP authentication and 3GPP2 packet data accounting over the fifth interface.

56. An interface entity that enables communication between a home GPRS (General Packet Radio Service) system comprising a GSM home location register, a GGSN, and an AAA (Authentication, Authorization, and Accounting) entity, and a visited CDMA (Code Division Multiple Access) 2000 packet data system that comprises an ANSI-41 visited location register, an AAA entity, and a packet data serving node/foreign agent, when a GPRS native subscriber using Mobile IPv4 roams to the visited CDMA 2000 packet data system, wherein the interface entity includes a distinct interface for each of the GSM home location register, the GGSN, and the AAA entity.

57. An interface entity according to claim 56, wherein the interface entity further comprises:

a home agent emulation module, coupled to the packet data serving node/foreign agent via a first interface, that presents a home agent interface to the visited system; and

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a SGSN emulation module, coupled to the GGSN via a second interface, that presents a SGSN interface to the home system to support bearer connectivity between the visited and home networks by providing a packet routing function between the SGSN interface and the home agent interface.

5 58. An interface entity according to claim 57, wherein the interface entity serves as an endpoint for a GTP tunnel and a Mobile IP tunnel.

59. An interface entity according to claim 57, wherein the interface entity further comprises:

10 a ANSI-41 home location register emulation module, coupled to the ANSI-41 visited location register via a third interface; and

a GSM visited location register emulation module, coupled to the GSM home location register via a third interface, to allow a subscriber to register.

60. An interface entity according to claim 59, wherein the interface entity further comprises:

15 a AAA emulation module, coupled to the AAA entity via a fourth interface and coupled to the AAA entity via a fifth interface, that interacts with:

the visited network's AAA for Mobile IP authentication and 3GPP2 packet data accounting, over the fifth interface, and

20 the home network's AAA for 3GPP packet data accounting, over the fourth interface.

61. An interface entity that enables communication between a home GPRS (General Packet Radio Service) system comprising a GSM home location register, a GGSN, and an AAA(Authentication, Authorization, and Accounting) entity, and a visited CDMA 2000 packet data system that comprises an ANSI-41  
25 visited location register, an AAA entity, and a packet data serving node/LAC entity, when a GPRS native subscriber using Simple IP roams to the visited CDMA 2000

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packet data system, wherein the interface entity includes a distinct interface for each of the GSM home location register, the GGSN, and the AAA entity.

62. An interface entity according to claim 61, wherein the interface entity supports bearer connectivity between the visited and home networks by providing  
5 a packet routing function.

63. An interface entity according to claim 62, wherein the interface entity further comprises:

a SGSN emulation module, coupled to the GGSN over a first interface, that presents a SGSN interface to the home system; and

10 a LNS emulation module, coupled to the packet data serving node/LAC entity over a second interface, that presents a L2TP Network Server (LNS) interface to the visited system,

wherein the interface provides the packet routing function between the SGSN emulation module and the LNS emulation module.

15 64. An interface entity according to claim 63, wherein the interface entity serves as an endpoint for a GTP tunnel and a Mobile L2TP tunnel.

65. An interface entity according to claim 64, wherein the interface entity further comprises:

20 a ANSI-41 home location register emulation module, coupled to the ANSI-41 visited location register via a third interface, that allows a subscriber to register; and

a GSM visited location register emulation module, coupled to the GSM home location register via another third interface, that allows the subscriber to register.

25 66. An interface entity according to claim 65, wherein the interface entity further comprises:

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an AAA emulation module, coupled to the AAA entity via a fourth interface and coupled to the AAA entity via a fifth interface, that interacts with:

the visited network's AAA entity, over a fifth interface, for L2TP authentication and 3GPP2 packet data accounting, and

5 the home network's AAA entity, over a sixth interface, for 3GPP packet data accounting.

67. An apparatus for enabling communications between a CDMA (Code Division Multiple Access) packet data system and a GPRS (General Packet Radio Service) system, wherein a CDMA 2000 packet data native subscriber using  
10 Mobile IPv4 (Internet Protocol version 4) roams from a home CDMA 2000 packet data system to a visited GPRS system comprising a SGSN (Serving GPRS Support Node), comprising:

means for coupling the home system to the visited system to enable communication between the home system and the visited system, wherein the  
15 home CDMA 2000 packet data system comprises a ANSI (American National Standards Institute)-41 home location register, an AAA (Authentication, Authorization, and Accounting) entity, and a home agent; and

means for providing a distinct interface for each of the ANSI-41 home location register, the AAA entity, and the home agent.

20 68. The apparatus according to claim 67, wherein the home CDMA 2000 packet data system comprises a ANSI-41 home location register, an AAA entity, and a home agent, further comprising:

means for allowing a subscriber to register over a first interface; and allowing the subscriber to register over a second interface.

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69. The apparatus according to claim 67, further comprising:

means for supporting bearer connectivity between the visited system and the home system such that a foreign agent interface and an AAA interface are presented to the CDMA 2000 packet data system over a third interface; and

5 means for supporting bearer connectivity between the visited system and the home system such that a GGSN (Gateway GPRS Support Node) interface is presented to the visited system over a fourth interface.

70. The apparatus according to claim 69, further comprising: means for providing an endpoint for a GTP (GPRS Tunneling Protocol) tunnel and a  
10 Mobile IP tunnel.

71. The apparatus according to claim 70, further comprising: means for providing a packet routing function between the GGSN interface and a foreign agent interface.

72. The apparatus according to claim 67, further comprising:  
15 means for providing an accounting function by interacting with a home network's AAA for Mobile IP Foreign Agent challenge authentication and 3GPP2 (3rd Generation Partnership Project 2) packet data accounting.

73. An apparatus for enabling communications between a CDMA (Code Division Multiple Access) packet data system and a GPRS (General Packet Radio  
20 Service) system, wherein a CDMA 2000 packet data native subscriber using Simple IP roams from a home CDMA 2000 packet data system to a visited GPRS system comprising a SGSN, (Serving GPRS Support Node) comprising:

means for coupling the home system to the visited system to enable communication between the home system and the visited system,

25 wherein the home CDMA 2000 packet data system comprises a ANSI-41 home location register, an AAA (Authentication, Authorization, and Accounting) entity, and a LNS (Layer 2 Tunneling Protocol Network Server); and

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means for providing a distinct interface for each of the ANSI-41 home location register, the AAA entity, and LNS.

74. The apparatus according to claim 73, further comprising: means for allowing a subscriber to register over a first interface; and allowing the subscriber  
5 to register over a second interface.

75. The apparatus according to claim 74, further comprising:

means for supporting bearer connectivity between the visited and home networks over a third interface; and

means for supporting bearer connectivity between the visited and  
10 home networks over a fourth interface by presenting a GGSN interface to the visited system and presenting a normal routing interface to the CDMA 2000 packet data system to thereby provide a packet routing function between the GGSN interface and the home system.

76. The apparatus according to claim 75, further comprising: means for  
15 providing an endpoint for a GTP tunnel and an IPSec tunnel.

77. The apparatus according to claim 76, further comprising:

means for providing an accounting function by interacting with the home network's AAA for L2TP (Layer 2 Tunneling Protocol) authentication and 3GPP2 packet data accounting over a fifth interface.

20 78. An apparatus for enabling communications between a CDMA (Code Division Multiple Access) packet data system and a GPRS (General Packet Radio Service) system, wherein a GPRS native subscriber using Mobile IPv4 (Internet Protocol version 4) roams from a home GPRS system to a visited CDMA 2000 packet data system that comprises an ANSI-41 visited location register, an AAA  
25 (Authentication, Authorization, and Accounting) entity, and a packet data serving node/foreign agent, comprising:

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means for coupling the home system to the visited system to enable communication between the home system and the visited system,

wherein the home GPRS system comprises a GSM home location register, a GGSN, and an AAA entity; and

5 means for providing a distinct interface for each of the GSM home location register, the GGSN, and the AAA entity.

79. The apparatus according to claim 78, further comprising:

means for presenting a home agent interface to the visited system;  
and

10 means for presenting a SGSN interface to the home system to support bearer connectivity between the visited and home networks by providing a packet routing function between the SGSN interface and the home agent interface.

80. The apparatus according to claim 79, further comprising: means for  
15 providing endpoints for a GTP tunnel and a Mobile IP tunnel.

81. The apparatus according to claim 79, further comprising: means for allowing a subscriber to register.

82. The apparatus according to claim 81, further comprising:

20 means for interacting with the visited network's AAA for Mobile IP authentication and 3GPP2 packet data accounting over a fifth interface; and

means for interacting with the home network's AAA for 3 GPP packet data accounting over a fourth interface.

83. An apparatus for enabling communications between a CDMA (Code  
Division Multiple Access) packet data system and a GPRS (General Packet Radio  
25 Service) system, wherein a GPRS native subscriber using Simple IP roams from home GPRS system to a visited CDMA 2000 packet data system that comprises a

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ANSI-41 visited location register, a AAA (Authentication, Authorization, and Accounting) entity, and a PDSN/LAC (Packet Data Serving Node/Layer 2 Tunneling Protocol Access Concentrator) entity, comprising:

means for coupling the home system to the visited system to enable  
5 communication between the home system and the visited system,

wherein the home GPRS system comprises a GSM home location register, a GGSN, and an AAA entity; and

means for providing a distinct interface for each of the GSM home location register, the GGSN, and the AAA entity.

10 84. The apparatus according to claim 83, further comprising:

means for supporting bearer connectivity between the visited and home networks by providing a packet routing function.

85. The apparatus according to claim 84, further comprising:

means for presenting a SGSN interface to the home system;

15 means for presenting a L2TP Network Server (LNS) interface to the visited system; and

means for providing the packet routing function between a SGSN emulation module and a LNS emulation module.

86. The apparatus according to claim 85, further comprising: means for  
20 providing endpoints for a GTP tunnel and a Mobile L2TP tunnel.

87. The apparatus according to claim 86, further comprising: allowing a subscriber to register.

88. The apparatus according to claim 87, further comprising:

means for interacting with the visited network's AAA entity, over an  
25 fifth interface, for L2TP authentication and 3GPP2 packet data accounting; and

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means for interacting with the home network's AAA entity, over an sixth interface, for 3GPP packet data accounting.

89. An apparatus for enabling communication between a home CDMA 2000 packet data system and a visited GPRS (General Packet Radio Service) system comprising a SGSN (Serving GPRS Support Node), when a  
5 CDMA 2000 packet data native subscriber using Mobile IPv4 roams to a visited GPRS system, the method comprising:

means for allowing a subscriber to register over a first interface that couples a GSM home location register emulation module to the SGSN; and

- 10 means for allowing the subscriber to register over a second interface that couples an ANSI-41 visited location register emulation module to a ANSI-41 home location register.

90. The apparatus according to claim 89, wherein the home CDMA 2000 packet data interface entity comprises a ANSI-41 home location register, an AAA  
15 entity, and a home agent.

91. The apparatus according to claim 89, further comprising:

- means for coupling the home agent to a foreign agent emulation module via a third interface, wherein the foreign agent emulation module supports bearer connectivity between the visited interface entity and the home interface  
20 entity such that a foreign agent interface and an AAA interface are presented to the CDMA 2000 packet data interface entity over the third interface; and

- means for coupling a GGSN emulation module to the SGSN via a fourth interface, wherein the GGSN emulation module supports bearer connectivity between the visited interface entity and the home interface entity such  
25 that a GGSN interface is presented to the visited interface entity over the fourth interface.

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92. The apparatus according to claim 91, further comprising:

means for providing endpoints for a GTP tunnel and a Mobile IP tunnel.

93. The apparatus according to claim 92, further comprising:

5 means for providing a packet routing function between the GGSN interface and the foreign agent interface.

94. The apparatus according to claim 89, further comprising:

means for coupling an AAA emulation module to the AAA entity via a fifth interface,

10 wherein the AAA emulation module provides an accounting function by interacting with a home network's AAA for Mobile IP Foreign Agent challenge authentication and 3GPP2 packet data accounting.

95. An apparatus that enables communication between a home CDMA (Code Division Multiple Access) 2000 packet data system and a visited GPRS

15 (General Packet Radio Service) system comprising a SGSN (Serving GPRS Support Node), when a CDMA 2000 packet data native subscriber using Simple IP roams to a visited GPRS system, wherein the home CDMA2000 packet data system comprises a ANSI-41 home location register, an AAA entity, and a LNS, comprising:

20 means for coupling an ANSI-41 visited location register to the ANSI-41 home location register via a first interface, wherein the ANSI-41 visited location register allows a subscriber to register over the first interface; and

means for coupling a GSM home location register to the SGSN via a second interface, wherein the GSM home location register allows a subscriber to  
25 register over the second interface.

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96. The apparatus according to claim 95, further comprising:

means for coupling a LAC (Layer 2 Tunneling Protocol Access Concentrator) emulation module to the LNS (Layer 2 Tunneling Protocol Network Server) via an third interface, wherein the LAC emulation module supports bearer  
5 connectivity between the visited and home networks over the third interface; and

means for coupling a GGSN emulation module to the SGSN via a fourth interface, wherein the GGSN emulation module supports bearer connectivity between the visited and home networks over the fourth interface by:

means for presenting a GGSN interface to the visited system; and

10 means for presenting a normal routing interface to the CDMA 2000 packet data system to thereby provide a packet routing function between the GGSN interface and the home system.

97. The apparatus according to claim 95, further comprising: means for providing endpoints for a GTP tunnel and an IPSec tunnel.

15 98. The apparatus according to claim 97, further comprising:

means for coupling an AAA emulation module to the AAA entity via a fifth interface, wherein the AAA emulation module provides an accounting function by:

20 means for interacting with the home network's AAA for L2TP authentication and 3GPP2 packet data accounting over the fifth interface.

99. An apparatus that enables communication between a home GPRS (General Packet Radio Service) system comprising a GSM home location register, a GGSN, and an AAA (Authentication, Authorization, and Accounting) entity; and a visited CDMA 2000 packet data system that comprises an ANSI-41 visited  
25 location register, an AAA entity, and a packet data serving node/foreign agent, when a GPRS native subscriber using Mobile IPv4 (Internet Protocol version 4) roams to the visited CDMA 2000 packet data system, comprising:

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means for coupling a home agent emulation module to the packet data serving node/foreign agent via a first interface, wherein the home agent emulation module presents a home agent interface to the visited system; and

5 means for coupling a SGSN emulation module to the GGSN via a second interface, wherein the SGSN emulation module presents a SGSN interface to the home system to support bearer connectivity between the visited and home networks by providing a packet routing function between the SGSN interface and the home agent interface.

100. The apparatus according to claim 99, further comprising:

10 means for providing endpoints for a GTP tunnel and a Mobile IP tunnel.

101. The apparatus according to claim 99, further comprising:

means for coupling a ANSI-41 home location register emulation module to the ANSI-41 visited location register via a third interface; and

15 means for coupling a GSM visited location register emulation module to the GSM home location register via a third interface to allow a subscriber to register.

102. The apparatus according to claim 101, further comprising:

20 means for coupling a AAA emulation module to the AAA entity via a fourth interface and to the AAA entity via a fifth interface, wherein the AAA emulation module interacts with:

the visited network's AAA for Mobile IP authentication and 3GPP2 packet data accounting, over the fifth interface, and

25 the home network's AAA for 3GPP packet data accounting, over the fourth interface.

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103. An apparatus that enables communication between a home GPRS (General Packet Radio Service) system comprising a GSM home location register, a GGSN, and an AAA (Authentication, Authorization, and Accounting) entity, and a visited CDMA 2000 packet data system that comprises an ANSI-41 visited location register, an AAA entity, and a packet data serving node/LAC entity, when a GPRS native subscriber using Simple IP roams to the visited CDMA 2000 packet data system, comprising:

means for coupling a SGSN emulation module to the GGSN over a first interface, wherein the SGSN emulation module presents a SGSN interface to the home system; and

means for coupling a LNS emulation module to the packet data serving node/LAC entity over a second interface, wherein the LNS emulation module presents a L2TP Network Server (LNS) interface to the visited system,

wherein the interface provides the packet routing function between the SGSN emulation module and the LNS emulation module.

104. The apparatus according to claim 103, wherein bearer connectivity is supported between the visited and home networks by providing a packet routing function.

105. The apparatus according to claim 104, further comprising: means for providing endpoints for a GTP tunnel and a Mobile L2TP tunnel.

106. The apparatus according to claim 104, further comprising:

means for coupling a ANSI-41 home location register emulation module to the ANSI-41 visited location register via a third interface, wherein the ANSI-41 home location register emulation module allows a subscriber to register; and

means for coupling a GSM visited location register emulation module to the GSM home location register via another third interface,

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wherein the GSM visited location register emulation module allows the subscriber to register.

107. The apparatus according to claim 106, further comprising:

means for coupling an AAA emulation module to the AAA entity via a fourth interface and coupled to the AAA entity via a fifth interface, wherein the AAA emulation module interacts with:

the visited network's AAA entity, over a fifth interface, for L2TP authentication and 3GPP2 packet data accounting, and

the home network's AAA entity, over a sixth interface, for 3GPP packet data accounting.

108. A method in which a user using Mobile IP roams from a home system to a visited system having a Serving GPRS Support Node (SGSN), comprising:

coupling the home system to the visited system to enable communication between the home system and the visited system, wherein the home system comprises a home agent, a home location register, and an Access, Authorization, and Accounting (AAA) entity, by:

providing a foreign agent emulation module to the home system over a third interface;

providing a Gateway GPRS Support Node (GGSN) emulation module to the visited system over a fourth interface;

providing an AAA emulation module to the home system; and

providing an accounting function by interacting with the home system's AAA entity for Mobile IP Foreign Agent challenge authentication and 3GPP2 packet data accounting.

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109. A method that enables communication between a home system comprising a home agent, and a visited system having a Serving GPRS Support Node (SGSN), when a user using Mobile IP roams to a visited system, comprising:

5 coupling the home agent to a foreign agent emulation module via a third interface, wherein the foreign agent emulation module supports bearer connectivity between the visited system and the home system over the third interface, wherein the home system comprises a home location register, an Access, Authorization, and Accounting (AAA) entity;

10 coupling a Gateway GPRS Support Node (GGSN) emulation module to the Serving GPRS Support Node (SGSN) via a fourth interface, wherein the Gateway GPRS Support Node (GGSN) emulation module supports bearer connectivity between the visited system and the home system over the fourth interface;

15 allowing the user to register over a first interface that couples a Global System for Mobile communications home location register emulation module to the SGSN;

allowing the user to register over a second interface that couples an visited location register emulation module to a home location register; and

20 coupling an AAA emulation module to the AAA entity via a fifth interface, wherein the AAA emulation module provides an accounting function by interacting with the home system's AAA entity for Mobile IP Foreign Agent challenge authentication and 3GPP2 packet data accounting.

110. A system in which a user using Mobile IP roams to a visited system  
25 having a Serving GPRS Support Node (SGSN), comprising:

a home system having a home agent, wherein the home system further comprising a home location register and an Access, Authorization, and Accounting (AAA) entity;

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an interface entity that couples the home system to the visited system to enable communication between the home system and the visited system, wherein the interface entity comprises:

5 a foreign agent emulation module, coupled to the home agent via a third interface, that supports bearer connectivity between the visited system and the home system such that a foreign agent emulation module is presented to the home system over the third interface;

10 a Global System for Mobile communications home location register emulation module, coupled to the Serving GPRS Support Node (SGSN) via a first interface, that allows a user to register over the first interface;

an visited location register emulation module, coupled to the home location register via a second interface, that allows a user to register over the second interface; and

15 an AAA emulation module, coupled to the AAA entity via a fifth interface, that provides an accounting function by to interacting with the home system's AAA entity for Mobile IP Foreign Agent challenge authentication and 3GPP2 packet data accounting.

111. An interface entity that enables communication between a home system having a home agent, a home location register and an Access,  
20 Authorization and Accounting (AAA) entity, and a visited system comprising a Serving GPRS Support Node (SGSN), when a user using Mobile IP roams to a visited system, the interface entity comprising:

a foreign agent emulation module, coupled to the home agent via an  
third interface, that supports bearer connectivity between the visited interface  
25 entity and the home interface entity such that a foreign agent emulation module and an AAA emulation module are presented to the interface entity over the third interface;

a Gateway GPRS Support Node (GGSN) emulation module, coupled to the Serving GPRS Support Node (SGSN) via a fourth interface, that supports

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bearer connectivity between the visited system and the home system such that a Gateway GPRS Support Node (GGSN) emulation module is presented to the visited system over the fourth interface, wherein the interface entity provides a packet routing function between the Gateway GPRS Support Node (GGSN) emulation module and the foreign agent emulation module, and serves as an endpoint for a GPRS Tunneling Protocol (GTP) tunnel and a Mobile IP tunnel;

a Global System for Mobile communications home location register emulation module, coupled to the Serving GPRS Support Node (SGSN) via a first interface, that allows a user to register over a first interface;

an visited location register emulation module, coupled to the home location register via a second interface, that allows a user to register over the second interface; and

an AAA emulation module, coupled to the AAA entity via an fifth interface, that provides an accounting function by to interacting with the home system's AAA entity for Mobile IP Foreign Agent challenge authentication and 3GPP2 packet data accounting.

112. A method in which a user using Simple IP roams from a home system comprising a L2TP Network Server (LNS) to a visited system comprising a Serving GPRS Support Node (SGSN), comprising:

coupling the home system to the visited system to enable communication between the home system and the visited system, by:

providing a Gateway GPRS Support Node (GGSN) emulation module to the visited system to support bearer connectivity between the visited and home networks over a third interface; and

providing a Link Access Control (LAC) emulation module coupled to the L2TP Network Server via a third interface, wherein the Link Access Control (LAC) emulation module supports bearer connectivity between the visited and home system over the fourth interface thereby providing a normal routing interface to the home system.

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113. A method according to claim 112, wherein providing a Gateway GPRS Support Node (GGSN) emulation module to the visited system to support bearer connectivity between the visited and home networks over a third interface provides a packet routing function between the Gateway GPRS Support Node  
5 (GGSN) emulation module and the home system.

114. A method according to claim 112, further comprising:

allowing a user to register over a first interface; and

allowing the user to register over a second interface.

115. A method according to claim 112, further comprising:

10 providing endpoints for a GPRS Tunneling Protocol (GTP) tunnel and an IPSec tunnel.

116. A method according to claim 112, wherein the home system further comprises a home location register and an Access, Authorization, and Accounting (AAA) entity, and further comprising:

15 providing an accounting function by interacting with the home system's Access, Authorization, and Accounting (AAA) for L2TP authentication and 3GPP2 packet data accounting over a fifth interface.

117. A method that enables communication between a home system comprising a L2TP Network Server (LNS) and a visited system comprising a  
20 Serving GPRS Support Node (SGSN), when a user using Simple IP roams to the visited system, comprising:

coupling a Link Access Control (LAC) emulation module to the L2TP Network Server via a third interface, wherein the Link Access Control (LAC) emulation module supports bearer connectivity between the visited and home  
25 systems over the third interface; and

coupling a Gateway GPRS Support Node (GGSN) emulation module to the Serving GPRS Support Node (SGSN) via a fourth interface to support

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bearer connectivity between the visited and home systems over the fourth interface.

118. A method according to claim 117, wherein coupling a Gateway GPRS Support Node (GGSN) emulation module to the Serving GPRS Support Node (SGSN) via a fourth interface to support bearer connectivity between the  
5 visited and home networks over the fourth interface, comprises:

providing a Gateway GPRS Support Node (GGSN) emulation module to the visited system.

119. A method according to claim 117, further comprising:

10 providing a packet routing function between the Gateway GPRS Support Node (GGSN) emulation module and the home system.

120. A method according to claim 117, wherein the home system further comprises a home location register, and further comprising:

15 coupling an visited location register emulation module to the home location register via a first interface, wherein the visited location register emulation module allows a user to register over the first interface;

coupling a Global System for Mobile communications home location register emulation module to the Serving GPRS Support Node (SGSN) via a second interface, wherein the Global System for Mobile communications home location register emulation module allows a user to register over the second  
20 interface.

121. A method according to claim 119, further comprising:

providing endpoints for a GPRS Tunneling Protocol (GTP) tunnel and an IPsec tunnel.

25 122. A method according to claim 117, wherein the home system further comprises an Access, Authorization, and Accounting (AAA) entity, and further comprising:

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coupling an Access, Authorization, and Accounting (AAA) emulation module to the Access, Authorization, and Accounting (AAA) entity via a fifth interface, wherein the Access, Authorization, and Accounting (AAA) emulation module provides an accounting function by interacting with the home system's

5 Access, Authorization, and Accounting (AAA) entity for L2TP authentication and 3GPP2 packet data accounting over the fifth interface.

123. A system in which a user using Simple IP roams to a visited system comprising a Serving GPRS Support Node (SGSN), comprising:

a home system that comprises a L2TP Network Server (LNS); and

10 an interface entity that couples the home system to the visited system to enable communication between the home system and the visited system, wherein the interface entity further comprises:

a Link Access Control (LAC) emulation module, coupled to the L2TP Network Server via an third interface, that supports bearer connectivity between

15 the visited and home networks over the third interface; and

a Gateway GPRS Support Node (GGSN) emulation module, coupled to the Serving GPRS Support Node (SGSN) via a fourth interface, that supports bearer connectivity between the visited and home networks over the fourth interface by providing a Gateway GPRS Support Node (GGSN) emulation module

20 to the visited system and providing a normal routing interface to the system to thereby provide a packet routing function between the Gateway GPRS Support Node (GGSN) emulation module and the home system.

124. A system according to claim 123, wherein the interface serves as an endpoint for a GPRS Tunneling Protocol (GTP) tunnel and an IPSec tunnel.

25 125. A system according to claim 123, wherein the home system further comprises a home location register, and wherein the interface entity further comprises:

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a visited location register emulation module, coupled to the home location register via a first interface, that allows a user to register over the first interface; and

5 a Global System for Mobile communications home location register emulation module, coupled to the Serving GPRS Support Node (SGSN) via a second interface, that allows a user to register over the second interface.

126. A system according to claim 123, wherein the home system further comprises an Access, Authorization, and Accounting (AAA) entity, and wherein the interface further comprises:

10 an Access, Authorization, and Accounting (AAA) emulation module, coupled to the Access, Authorization, and Accounting (AAA) entity via an fifth interface, that provides an accounting function by interacting with the home system's Access, Authorization, and Accounting (AAA) for L2TP authentication and 3GPP2 packet data accounting over the fifth interface.

15 127. An interface entity that enables communication between a home system and a visited system comprising a Serving GPRS Support Node (SGSN), when a user using Simple IP roams to a visited system, wherein the home system comprises a L2TP Network Server (LNS), and wherein the interface entity comprises:

20 a Link Access Control (LAC) emulation module, coupled to the L2TP Network Server via an third interface, that supports bearer connectivity between the visited and home networks over the third interface; and

a Gateway GPRS Support Node (GGSN) emulation module, coupled to the Serving GPRS Support Node (SGSN) via a fourth interface, that supports  
25 bearer connectivity between the visited and home networks over the fourth interface by providing a Gateway GPRS Support Node (GGSN) emulation module to the visited system and providing a normal routing interface to the home system to thereby provide a packet routing function between the Gateway GPRS Support Node (GGSN) emulation module and the home system.

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128. An interface entity according to claim 127, wherein the interface entity serves as an endpoint for a GPRS Tunneling Protocol (GTP) tunnel and an IPSec tunnel.

129. An interface entity according to claim 127, wherein the home system  
5 further comprises a home location register, and wherein the interface entity further comprises:

a visited location register emulation module, coupled to the home location register via a first interface, that allows a user to register over the first interface;

10 a Global System for Mobile communications home location register emulation module, coupled to the Serving GPRS Support Node (SGSN) via a second interface, that allows a user to register over the second interface.

130. An interface entity according to claim 127, wherein the home system further comprises an Access, Authorization, and Accounting (AAA) entity, and  
15 wherein the interface entity further comprises:

an AAA emulation module, coupled to the AAA entity via an fifth interface, that provides an accounting function by interacting with the home system's AAA entity for L2TP authentication and 3GPP2 packet data accounting over the fifth interface.

20 131. A method in which a user using Mobile IP roams from a home system to a visited system comprising a Serving GPRS Support Node (SGSN), comprising:

coupling the home system to the visited system to enable communication between the home system and the visited system, wherein the  
25 home system comprises a home location register, an Access, Authorization, and Accounting (AAA) entity, and a home agent; and

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providing an accounting function by interacting with a home system's Access, Authorization, and Accounting (AAA) for Mobile IP Foreign Agent challenge authentication and 3GPP2 packet data accounting.

132. A method according to claim 131, further comprising:

5 allowing the user to register over a first interface; and

allowing the user to register over a second interface.

133. A method according to claim 131, wherein coupling the home system to the visited system to enable communication between the home system and the visited system, comprises:

10 supporting bearer connectivity between the home system and the visited system to enable communication between the home system and the visited system.

134. A method according to claim 133, wherein supporting bearer connectivity between the home system and the visited system to enable  
15 communication between the home system and the visited system, comprises:

presenting a foreign agent emulation module and an Access, Authorization, and Accounting (AAA) emulation module to the home system over a third interface; and

20 presenting a Gateway GPRS Support Node (GGSN) emulation module to the visited system over a fourth interface.

135. A method according to claim 134, wherein further comprising:

providing a packet routing function between the Gateway GPRS Support Node (GGSN) emulation module and a foreign agent emulation module.

136. A method according to claim 135, further comprising:

25 providing an endpoint for a GPRS Tunneling Protocol (GTP) tunnel and a Mobile IP tunnel.

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137. A method in which a user using Simple IP roams from a home system to a visited system comprising a Serving GPRS Support Node (SGSN), comprising:

coupling the home system to the visited system to enable  
5 communication between the home system and the visited system, wherein the home system comprises a home location register, an Access, Authorization, and Accounting (AAA) entity, and a L2TP Network Server (LNS);

providing endpoints for a GPRS Tunneling Protocol (GTP) tunnel and an IPSec tunnel; and

10 providing an accounting function by interacting with the home system's Access, Authorization, and Accounting (AAA) for L2TP authentication and 3GPP2 packet data accounting over a fifth interface.

138. A method according to claim 137, wherein coupling the home system to the visited system to enable communication between the home system  
15 and the visited system, comprises:

supporting bearer connectivity between the visited and home networks over a third interface by presenting a Gateway GPRS Support Node (GGSN) emulation module to the visited system, and supporting bearer connectivity between the visited and home networks over a fourth interface by  
20 presenting a normal routing interface to the home system.

139. A method according to claim 137, further comprising:

providing a packet routing function between the Gateway GPRS Support Node (GGSN) emulation module and the home system.

140. A method according to claim 137, further comprising:

25 allowing a user to register over a first interface; and

allowing the user to register over a second interface.

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141. A method that enables communication between a home system and a visited system comprising a Serving GPRS Support Node (SGSN), when a user using Mobile IP roams to a visited system, comprising:

wherein the home system comprises a home location register, an  
5 Access, Authorization, and Accounting (AAA) entity, and a home agent; coupling the home agent to a foreign agent emulation module via a third interface, wherein the foreign agent emulation module supports bearer connectivity between the visited system and the home system such that the foreign agent emulation module and an Access, Authorization, and Accounting (AAA) emulation module are  
10 presented to the system over the third interface; and

coupling a Gateway GPRS Support Node (GGSN) emulation module to the Serving GPRS Support Node (SGSN) via a fourth interface, wherein the Gateway GPRS Support Node (GGSN) emulation module supports bearer connectivity between the visited system and the home system such that a  
15 Gateway GPRS Support Node (GGSN) emulation module is presented to the visited system over the fourth interface;

allowing a user to register over a first interface that couples a Global System for Mobile communications home location register emulation module to the SGSN; and

20 allowing the user to register over a second interface that couples a visited location register emulation module to a home location register.

142. A method according to claim 141, further comprising:

providing endpoints for a GPRS Tunneling Protocol (GTP) tunnel and a Mobile IP tunnel.

25 143. A method according to claim 142, further comprising:

providing a packet routing function between the Gateway GPRS Support Node (GGSN) emulation module and the foreign agent emulation module.

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144. A method according to claim 141, further comprising:

coupling an Access, Authorization, and Accounting (AAA) emulation module to the Access, Authorization, and Accounting (AAA) entity via an fifth interface, wherein the Access, Authorization, and Accounting (AAA) emulation module provides an accounting function by interacting with a home system's Access, Authorization, and Accounting (AAA) for Mobile IP Foreign Agent challenge authentication and 3GPP2 packet data accounting.

145. A method that enables communication between a home system and a visited system comprising a Serving GPRS Support Node (SGSN), when a user using Simple IP roams to a visited system, wherein the home system comprises a home location register, an Access, Authorization, and Accounting (AAA) entity, and a L2TP Network Server (LNS), comprising:

coupling a Gateway GPRS Support Node (GGSN) emulation module to the Serving GPRS Support Node (SGSN) via a fourth interface to support bearer connectivity between the visited and home networks over the fourth interface;

providing endpoints for a GPRS Tunneling Protocol (GTP) tunnel and an IPSec tunnel; and

coupling an Access, Authorization, and Accounting (AAA) emulation module to the Access, Authorization, and Accounting (AAA) entity via a fifth interface, wherein the Access, Authorization, and Accounting (AAA) emulation module provides an accounting function by interacting with the home system's Access, Authorization, and Accounting (AAA) for L2TP authentication and 3GPP2 packet data accounting over the fifth interface.

146. A method according to claim 145, wherein coupling a Gateway GPRS Support Node (GGSN) emulation module to the Serving GPRS Support Node (SGSN) via a fourth interface to support bearer connectivity between the visited and home networks over the fourth interface, comprises:

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presenting a Gateway GPRS Support Node (GGSN) emulation module to the visited system; and presenting a normal routing interface to the home system.

147. A method according to claim 145, further comprising:

5 providing a packet routing function between the Gateway GPRS Support Node (GGSN) emulation module and the home system.

148. A method that enables communication between a home system and a visited system comprising a Serving GPRS Support Node (SGSN), when a user using Simple IP roams to a visited system, wherein the home system comprises a  
10 home location register, an Access, Authorization, and Accounting (AAA) entity, and a L2TP Network Server (LNS), comprising:

coupling a Gateway GPRS Support Node (GGSN) emulation module to the Serving GPRS Support Node (SGSN) via a fourth interface to support bearer connectivity between the visited and home networks over the fourth  
15 interface;

coupling a visited location register to the home location register via a first interface, wherein the visited location register allows a user to register over the first interface;

coupling a Global System for Mobile communications home location register to the Serving GPRS Support Node (SGSN) via a second interface, wherein the Global System for Mobile communications home location register allows a user to register over the second interface; and  
20

coupling a Link Access Control (LAC) emulation module to the L2TP Network Server via an third interface, wherein the Link Access Control (LAC) emulation module supports bearer connectivity between the visited and home networks over the third interface.  
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149. A system in which a user using Mobile IP roams to a visited system comprising a Serving GPRS Support Node (SGSN), comprising:

a home system comprising a home location register, an Access, Authorization, and Accounting (AAA) entity, and a home agent; and

5 an interface entity that couples the home system to the visited system to enable communication between the home system and the visited system, and wherein the interface entity further comprises:

a Global System for Mobile communications home location register emulation module, coupled to the Serving GPRS Support Node (SGSN) via a first  
10 interface, that allows a user to register over a first interface; and

a visited location register emulation module, coupled to the home location register via a second interface, that allows a user to register over the second interface;

a foreign agent emulation module, coupled to the home agent via an  
15 third interface, that supports bearer connectivity between the visited system and the home system such that a foreign agent emulation module and an Access, Authorization, and Accounting (AAA) emulation module are presented to the system over the third interface; and

a Gateway GPRS Support Node (GGSN) emulation module, coupled  
20 to the Serving GPRS Support Node (SGSN) via a fourth interface, that supports bearer connectivity between the visited system and the home system such that a Gateway GPRS Support Node (GGSN) emulation module is presented to the visited system over the fourth interface.

150. A system according to claim 149, wherein the interface entity serves  
25 as an endpoint for a GPRS Tunneling Protocol (GTP) tunnel and a Mobile IP tunnel.

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151. A system according to claim 150, wherein the interface entity provides a packet routing function between the Gateway GPRS Support Node (GGSN) emulation module and the foreign agent emulation module.

152. A system according to claim 149, wherein the interface entity further  
5 comprises:

an Access, Authorization, and Accounting (AAA) emulation module, coupled to the Access, Authorization, and Accounting (AAA) entity via an fifth interface, that provides an accounting function by to interacting with a home system's Access, Authorization, and Accounting (AAA) for Mobile IP Foreign  
10 Agent challenge authentication and 3GPP2 packet data accounting.

153. A system in which a user using Simple IP roams to a visited system comprising a Serving GPRS Support Node (SGSN), comprising:

a home system that comprises: a home location register;

an Access, Authorization, and Accounting (AAA) entity; and a L2TP  
15 Network Server (LNS); and

an interface entity that couples the home system to the visited system to enable communication between the home system and the visited system, wherein the interface entity further comprises:

an visited location register, coupled to the home location register via  
20 a first interface, that allows a user to register over the first interface; and

a Global System for Mobile communications home location register, coupled to the Serving GPRS Support Node (SGSN) via a second interface, that allows a user to register over the second interface;

a Link Access Control (LAC) emulation module, coupled to the L2TP  
25 Network Server via an third interface, that supports bearer connectivity between the visited and home networks over the third interface; and

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a Gateway GPRS Support Node (GGSN) emulation module, coupled to the Serving GPRS Support Node (SGSN) via a fourth interface, that supports bearer connectivity between the visited and home networks over the fourth interface by presenting a Gateway GPRS Support Node (GGSN) emulation module to the visited system and presenting a normal routing interface to the system to thereby provide a packet routing function between the Gateway GPRS Support Node (GGSN) emulation module and the home system.

154. A system according to claim 153, wherein the interface serves as an endpoint for a GPRS Tunneling Protocol (GTP) tunnel and an IPSec tunnel.

10 155. A system according to claim 154, wherein the interface further comprises:

an Access, Authorization, and Accounting (AAA) emulation module, coupled to the Access, Authorization, and Accounting (AAA) entity via an fifth interface, that provides an accounting function by interacting with the home system's Access, Authorization, and Accounting (AAA) for L2TP authentication and 3GPP2 packet data accounting over the fifth interface.

156. An interface entity that enables communication between a home system and a visited system comprising a Serving GPRS Support Node (SGSN), when a user using Mobile IP roams to a visited system, wherein the home system comprises a home location register, an Access, Authorization, and Accounting (AAA) entity, and a home agent, and wherein the interface entity comprises:

a Global System for Mobile communications home location register emulation module, coupled to the Serving GPRS Support Node (SGSN) via a first interface, that allows a user to register over a first interface; and

25 a visited location register emulation module, coupled to the home location register via a second interface, that allows a user to register over the second interface;

a foreign agent emulation module, coupled to the home agent via an third interface, that supports bearer connectivity between the visited interface

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entity and the home interface entity such that a foreign agent emulation module and an Access, Authorization, and Accounting (AAA) emulation module are presented to the interface entity over the third interface; and

a Gateway GPRS Support Node (GGSN) emulation module, coupled  
 5 to the Serving GPRS Support Node (SGSN) via a fourth interface, that supports bearer connectivity between the visited system and the home system such that a Gateway GPRS Support Node (GGSN) emulation module is presented to the visited system over the fourth interface, wherein the interface entity provides a packet routing function between the Gateway GPRS Support Node (GGSN)  
 10 emulation module and the foreign agent emulation module, and serves as an endpoint for a GPRS Tunneling Protocol (GTP) tunnel and a Mobile IP tunnel.

157. An interface entity according to claim 156, wherein the interface entity further comprises:

an Access, Authorization, and Accounting (AAA) emulation module,  
 15 coupled to the Access, Authorization, and Accounting (AAA) entity via an fifth interface, that provides an accounting function by to interacting with a home system's Access, Authorization, and Accounting (AAA) for Mobile IP Foreign Agent challenge authentication and 3GPP2 packet data accounting.

158. An interface entity that enables communication between a home  
 20 system and a visited system comprising a Serving GPRS Support Node (SGSN), when a user using Simple IP roams to a visited system, wherein the home system comprises a home location register, an Access, Authorization, and Accounting (AAA) entity, and a L2TP Network Server (LNS), and wherein the interface entity comprises:

25 a visited location register, coupled to the home location register via a first interface, that allows a user to register over the first interface;

a Global System for Mobile communications home location register, coupled to the SGSN via a second interface, that allows a user to register over the second interface;

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a Link Access Control (LAC) emulation module, coupled to the L2TP Network Server via an third interface, that supports bearer connectivity between the visited and home networks over the third interface; and

5 a Gateway GPRS Support Node (GGSN) emulation module, coupled to the Serving GPRS Support Node (SGSN) via a fourth interface, that supports bearer connectivity between the visited and home networks over the fourth interface by presenting the GGSN emulation module to the visited system and presenting a normal routing interface to the home system to thereby provide a packet routing function between the GGSN emulation module and the home  
10 system.

159. An interface entity according to claim 158, wherein the interface entity serves as an endpoint for a GPRS Tunneling Protocol (GTP) tunnel and an IPSec tunnel.

160. An interface entity according to claim 159, wherein the interface  
15 entity further comprises:

an AAA emulation module, coupled to the AAA entity via a fifth interface, that provides an accounting function by interacting with the home system's AAA entity for L2TP authentication and 3GPP2 packet data accounting over the fifth interface.

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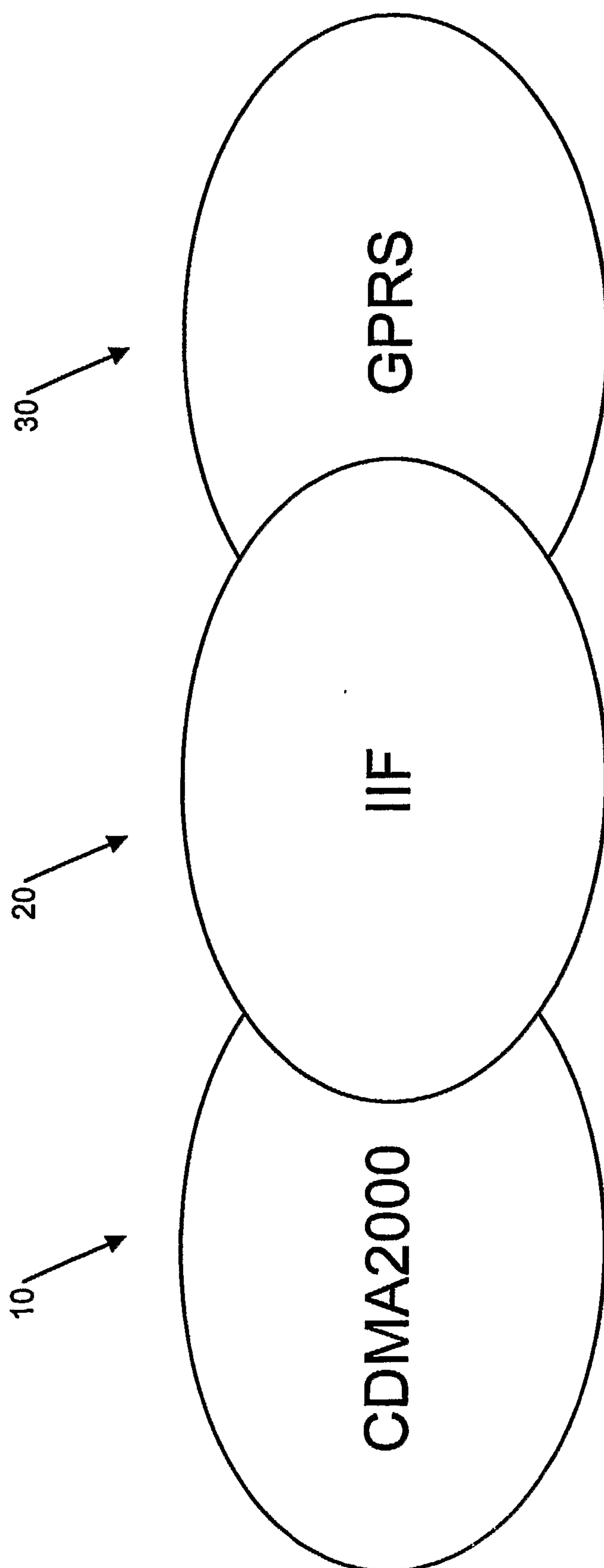


FIG. 1



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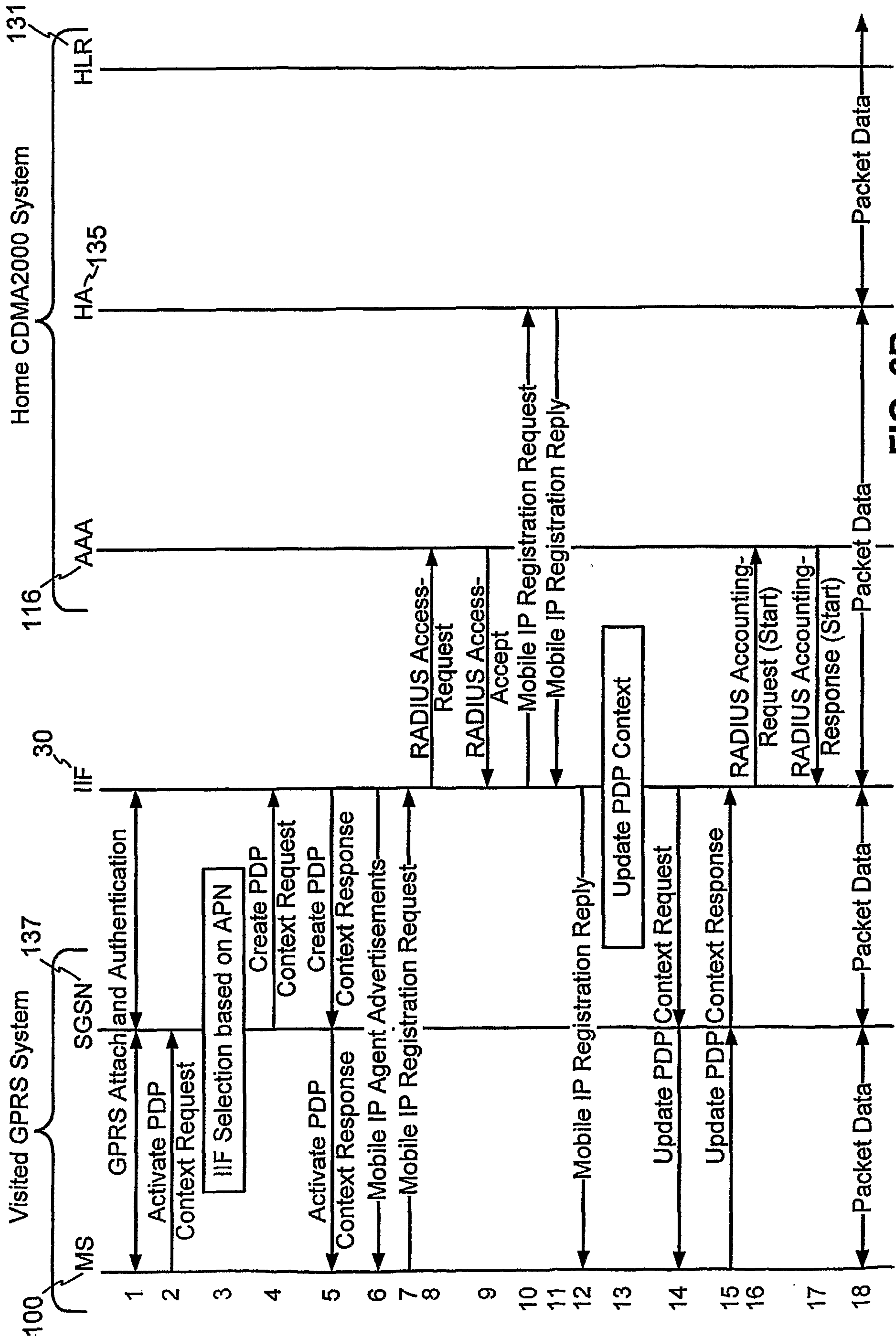
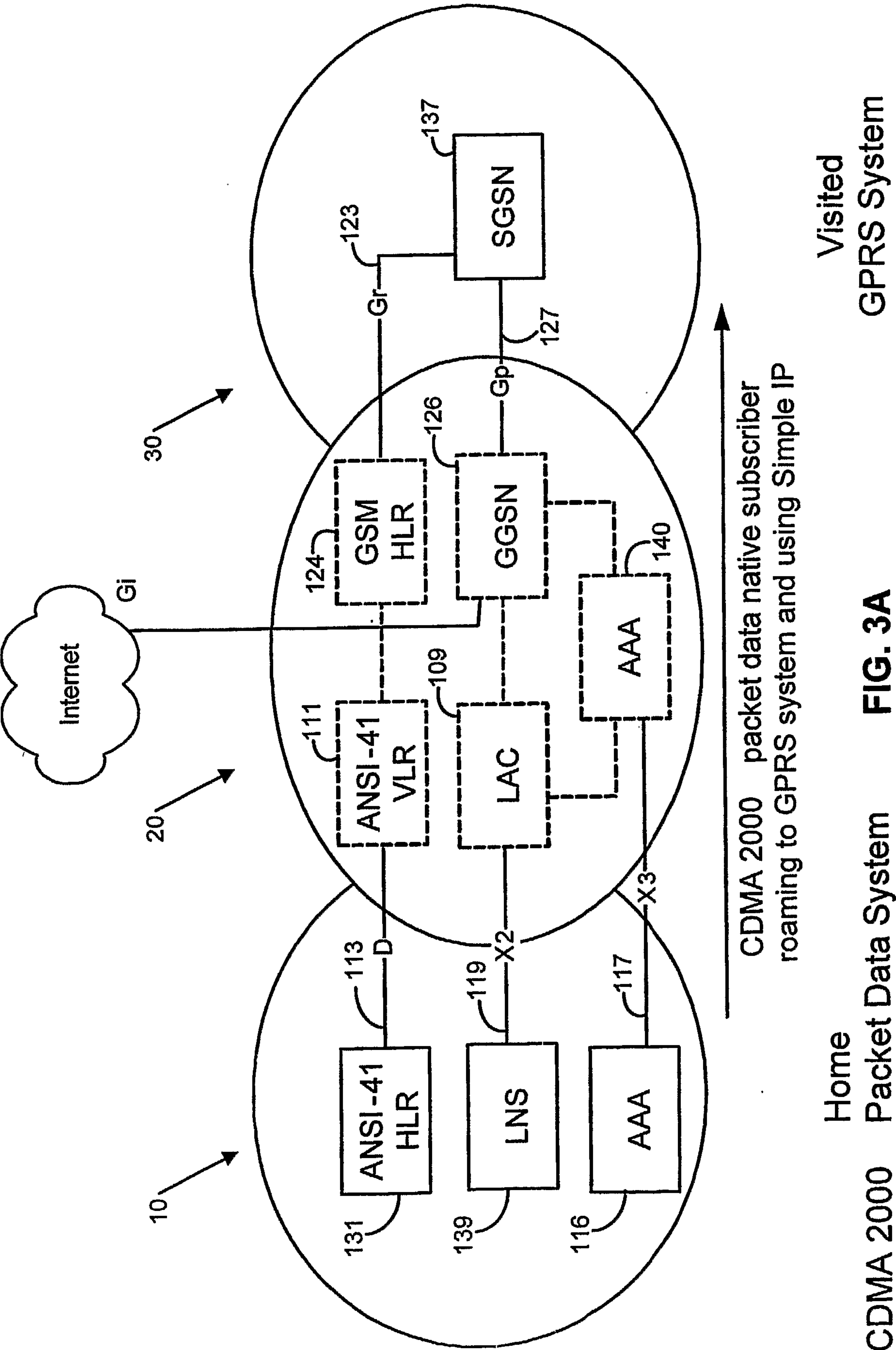


FIG. 2B

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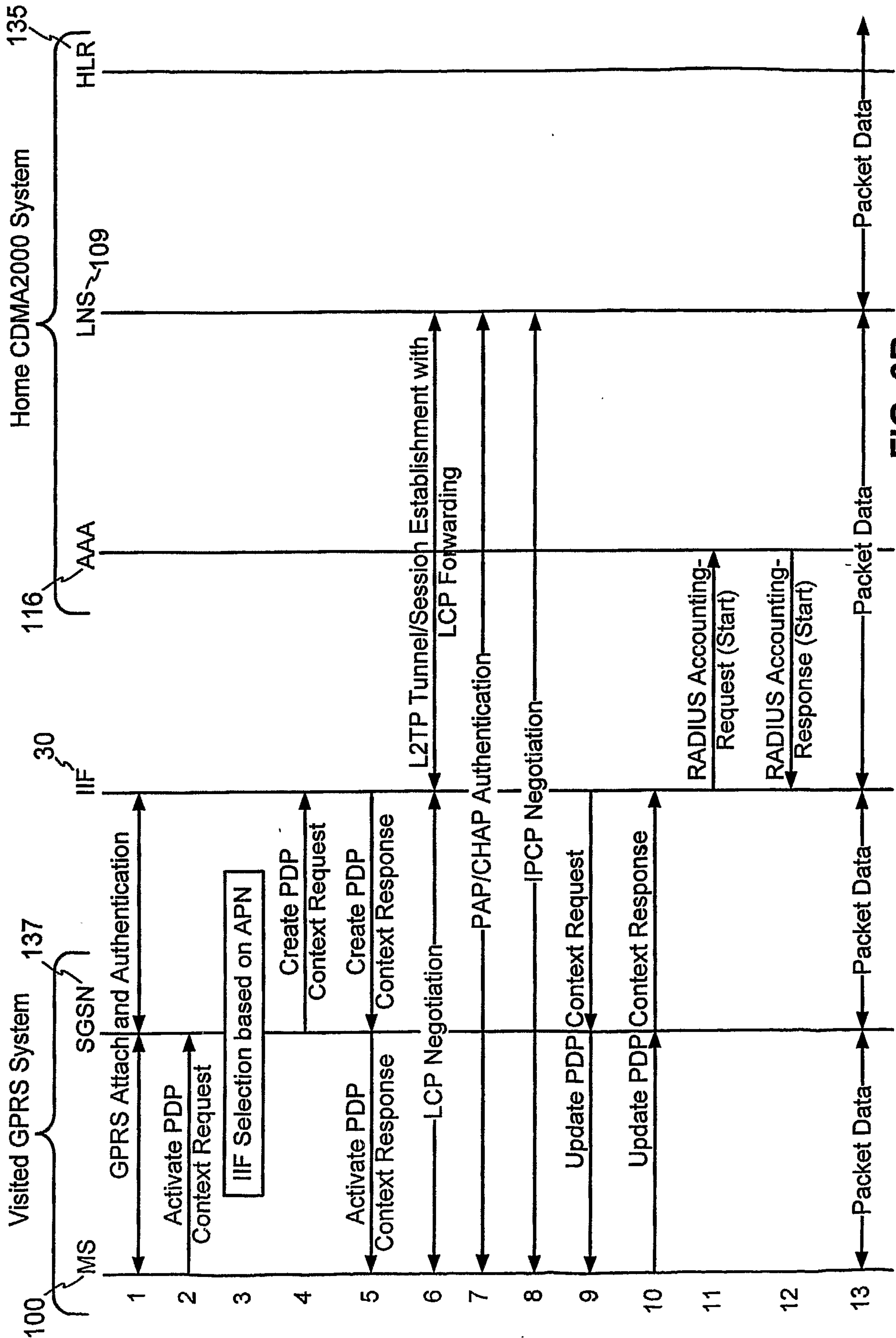


FIG. 3B

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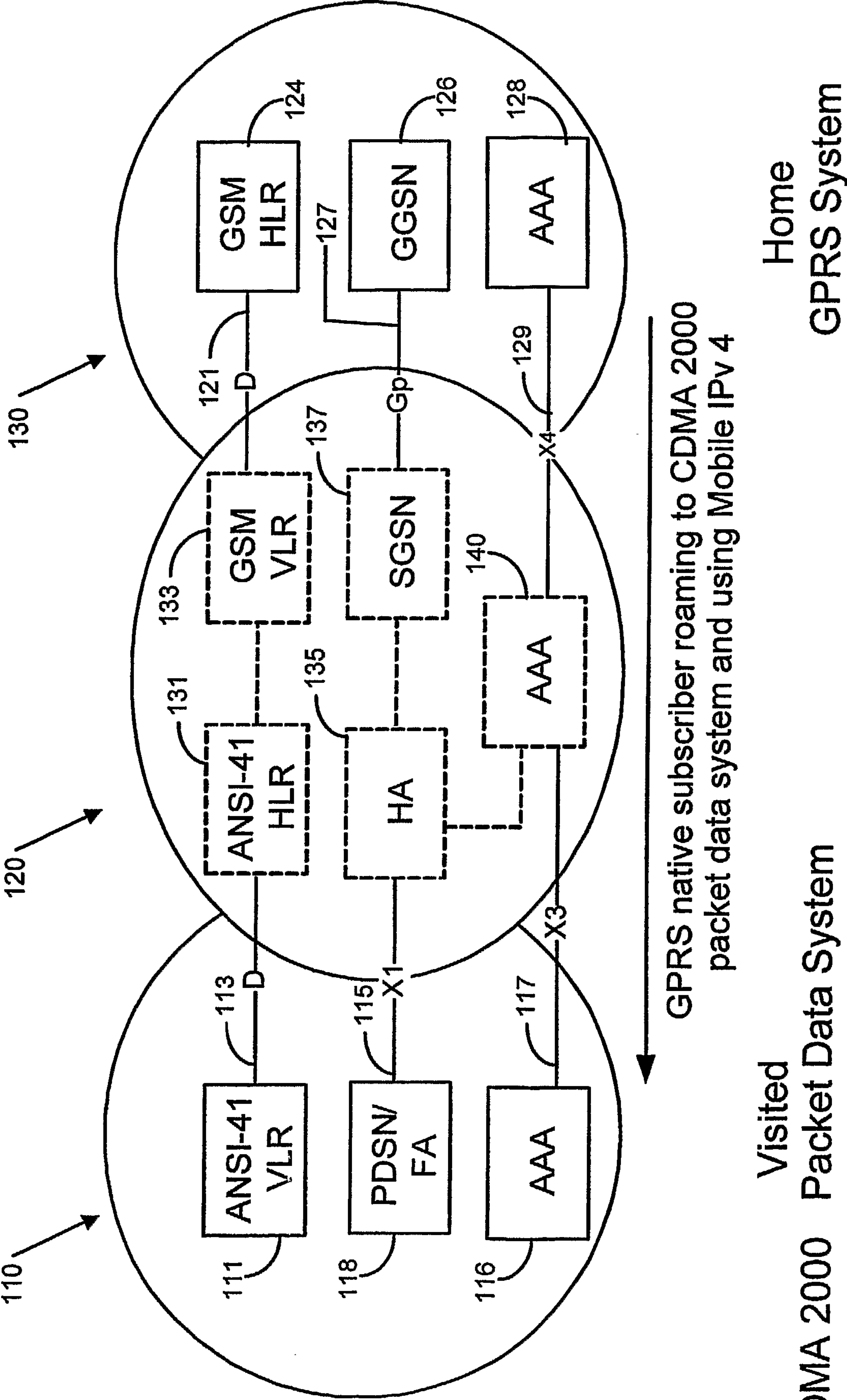


FIG. 4A

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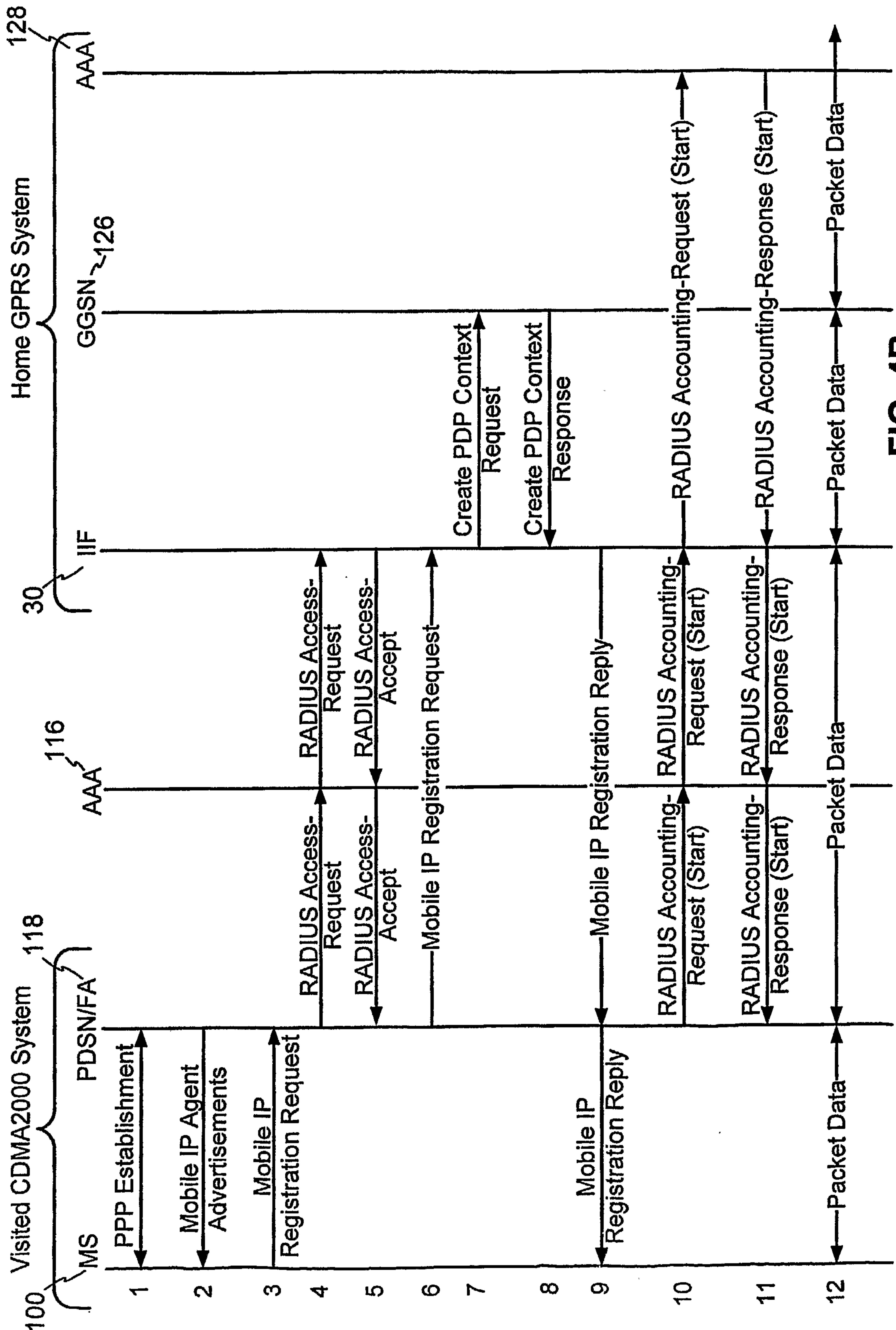


FIG. 4B

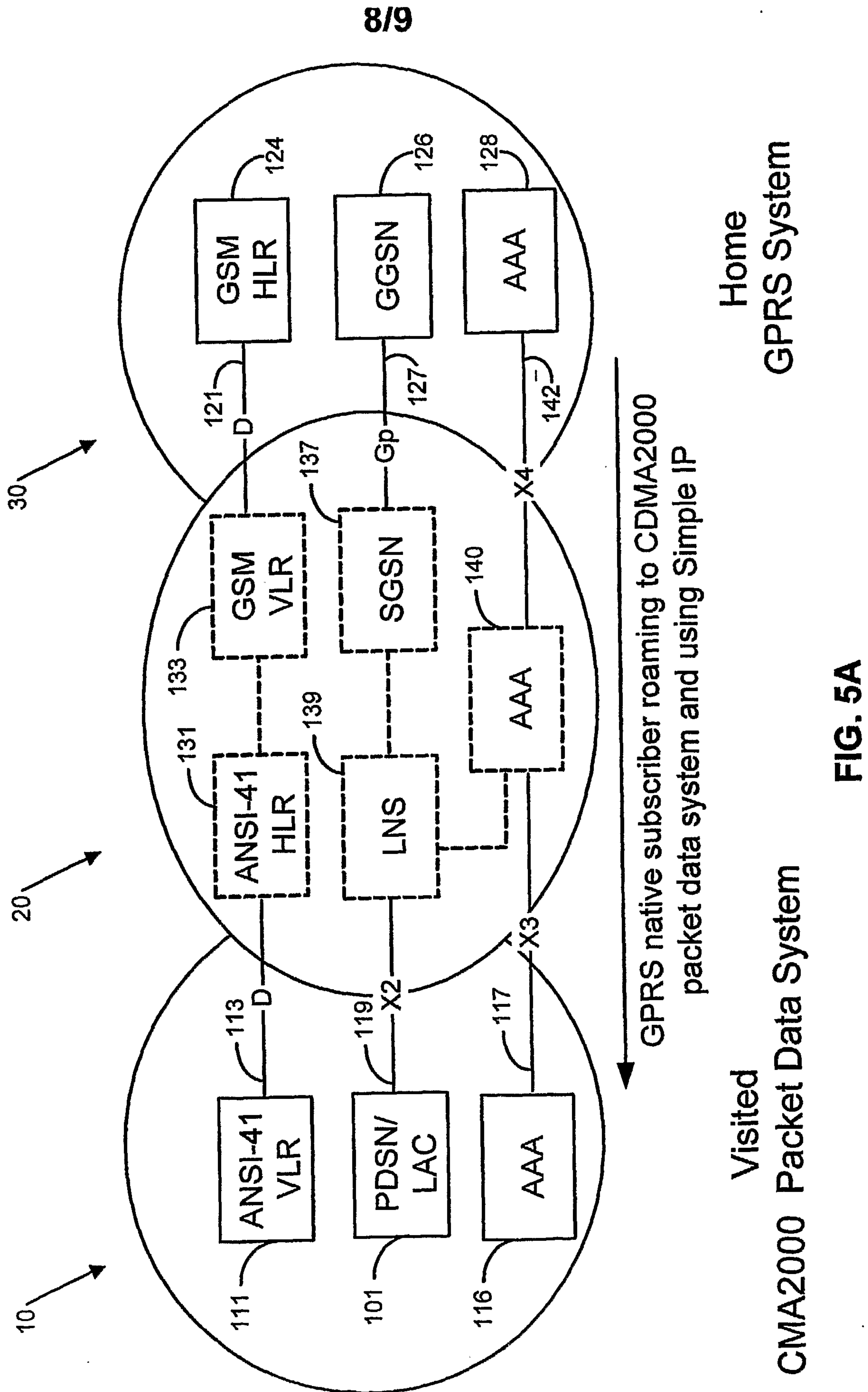


**FIG. 5A**

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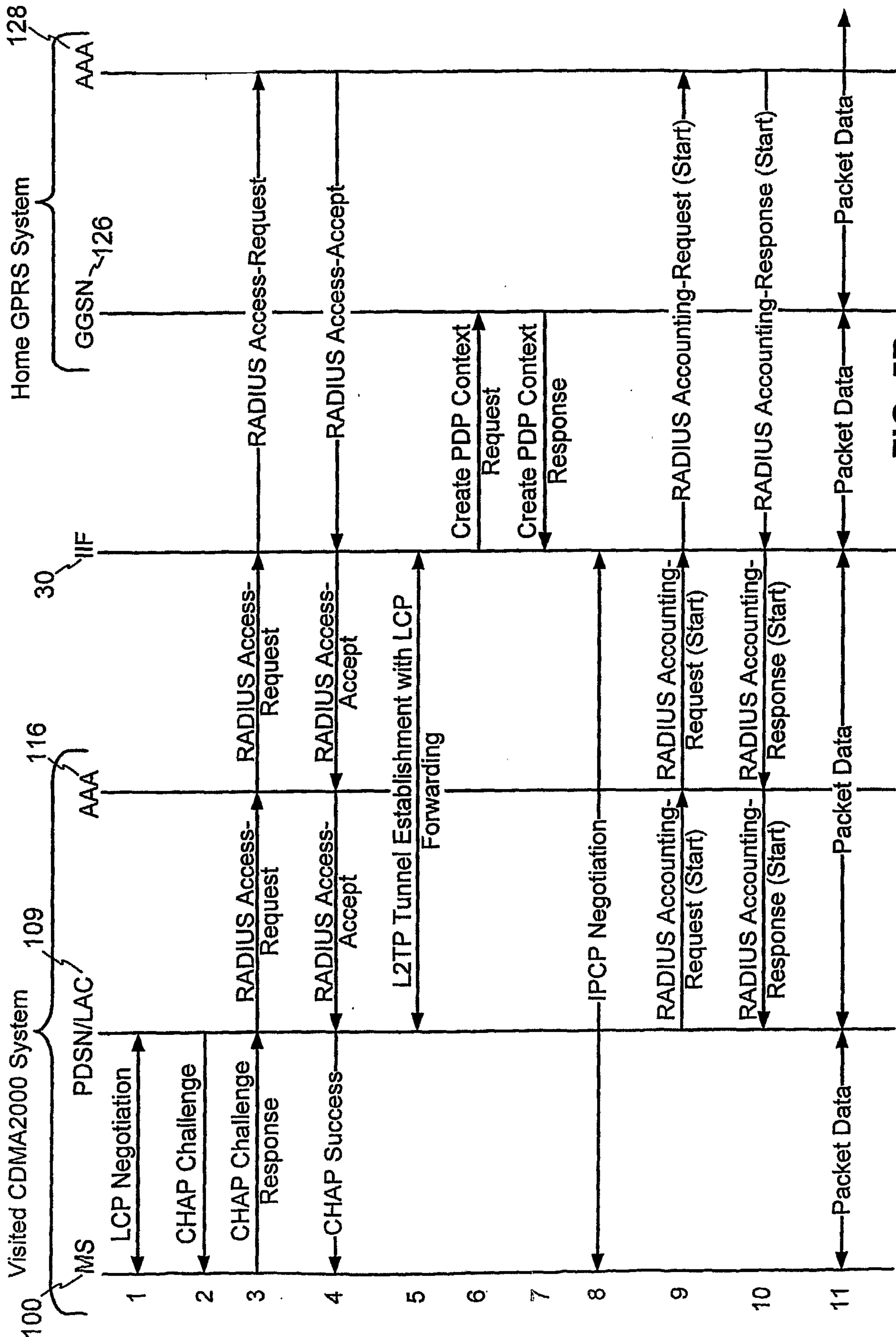


FIG. 5B

