

Method and System for Providing SIMM Service to Outbound Roamers of a Home Network Using a Passive-Monitoring-Based Solution

5 Related Applications

This application claims the benefit of United States Provisional Patent Application No. 60/902,362 entitled "A Passive Monitoring-Based Method and System for Providing Mobile Outbound Roaming Communication Corresponding to Multiple MSISDNs Associated with a Single IMSI for Multiple Roaming Partners," filed on
10 February 21, 2007. It is also a continuation-in-part of United States Patent Application No. 10/782,681 entitled "Providing Multiple MSISDN Numbers in a Mobile Device with a Single IMSI," filed on February 18, 2004, claiming priority from United States Provisional Patent Application No. 60/447,998, entitled "SIMM Variations," filed on February 18, 2003. Each of these related patent applications is incorporated herein by this
15 reference in its entirety.

Field of the Invention

The present invention generally relates to mobile communication. More
20 specifically, the invention relates to mobile communication corresponding to multiple MSISDNs associated with a single IMSI, for multiple roaming partners.

Background of the Invention

25 Providing mobile communication services to subscribers ("roamers") outside of the home network to which they subscribe ("roaming") is becoming increasingly popular. Mobile operators compete to attract roamers and consequently increase their roaming revenues. A majority of roaming revenue comes from inbound roamers who frequently roam in one or more geographic areas outside of their home network.. the
30 home networks and the visited network may be either in the same country, or in different countries.

Providing an inbound roamer with a local Mobile Station International Subscriber Directory Number (MSISDN) of a visited network allows the inbound roamer to make local calls within the visited network at local rates, instead of the more expensive roaming rates that would have applied using his home network's MSISd. And when an inbound roamer is so equipped, even other local subscribers of the visited networks can call him at local rates. So in today's state of the art, roamers – especially those who frequent a certain country or visited network often purchase Subscriber Identity Modules (SIM) cards of the visited networks to insert in their handsets when traveling there, in order to take advantage of those lower local, non-roaming charges. But those roamers need to swap their existing home-network SIM cards with the visited networks' SIM cards. So they normally are not able to make and receive calls and other communications using their home network MSISDN or phone number. Similarly, when those roamers return to their home network, they normally cannot make and receive calls and other communications using their the MSISDN (or phone number) of their visited-network SIM card. So in some state-of-the art solutions among mobile operators whose subscribers frequent each other's territory, network operators provide both the home network MSISDN and visited network MSISDNs within a special SIM card. That affords subscribers the convenience of keeping a single SIM card and number, but it compels the subscriber to incur roaming charges when in the participating visited networks.

There are one or more techniques known in the art that offer these services to outbound roamers from a Home Public Mobile Network (HPMN), where the outbound roamer enjoys local rates on his Friendly Public Mobile Network (FPMN) MSISDNs of one or more FPMNs, and is also able to make/receive calls and SMS using his HPMN MSISDN. The one or more FPMNs are Public Mobile Networks (PMNs) which have roaming relationships with the HPMN. However, in these techniques, the outbound roamer needs to replace his existing HPMN SIM card with either multiple International Mobile Subscriber Identity(s) (IMSI(s)) SIM card or a special HPMN SIM card.

Another technique allocates multiple FPMN MSISDNs to the HPMN's outbound roamer, in addition to his existing HPMN MSISDN without requiring the outbound roamer to change his existing HPMN SIM card. The FPMN operator assigns a pre-defined range of FPMN MSISDNs to the partner HPMN for providing the service, and the HPMN operator deploys a Signaling Gateway (SG) to associate its outbound roamer's existing HPMN MSISDN with these assigned FPMN MSISDNs. However this technique necessitates a Signal Transfer Point (STP) in the HPMN to have Signaling Connection Control Part (SCCP) Calling Party Address (CgPA) based Global Title (GT) routing capability to avoid routing all SCCP signaling from the FPMN to the HPMN via the SG. Since the technique requires all SCCP signaling of the outbound roamers in the FPMN to pass through the SG, it presents a risk point of failure for such outbound roamers in case of breakdown of the SG as all registered outbound roamers will be unable to receive calls or SMS.

So there is a need in the art of a system, a method, and a computer program product, which assigns multiple MSISDNs corresponding to one or more visited networks to each outbound roamer of a home network who is roaming in any of these visited networks, without changing their existing SIM cards, and without intruding in the signaling path of these outbound roamers at the visited networks.

Summary

The present invention is directed towards a method for facilitating mobile communication of a subscriber associated with an HPMN. The method includes assigning one or more FPMN MSISDNs by an SG to the subscriber, based on a subscription activation request received from the subscriber at the SG either via an HPMN USSD gateway or via an HPMN SMSC. The SG can reside either at the HPMN or an MVNO of the HPMN. And the subscriber has an HPMN SIM with a corresponding HPMN IMSI and an HPMN MSISDN. The method further includes the SG associating the assigned MSISDNs with the HPMN MSISDN. The method further includes detecting passively by the SG, the subscriber's registration with an FPMN. The method further includes sending by the SG, a default MSISDN to an FPMN VLR. The method further includes modifying

by the SG, the default MSISDN to either any assigned MSISDN or the HPMN MSISDN, when an MSISDN change request is received from the subscriber at the SG either via the HPMN SMSC or via the HPMN USSD gateway. The method further includes facilitating by the SG, mobile communication of the subscriber in the FPMN using the default MSISDN and the HPMN MSISDN.

Another aspect of the present invention presents a system for facilitating mobile communication of a subscriber associated with an HPMN. The system includes an SG deployed at either the HPMN or an MVNO of the HPMN. The SG assigns one or more MSISDNs to the subscriber, based on a subscription activation request received from the subscriber at the SG either via an HPMN SMSC or via an HPMN USSD gateway. In fact, the request may be received by any other means through which any kind of subscription requests may otherwise be received, including without limitation, phone call, mail, in-person request (at a home network office, branch office or kiosk), email, internet website). Assume that the subscriber has an HPMN SIM with a corresponding HPMN IMSI and an HPMN MSISDN. The SG can associate the assigned MSISDNs with the HPMN MSISDN. Further, the SG passively detects the subscriber's registration with an FPMN. Further, the SG sends a default MSISDN to an FPMN VLR. Further, the SG modifies the default MSISDN to either any assigned MSISDN or the HPMN MSISDN, when an MSISDN change request is received from the subscriber at the SG either via the HPMN USSD gateway or via the HPMN SMSC. And the SG can facilitate mobile communication of the subscriber in the FPMN using the default MSISDN and the HPMN MSISDN.

Yet another aspect of the present invention provides a computer program product including a computer usable program code for facilitating mobile communication of a subscriber associated with an HPMN by assigning one or more MSISDNs to the subscriber, based on a subscription activation request received from the subscriber at an SG either via an HPMN USSD gateway or via an HPMN SMSC. The SG is deployed at either the HPMN or an MVNO of the HPMN. Moreover, the subscriber has an HPMN SIM with a corresponding HPMN IMSI and an HPMN MSISDN. Further, the computer

program product associates the assigned MSISDNs with the HPMN MSISDN using the SG. Further, the computer program product detects the subscriber's registration with an FPMN by the SG. Further, the computer program product sends a default MSISDN from the SG to an FPMN VLR. Further, the computer program product modifies by the SG,
5 the default MSISDN to either any assigned MSISDN or the HPMN MSISDN. Further, the computer program product facilitates by the SG, mobile communication of the subscriber in the FPMN using the default MSISDN and the HPMN MSISDN.

Brief Description of Drawings

10 In the drawings, the same or similar reference numbers identify similar elements or acts.

FIG. 1 illustrates a system for providing Single International Mobile Subscriber Identity (IMSI) Multiple MSISDNs (SIMM) service to outbound roamers of a Home
15 Public Mobile Network (HPMN), in accordance with an embodiment of the present invention;

FIG. 2 represents a flowchart for facilitating mobile communication of the HPMN's SIMM outbound roamer having one or more Mobile Station International Subscriber Directory Numbers (MSISDNs) corresponding to special partner FPMNs, and
20 an HPMN MSISDN, using a passive monitoring based solution, in accordance with an embodiment of the present invention;

FIG. 3 represents a flow diagram of SIMM service subscription activation at an XPMN using Short Message Service (SMS), in accordance with an embodiment of the
present invention;

25 FIGS. 4A and 4B represent a flow diagram for passively detecting the outbound roamer's registration with an FPMN using a monitoring module, in accordance with an embodiment of the present invention.

FIG. 5 represents a flow diagram for facilitating Mobile Terminated (MT) call on the SIMM outbound roamer's special range FPMN MSISDN, when the SIMM outbound
30 roamer is passively detected to be registered with a PMN, in accordance with a first embodiment of the present invention;

FIG. 6 represents a flow diagram for terminating MT call on the SIMM outbound roamer's special range FPMN MSISDN, when the SIMM outbound roamer is passively detected to be registered with the PMN other than the FPMN, in accordance with a second embodiment of the present invention;

5 FIG. 7 represents a flow diagram for facilitating MT SMS on the SIMM outbound roamer's special range FPMN MSISDN, when a sender of the MT SMS belongs to the HPMN, in accordance with a first embodiment of the present invention;

FIG. 8 represents a flow diagram for facilitating MT SMS on the SIMM outbound roamer's special range FPMN MSISDN without routing the MT SMS via the SG, in
10 accordance with a second embodiment of the present invention;

FIG. 9 represents a flow diagram for facilitating MT SMS on the SIMM outbound roamer's special range FPMN MSISDN, when the sender does not belong to the HPMN, in accordance with a third embodiment of the present invention;

FIG. 10 represents a flow diagram for facilitating Mobile Originated (MO) call by
15 the SIMM outbound roamer in the FPMN, when the SIMM outbound roamer is a prepaid subscriber of the HPMN, in accordance with an embodiment of the present invention;

FIG. 11 represents a flow diagram for facilitating MO SMS by the SIMM outbound roamer, when a recipient number of the MO SMS is of a country different from the FPMN country, in accordance with a first embodiment of the present invention; and

20 FIGS. 12A, 12B, and 12C represent a flow diagram for facilitating MO SMS by the SIMM outbound roamer, when the recipient number is of the FPMN country, in accordance with a second embodiment of the present invention.

Detailed Description

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In the following description, for purposes of explanation, specific numbers, materials and configurations are set forth in order to provide a thorough understanding of the present invention. It will be apparent, however, to one having ordinary skill in the art that the present invention may be practiced without these specific details. In some
30 instances, well-known features may be omitted or simplified, so as not to obscure the present invention. Furthermore, reference in the specification to "one embodiment" or

"an embodiment" means that a particular feature, structure or characteristic, described in connection with the embodiment, is included in at least one embodiment of the present invention. The appearance of the phrase "in an embodiment", in various places in the specification, does not necessarily refer to the same embodiment.

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The present invention provides a system, a method, and a computer program product that allows a home network operator to provide Single International Mobile Subscriber Identity ("IMSI") Multiple MSISDNs ("SIMM") service to its outbound roamers visiting one or more friendly visited networks.

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In the SIMM service each subscriber (or outbound roamer) of home network, who is roaming in the coverage area of participating visited networks (called "friendly" visited networks or "FPMN" for the purpose of this specification), is offered one or more Mobile Station International Subscriber Directory Numbers (MSISDNs) corresponding to those friendly visited networks. (The outbound roamers that subscribe to the home network's SIMM service are hereinafter interchangeably referred to as (SIMM subscribers.") Such a SIMM service can assign the MSISDNs of friendly visited networks to a SIMM outbound roamer, and allows the roamer to make and receive calls, and send and receive Short Message Service (SMS) using his assigned MSISDNs at tariffs less than normal roaming rates (i.e., roaming rates without the SIMM service). In order to provide SIMM service, the home network's friendly visited network operators each ascribes a pre-defined range of MSISDNs (i.e. special range MSISDNs) to the home network for outbound roamers traveling from their home network to any of the friendly visited networks. Under the present invention, those special range MSISDNs can be allocated to SIMM subscribers when they roam in the coverage area of FPMNs and do not otherwise have an MSISDN from that FPMN (for example by means of swapping their SIM cards).

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One or more MSISDNs belong to this pre-defined range of MSISDNs, in accordance with an embodiment of the present invention. In another embodiment of the present invention, the home network operator offers the SIMM service to its outbound roamers who already possess friendly visited network MSISDNs, by other means (such as already being subscribers to the FPMN, already having purchased a SIM card from that FPMN, or already participating in another program that assigns them an MSISDN

from the friendly network). So under the present invention, SIMM service can even be provided in concert with an outbound roamer's existing friendly visited network MSISDN (i.e., no new special range friendly visited network MSISDN is required in such case).

5 In yet another embodiment of the present invention, the home network operator offers the SIMM service to its outbound roamers on a new special range of friendly visited network MSISDNs at a first friendly visited network, even when they already possess friendly visited network MSISDN corresponding to a second friendly visited network. The SIMM service allows SIMM subscribers to switch between any of the
10 assigned friendly visited network MSISDNs (even within the same coverage area) based on their needs and benefits.

In addition, the SIMM subscribers may also use their respective home network MSISDNs to initiate and receive calls or other communications while they are roaming in
15 any friendly visited network of the home network. In other words, the SIMM service allows SIMM subscriber to swap his assigned friendly visited network MSISDNs with his home network MSISDN depending on his requirements. The present invention facilitates mobile communication of SIMM outbound roamers of the home network using their respective friendly visited network MSISDNs and home network MSISDN without
20 changing their home network's existing Subscriber Identity Module (SIM) card. The present invention also caters to both prepaid and postpaid outbound roamers of the home network.

In an embodiment of the present invention, the home network operator defines the
25 tariff for calls, SMS, data or any communications to and from the friendly visited network MSISDNs for these roamers based in concert with the friendly visited network operators for offering the SIMM service. An agreement between a home operator running a SIMM service and participating friendly network operators can include provisions for the exchange of billing information, and other features described in this specification In
30 another embodiment of the present invention, the home network operator charges its SIMM outbound roamers at local rates for mobile communication to and from the

friendly visited network MSISDNs. In addition, the home network operator may also offer various other Value Added Services (VAs) such as, but not limited to, Missed Call Alert (MCA) and Calling Line Identification (CLI) to its SIMM outbound roamers. Moreover, the present invention ensures that other mobile services, such as General
5 Packet Radio System (GPRS), Wireless Access Protocol (WAP), and Multimedia Message Service (MMS) of these SIMM roamers remain unaffected by the SIMM service.

To establish a SIMM service, the home network operator can deploy a Signaling
10 Gateway (SG) and a monitoring module, either at a Mobile Virtual Network Operator (MVNO) of the home network or in the home network itself, in order to allow its outbound roamers to avail SIMM service. FIG. 1 illustrates a system 100 that provides SIMM service to outbound roamers of a Home Public Mobile Network (HPMN) 102 (i.e., the home network), in accordance with an embodiment of the present invention.
15 System 100 includes an SG 104 and a monitoring module 106 in HPMN 102, in accordance with an embodiment of the present invention.

In another embodiment of the present invention, SG 104 and monitoring module 106 resides in an MVNO of HPMN 102. System 100 further includes a first Friendly Public Mobile Network (FPMN1) 108 (i.e., the friendly visited network), and a second
20 FPMN (FPMN2) 110. It will be apparent to a person skilled in the art that system 100 may apply also to various other FPMNs (other than FPMN1 108 and FPMN2 110). However, for the sake of convenience, this embodiment considers only two FPMNs (i.e., FPMN1 108 and FPMN2 110). An operator of HPMN 102 offers the SIMM service to its outbound roamers in any of these FPMNs.

25 In one embodiment of the present invention these FPMNs are national roaming partners of HPMN 102. In another embodiment of the present invention, the FPMNs can be international roaming "partners" of HPMN 102. So HPMN 102, FPMN1 108, and FPMN2 110 may reside in the same country or in different countries.

30 In an embodiment of the present invention, a subscriber 112 of HPMN 102 makes a registration attempt at FPMN1 108 and a standard registration process follows where

FPMN1 108 and HPMN 102 exchanges registration Mobile Application Part (MAP) messages, such as a Location Update (LUP), an Insert Subscriber Data (ISD), an ISD-ACK, and a LUP-ACK. Subscriber 112 may request for HPMN 102's SIMM service in FPMN1 108 either once he is registered with FPMN1 108 or from a different network even before he registers with FPMN1 108. Of course, in the latter case, subscriber 112 is able to start making use of the SIMM service in FPMN1 108 only once when he registers with FPMN1 108.

HPMN 102 operator can also provide SIMM service to subscriber 112 (i.e. outbound roamer 112) even when he moves to a network different from FPMN1 108. (Hereinafter, subscriber 112 is interchangeably referred to as outbound roamer 112). When subscriber 112 registers for the SIMM service he is referred to as SIMM outbound roamer 112. Once outbound roamer 112 subscribes to HPMN 102's SIMM service, SG 104 assigns a special range FPMN1 MSISDN (i.e., a special range MSISDN from one or more assigned MSISDNs) hereinafter referred to as MSISDN-F1, a special range FPMN2 MSISDN hereinafter referred to as MSISDN-F2, and so on to outbound roamer 112. SG 104 may do this whenever outbound roamer 112 does not have an existing SIMM subscription with HPMN 102. Alternatively, in case outbound roamer 112 has an pre-existing FPMN1 MSISDN, hereinafter interchangeably referred to as MSISDN-F1', SG 104 actually itself assigns the MSISDN-F1' to outbound roamer 112.

In an embodiment of the present invention, if SG 104 is integrated with monitoring module 106, SG 104 passively (i.e., non-intrusively taps signaling path) detects subscriber 112's registration with FPMN1 108, using monitoring module 106. Monitoring module 106 taps national or international Signaling System #7 (SS7) (or Sigtran, or any other type of signaling) links (corresponds to roaming signaling links) of subscriber 112 in HPMN 102, in order to monitor the exchange of various MAP messages including, but not limited to, all registration messages, a RestoreData message, and a RestoreData-ACK message. In other words, SG 104 does not intrude signaling path between FPMN1 108 and HPMN 102 for subscriber 112's registration with FPMN1 108, but utilizes the information from that signalling.

Also, in some cases, SG 104 may not even monitor a signaling path for subscriber 112's MO activities (like calls, SMS, and GPRS) in FPMN1 108. Similarly, SG 104 may optionally not involve itself with Mobile Terminated (MT) calls, SMSs or other traffic from SIMM subscriber 112's HPMN MSISDN (i.e., the home network MSISDN), hereinafter referred to as MSISDN-H. So even when SG 104 is inoperable or fails, the MT roaming services on the MSISDN-H and MO roaming services could remain uninterrupted. Another example of coping with a failure or crash of SG 104, HPMN 102 operator whose outbound roamers are subscribed to the SIMM service in FPMN1 108, need to configure its Short Message Service Centers (SMSCs) or SMS gateways to allow access by these SIMM outbound roamers using any assigned MSISDN in FPMN1 108. Moreover, SG 104 does not even intercept SIMM subscriber 112's signaling path for GPRS, WAP, and MMS services, in accordance with an embodiment of the present invention. Furthermore, HPMN 102 operator uses SG 104 to handle billing of its SIMM outbound roamer 112 while he is subscribed to HPMN 102's SIMM service in FPMN1 108 (or any other FPMN that has a special roaming agreement with HPMN 102, hereinafter interchangeably referred to as special partner FPMN, for supporting the SIMM service).

System 100 may further include in HPMN 102, a roaming Signal Transfer Point (STP) 114, a Home Location Register (HLR) 116, a Gateway Mobile Switching Center (GMSC) 118, an SMSC 120, a Visited Location Register (VLR) 122, a Visited Mobile Switching Center (VMSC) 124, and an Unstructured Supplementary Service Data (USSD) gateway 126. Since, STP 114, HLR 116, GMSC 118, SMSC 120, VLR 122, VMSC 124, and USSD Gateway 126 reside in HPMN 102, they are hereinafter referred to as STP-H 114, HLR-H 116, GMSC-H 118, SMSC-H 120, VLR-H 122, VMSC-H 124, and USSD-H 126, respectively. SG 104, STP-H 114, HLR-H 116, GMSC-H 118, SMSC-H 120, VLR-H 122, VMSC-H 124, and USSD-H 126 may be interconnected, and communicate with each other over SS7 (Sigtran or other signaling) links.

System 100 further includes in FPMN1 108, an STP 128, an HLR 130, a GMSC 132, an SMSC 134, a VLR 136, and a VMSC 138. Since, STP 128, HLR 130, GMSC

132, SMSC 134, VLR 136, and VMSC 138 reside in FPMN1 108, they are hereinafter referred to as STP-F1 128, HLR-F1 130, GMSC-F1 132, SMSC-F1 134, VLR-F1 136, and VMSC-F1 138, respectively. STP-F1 128, HLR-F1 130, GMSC-F1 132, SMSC-F1 134, VLR-F1 136, and VMSC-F1 138 are interconnected, and communicate with each other over the SS7 links. Similarly, system 100 further includes in FPMN2 110, an STP-F2 140, a VLR-F2 142, and a VMSC-F2 144.

Network elements in HPMN 102 communicate with network elements in FPMN1 108 and FPMN2 110 via an International Service Carrier (ISC) (not shown in FIG. 1), when HPMN 102, FPMN1 108, and FPMN2 110 reside in different countries, and subscribers of HPMN 102 are roaming in FPMN1 108 and FPMN2 110. System 100 further includes in the ISC, a first International STP (ISTP) that communicates with STP-F1 128, a second ISTP that communicates with STP-H 114, and a third ISTP that communicates with STP-F2 140. It will be apparent to a person skilled in the art that HPMN 102, FPMN1 108, and FPMN2 110 may also include various other network elements (not shown in FIG. 1), depending on the architecture under consideration.

As described earlier, HPMN 102 would normally need a discrete arrangement with every FPMN in order to provide SIMM service to outbound roamers traveling in these FPMNs. In an embodiment of the present invention, the special agreement entails a mutual understanding between HPMN 102 and FPMN1 108 operators to bill outbound roamers from HPMN 102 while they are subscribed to the SIMM service of HPMN 102.

As noted earlier, subscriber 112 of HPMN 102 would normally need first to subscribe for the SIMM service in order to avail benefits offered by HPMN 102 operator. An embodiment of the present invention presents a convenient method of permitting subscriber 112 to subscribe to the SIMM services when needed, or at his election. Subscriber 112 has an HPMN SIM with a corresponding HPMN IMSI, hereinafter referred to as IMSI-H, and MSISDN-H. FIG. 2 represents a flowchart for facilitating mobile communication of SIMM outbound roamer 112 having one or more MSISDNs corresponding to special partner FPMNs, (hereinafter interchangeably referred to as

MSISDN-Fs), and MSISDN-H using a passive monitoring based solution, in accordance with an embodiment of the present invention. At step 202, SG 104 passively detects subscriber 112's registration with FPMN1 108. In one embodiment of the present invention, SG 104 uses monitoring module 106 to passively detect exchange of registration messages between FPMN1 108 and HPMN 102.

Then at step 204, SG 104 assigns MSISDNs to subscriber 112 based on a received subscription activation request. In an embodiment of the present invention, SG 104 assigns MSISDN-F1 (or MSISDN-F1' in case he already has an MSISDN) to subscriber 112 upon receiving the subscription activation request from subscriber 112 at SG 104. In another embodiment of the present invention, SG 104 assigns MSISDN-F2 to subscriber 112. This subscription activation request corresponds to subscriber 112's request to utilize HPMN 102's SIMM service. In one embodiment of the present invention, SG 104 assigns MSISDN-F1 (or MSISDN-F1') to subscriber 112 temporarily. In another embodiment of the present invention, SG 104 can assign MSISDN-F1 (or MSISDN-F1') to subscriber 112 permanently. Moreover subscriber 112 can cancel that permanent or temporary assignment of MSISDN-F1 anytime by sending a subscription deactivation request to SG 104.

Then at step 206, SG 104 associates assigned MSISDNs (and its corresponding one or more IMSIs) with the MSISDN-H (and its corresponding IMSI-H) of subscriber 112. In an embodiment of the present invention, SG 104 stores the association of the assigned MSISDNs with the MSISDN-H in a subscription database coupled to SG 104. In another embodiment of the present invention, the subscription database stores an association of the HPMN IMSI with IMSIs corresponding to the assigned MSISDNs. In case SIMM outbound roamer 112 is using MSISDN-F1, the subscription database stores an association of the IMSI-H with an FPMN1 IMSI corresponding to the MSISDN-F1. The FPMN1 IMSI is hereinafter interchangeably referred to as IMSI-F1. In case subscriber 112 uses MSISDN-F1', IMSI-F1 is replaced with an existing FPMN1 IMSI (hereinafter referred to as IMSI-F1') corresponding to MSISDN-F1'. In addition, the subscription database stores subscriber 112's current location in FPMN1 108, in

accordance with yet another embodiment of the present invention. In an embodiment of the present invention, the subscription database resides within SG 104.

Alternatively, SG 104 may receive the subscription activation or subscription
5 deactivation request from subscriber 112, while he is registered on almost any network. For example, SG 104 can receive the subscription or deactivation requests via HPMN 102, the MVNO associated with HPMN 102, a Visited Public Mobile Network (VPMN), or any other partner FPMN of HPMN 102 (i.e., other than FPMN1 108). The VPMN
10 corresponds to a PMN that has no agreement with HPMN 102 to support SIMM service for outbound roamers of HPMN 102. In case subscriber 112 sends the subscription activation request from either HPMN 102, the MVNO of HPMN 102, the VPMN, or any other partner FPMN, steps 204 and 206 will be performed prior to step 202.

Then, at step 208, SG 104 sends a default MSISDN to VLR-F1 136. In an
15 embodiment of the present invention, SG 104 sends MSISDN-F1 (or MSISDN-F1') as the default MSISDN to VLR-F1 136. SIMM subscriber 112 can at anytime change this default MSISDN to a different MSISDN by sending a MSISDN change request message to set his default MSISDN to either MSISDN-H or any assigned MSISDN other than MSISDN-F1/MSISDN-F1'. So at step 210, SG 104 modifies the default MSISDN to
20 either the assigned MSISDN or MSISDN-H, when an MSISDN change request is received at SG 104 from SIMM subscriber 112. In one embodiment of the present invention, SG 104 receives the subscription activation request and MSISDN change request from subscriber 112 via SMSC-H 120. In another embodiment of the present invention, SG 104 receives the subscription activation and MSISDN change request from
25 subscriber 112 via USSD-H 126.

In one embodiment of the present invention, in order to allow subscriber 112 to change his default MSISDN from his HPMN 102, subscriber 112 needs to explicitly change his caller ID each time there is a change in HPMN 102 VLR location of subscriber 112. This is done since monitoring module 106 does not detect signaling
30 exchange, such as Location Update (LUP) at HPMN 102, since it is generally not cost effective for HPMN 102 operator to monitor its local links. The subscription activation

request, MSISDN change request and subscription deactivation request can be made by any means available, including without limitation by means of an SMS message, an USSD message, a customer care call, a Wireless Application Protocol (WAP) interaction, a World Wide Web (WWW) interaction, and an Interactive Voice Response (IVR) message. The explicit commands of MSISDN change allow subscriber 112 to set his default MSISDN to either MSISDN-H, MSISDN-F1 (in case this is not the last set default MSISDN), MSISDN-F2 or any other assigned MSISDN for subscriber 112. For example, subscriber 112 can change a Hong Kong FPMN number to a Taiwan FPMN number when registered at the Hong Kong FPMN. As mentioned earlier, HPMN 102 operator can also offer SIMM service to its outbound roamer in FPMN1 108 who already has MSISDN-F1' defined at HLR-F1 130.

Finally, at step 212, SG 104 facilitates SIMM subscriber 112's mobile communication in FPMN1 108 using either the default MSISDN (i.e. MSISDN-F1, MSISDN-F1', MSISDN-F2 or so on), or MSISDN-H, or both. In other words, subscriber 112's MO and MT activities are facilitated in FPMN1 108 using the default MSISDN and MSISDN-H of subscriber 112. Step 210 described earlier is optional, i.e., it is performed only when the MSISDN change request is received at SG 104. Hence in one embodiment of the present invention, SG 104 allows subscriber 112 to initiate and receive calls/SMS in FPMN1 108 using both the MSISDN-F1/MSISDN-F1' and MSISDN-H, when the default MSISDN remains unchanged as the MSISDN-F1/MSISDN-F1'. In another embodiment of the present invention, in case SG 104 changes the default MSISDN to MSISDN-H, SIMM subscriber 112 is able to make and receive calls/SMS using only MSISDN-H. In yet another embodiment of the present invention, SIMM subscriber 112 makes and receives calls/SMS in FPMN1 108 using any other partner FPMN MSISDN (i.e., any other assigned MSISDN) and MSISDN-H, when default MSISDN is set as the partner FPMN MSISDN (i.e., the MSISDN change request received at SG 104 indicates default MSISDN as partner FPMN MSISDN).

As explained earlier, HPMN 102's outbound roamers can subscribe or cancel or modify the SIMM service from any PMN. FIG. 3 represents a flow diagram of the SIMM

service subscription activation at an XPMN using SMS, in accordance with an embodiment of the present invention. The XPMN corresponds to any visited network including FPMN1 108. At step 302, SG 104 sends a welcome SMS to subscriber 112 via a VMSC-X 303 associated with the XPMN, in order to promote SIMM service. In an exemplary case, when subscriber 112 is already registered with FPMN1 108 and SG 104 has passively detected this registration at VLR-F1 136 (and VMSC-F1 138), the welcome message may contain the following text: "Dear HPMN 102 customer, you are currently registered with FPMN1 108 in country 'Y' (or zone 'Z' in country 'Y'). SMS 'SIMM' to 5678 and get local numbers for FPMN1 108 or any other FPMN in same or different country/zone. You may also call 12345678 and say 'SIMM' to avail this service. Wishing you a pleasant stay in FPMN1 108 'Y' (or FPMN1 108 'Z')." Subscriber 112 then sends the subscription activation request to VMSC-X 303 as a reply SMS in order to subscribe to HPMN 102's SIMM service. This subscription activation request needs to indicate country/zone or an FPMN (like FPMN1 108 in this embodiment of SIMM service subscription activation) or both corresponding to which subscriber 112 has an FPMN MSISDN. All subscription activation/MSISDN change/welcome/reminder messages are relayed to SG 104 either via SMSC-H 120 or via USSD-H 126.

Thereafter, at steps 304 and 306, VMSC-X 303 relays the subscription activation request to SG 104 via SMSC-H 120, along with the indication of subscriber 112's choice of FPMN/country/zone for availing the SIMM service. SG 104 then assigns MSISDNs corresponding to special partner FPMNs (and then associates these MSISDNs with the MSISDN-H) to subscriber 112 (who is either roaming or expected to roam in FPMN1 108), and sends a message containing information about these MSISDNs to subscriber 112. In an embodiment of the present invention, SG 104 sends an SMS to SIMM subscriber 112 in order to inform him about each assigned MSISDN and any associated charging (e.g., subscription fee, expiration rule (i.e., number of days/months/years for which MSISDN-F1 is temporarily allotted to subscriber 112), tariff, etc.). SG 104 then sets a default MSISDN for subscriber 112 at a VLR-X 307 associated with the XPMN. Hence at step 308, SG 104 sends the default MSISDN in a standalone Insert Subscriber Data (ISD) message to VLR-X 307. In an embodiment of the present invention, in case

subscriber 112 has indicated FPMN1 108 as the roaming network corresponding to which subscriber 112 needs a local number, HPMN 102 operator configures SG 104 to set the default MSISDN as MSISDN-F1 or MSISDN-F1' for subscriber 112's first time SIMM service subscription. Additionally at step 308, SG 104 sends an Intelligent Network (IN) trigger profile in the standalone ISD message to VLR-X 307. Finally, at step 310, VLR-X 307 returns an ISD-ACK message to SG 104. In case SIMM subscriber 112 selects an MSISDN from the group of assigned MSISDNs, subscriber 112's reply path is via SMSC-H 120, which further relays it to SG 104, in accordance with an embodiment of the present invention. This results in setting the selected MSISDN as the default MSISDN for subscriber 112. Thereafter, subscriber 112 uses this MSISDN while to perform mobile activities (like MO and MT call/SMS) while he is registered with FPMN1 108 (since he indicated FPMN1 108 during the subscription activation request).

Since subscriber 112 has the ability to change his default MSISDN anytime, he may send the MSISDN change request to SMSC-H 120 via VMSC-X 303. SMSC-H 120 then relays the received request to SG 104. This MSISDN change is hereinafter interchangeably referred to as Calling Line Identification (CLI) change, in accordance with an embodiment of the present invention. In case during subscription activation, MSISDN change, and subscription deactivation; subscriber 112's MSISDN (i.e., either any assigned MSISDN or MSISDN-H) at VLR-X 307 is different from the last set default MSISDN, then SG 104 issues the standalone ISD message to VLR-X 307 in order to set the new default MSISDN for subscriber 112. In case subscriber 112 sends the MSISDN change request for the first time, the default MSISDN (which is MSISDN-F1/ MSISDN-F1') is changed to either any other assigned MSISDN (i.e., other than MSISDN-F1/MSISDN-F1') or MSISDN-H at SG 104, in accordance with an embodiment of the present invention. Thus SG 104 sends the new default MSISDN (i.e., other than MSISDN-F1/MSISDN-F1') with an optional IN trigger profile in the standalone ISD message to VLR-X 307. Alternatively, subscriber 112 sends the subscription activation request or MSISDN change request or subscription deactivation request to VMSC-X 303 that relays the request to VLR-X 307. VLR-X 307 then relays the received request to USSD-H 126 via HLR-H 116. USSD-H 126 further relays the received request to SG

104, in accordance with an embodiment of the present invention. Moreover in this embodiment, SG 104 sends the standalone ISD message with the default MSISDN and optional IN trigger profile to VLR-X 307, which responds with ISD-ACK to SG 104.

5 In an embodiment of the present invention, subscriber 112 may subscribe to HPMN 102's SIMM service even before he travels to FPMN1 108 (e.g., from HPMN 102 or any other VPMN) or may subscribe to SIMM service while he is visiting FPMN1 108 for the second time. In such a case, whenever subscriber 112 registers with FPMN1 108, SG 104 sends a reminder message to subscriber 112 that indicating the last set
10 default MSISDN allotted to him during his previous subscription to the SIMM service.

FIGS. 4A and 4B represents a flow diagram for passively detecting outbound roamer 112's registration with the XPMN using monitoring module 106, in accordance with an embodiment of the present invention. In an embodiment of the present invention
15 HPMN 102 operator deploys a traffic steering mechanism to redirect SIMM outbound roamer 112's traffic to the XPMN (such as FPMN1 108) in case monitoring module 106 passively detects SIMM outbound roamer 112's registration attempt with the VPMN. In one embodiment of the invention the VPMN is a competitor PMN of HPMN 102. As shown at step 402, HLR-H 116 receives a LUP message on the IMSI-H and a VLR-C
20 location of SIMM outbound roamer 112 from a VLR-C 403 associated with the VPMN. Thereafter, at step 404, SG 104 using its integrated traffic steering mechanism sends a LUP-ACK message with error messages to VLR-C 403, in order to reject SIMM outbound roamer 112's registration attempt at VLR-C 403. The error messages include messages such as, but not limited to, System Failure (SF), Roaming Not Allowed (RNA),
25 Cancel Location, and Roaming Restricted due to unsupported feature (RR). In an embodiment of the present invention, HPMN 102 operator uses the integrated traffic steering mechanism to redirect SIMM outbound roamer 112's traffic to the XPMN for a configurable number of times (e.g., for four times). In one embodiment of the present invention, HPMN 102 operator allows SIMM outbound roamer 112 to register with the
30 VPMN in case either the XPMN does not have roaming coverage for SIMM outbound roamer 112, or SIMM outbound roamer 112 selects VPMN manually. In another

embodiment of the present invention, HPMN 102 operator restricts SIMM outbound roamer 112 to register with the VPMN in case VPMN resides in the XPMN country. In yet another embodiment of the present invention, HPMN 102 operator restricts SIMM outbound roamer 112 to GPRS register with the VPMN by rejecting GPRS LUP attempts of outbound roamer 112 at the VPMN that resides in the XPMN country. SG 104 may reject these GPRS LUP attempts until SIMM outbound roamer 112 registers successfully with the VPMN.

In another embodiment of the present invention, when outbound roamer 112 makes a registration attempt at the XPMN, VLR-X 307 exchanges standard registration messages with HLR-H 116, at steps 406 to 412. In an embodiment of the present invention, outbound roamer 112 registers with the XPMN using MSISDN-F1'. In another embodiment of the present invention, outbound roamer 112 registers with the XPMN using MSISDN-H. In an embodiment of the present invention, monitoring module 106 detects exchange of registration messages between VLR-X 307 and HLR-H 116. In another embodiment of the present invention, monitoring module 106 detects a receipt of cancel location message from HLR-H 116 to cancel outbound roamer 112's registration with the XPMN. Thereafter, at step 414, SG 104 sends the default MSISDN and optional IN trigger profile in the standalone ISD message to VLR-X 307, when outbound roamer 112 is already subscribed for HPMN 102's SIMM service. Finally, at step 416, VLR-X 307 responds with ISD-ACK to SG 104. Optionally, at step 418 (illustrated in dashed lines in FIGS. 4A and 4B), SG 104 sends a reminder message to outbound roamer 112 via VMSC-X 303 that indicates his last set default MSISDN allotted to him during subscription to the SIMM service. Alternatively, in case outbound roamer 112, who is registered with the XPMN, is not yet subscribed to HPMN 102's SIMM service, then the subscription process explained earlier in conjunction with FIG. 3 follows prior to performing steps 414 and 416. Rest of the call flow of outbound roamer 112's registration with the XPMN in such a case follows that explained above in conjunction with FIG. 4A and 4B.

In some cases, HLR-H 116 may reset due to any failure (or update) at HLR-H 116. This results in potentially affecting the SIMM service of outbound roamer 112 (and roaming services of other roamers of HLR-H 116 in the XPMN). In one kind of case in which a HLR-H 116 resets, a RESET (HLR-number, IMSI-LIST) message is received at VLR-X 307 from HLR-H 116. This removes the roaming profile of those outbound roamers of HPMN 102 from VLR-X 307; whose home network IMSIs match the IMSI-LIST (or HLR numbers stored in these roamers' record at VLR-X 307 match the HLR number) received in the RESET message. Since outbound roamer 112 is also currently registered with VLR-X 307 for the SIMM service, the IMSI-LIST contains IMSI-H of outbound roamer 112. Hence outbound roamer 112's profile is also removed from VLR-X 307.

In another case, VLR-X 307 receives a roaming number request (like Provide Roaming Number (PRN)) from HLR-H 116 for an MT call on the IMSI-H but VLR-X 307 has no record for outbound roamer 112's IMSI-H. So in both cases, VLR-X 307 restores outbound roamer 112's profile by exchanging various MAP messages, such as RestoreData (IMSI-H, VLR-X/VMSC-X), an ISD (MSISDN-H), an ISD-ACK, and a RestoreData-ACK with HLR-H 116. Monitoring module 106 detects exchange of these MAP messages, and in case outbound roamer 112 is subscribed to HPMN 102's SIMM service, steps 414 to 418 are performed where SG 104 sends standalone ISD message to VLR-X 307, and then SG 104 optionally sends the reminder message to outbound roamer 112 via VMSC-X 303.

SG 104 and monitoring module 106 control MT calls/SMS on the assigned MSISDN of SIMM subscriber 112 for better quality of service, monitoring and billing, in accordance with various embodiments of the present invention. Although direct MT call/SMS routing is also possible (i.e., without involving SG 104); however, even in such cases, a routing query (like SRI and SRI-SM) on the special range MSISDN-F1, or a roaming number request message (like PRN) is received at SG 104. This is because SG 104 acts as the virtual HLR for special range MSISDNs and the virtual VMSC/VLR for existing MSISDNs of FPMN1 108.

In the remainder of this specification, all call and SMS flows consider that outbound roamer 112 is already subscribed to HPMN 102's SIMM service. FIG. 5 represents a flow diagram for facilitating MT call on SIMM outbound roamer 112's special range MSISDN-F1, when SIMM outbound roamer 112 is passively detected to be registered with a PMN, in accordance with a first embodiment of the present invention. The PMN is hereinafter interchangeably referred to as the XPMN. This embodiment considers routing of the call from FPMN1 108 to the PMN via HPMN 102. In an embodiment of the present invention, HPMN 102 operator applies this case when SIMM subscriber 112 is detected to be either absent from FPMN1 108 of the special range MSISDN-F1 or absent from some PMN configured at SG 104. In an embodiment of the present invention, monitoring module 106 detects the current location of SIMM subscriber 112. Moreover, HPMN 102 operator can get billing records of SIMM subscriber 112 for reconciliation purpose. Additionally, HPMN 102 operator may also monitor the MT call on the MSISDN-F1 for legal interception and quality assurance purpose. In an embodiment of the present invention the quality assurance is to ensure caller ID delivery to outbound roamer 112 since HPMN 102 ensures guarantee of the delivery of caller ID to SIMM subscriber 112 which FPMN1 108 does not guarantee when SIMM subscriber 112 is registered with the PMN.

When B (i.e., a calling party in case of MT calls) makes a call to SIMM subscriber 112 (hereinafter interchangeably referred to as subscriber A) on his special range MSISDN-F1, at step 502 GMSC-F1 132 receives a call control request, such as ISDN User Part (ISUP) IAM (B, MSISDN-F1) from B. Then, at step 504, GMSC-F1 132 sends a routing request message, such as a Send Routing Information (SRI) query on the special range MSISDN-F1 to SG 104, since SG 104 is the virtual HLR for SIMM subscriber 112's special range MSISDN-F1. Since SG 104 is present in HPMN 102 (or the MVNO of HPMN 102), any node in FPMN1 108 (like GMSC-F1 132) can route signaling messages (e.g., SRI, SRI-SM, etc.) on the special range MSISDN-F1 to SG 104 either via a leased line connection (i.e., SCCP link) between FPMN1 108 and HPMN 102 for the Signal Connection Control part (SCCP) signaling on MSISDN-F1, or using a standard Global Title (GT) based routing. In case of GT based routing, STP-F1 128 maps

the SCCP Called Party Address (CdPA) MSISDN-F1 to SG 104's GT in order to route signaling messages on MSISDN-F1 to SG 104, in accordance with an embodiment of the present invention. SG 104 then can recover the MSISDN-F1 from the MAP parameter of SRI/SRI-SM messages. SG 104 then facilitates the MT call by replacing special range
5 MSISDN-F1 with MSISDN-H, and then sending MSISDN-H to HLR-H 116. So at step 506, SG 104 sends the SRI message (or query) on the MSISDN-H to HLR-H 116. And at step 508, HLR-H 116 sends a roaming number request on the IMSI-H, such as PRN (IMSI-H) message to VLR-X 307 (i.e., subscriber 112's current location) associated with the XPMN. At step 510, VLR-X 307 returns a roaming number, such as Mobile Station
10 Roaming Number (MSRN) in a Provide Roaming Number (PRN)-ACK message to HLR-H 116. Then, at step 512, SG 104 can receive MSRN in an SRI-ACK message from HLR-H 116.

Further at step 514, SG 104 modifies the MSRN to a new roaming number, such
15 as an MSRN', and issues SRI-ACK message with the MSRN' to GMSC-F1 132. In an embodiment of the present invention, SG 104 stores a mapping of MSRN and MSRN'. In one embodiment of the present invention, the MSRN' is a number of special range. In another embodiment of the present invention, the MSRN' is a special prefixed number. Since SG 104 has earlier modified MSRN to MSRN'; the call control signaling, such as
20 ISUP IAM (B, MSRN') is received at SG 104 from GMSC-F1 132, at step 516. It will be apparent to a person skilled in the art that various signaling options such as, but not limited to, an ISUP loop back and an IN protocol can be used from GMSC-F1 132 to SG 104. These signaling are exchanged over a leased line connection from FPMN1 108 to HPMN 102, in accordance with an embodiment of the present invention. Finally, at step
25 518, SG 104 modifies MSRN' back to MSRN, and then issues a call control signaling, such as IAM (B, MSRN) to a VMSC-X 303 associated with the XPMN.

Alternatively, in another embodiment of the present invention, the MT call on the special range MSISDN-F1 is optimally routed from FPMN1 108 to subscriber 112's
30 currently registered PMN without relaying the MT call through SG 104 in HPMN 102. Steps 502 to 512 are applicable even in this embodiment, where SG 104 modifies SRI

message on the special range MSISDN-F1 to SRI message on the MSISDN-H before sending the SRI message to HLR-H 116, and then later it receives MSRN in the SRI-ACK message from HLR-H 116. However, upon receiving this SRI-ACK message, SG 104 does not modify MSRN to MSRN', and hence relays the received SRI-ACK (MSRN) message to GMSC-F1 132. Finally, GMSC-F1 132 establishes a call ISUP IAM (B, MSRN) directly with VMSC-X 303. In an embodiment of the present invention, HPMN 102 operator applies this case when monitoring module 106 detects SIMM subscriber 112 to be present either in FPMN1 108 or at some other PMN configured at SG 104.

In yet another embodiment of the present invention, SIMM subscriber 112 while roaming in the PMN uses MSISDN-F1', and the MT call on subscriber 112's MSISDN-F1' is routed from FPMN1 108 to subscriber 112's currently registered PMN via SG 104 in HPMN 102. In this case, GMSC-F1 132 sends signaling messages, such as SRI (MSISDN-F1') to HLR-F1 130 (i.e., instead of SG 104) that has profile information (like MSISDN-F1') of SIMM subscriber 112. Thereafter, SG 104 receives a roaming number request message on the IMSI-F1', such as PRN (IMSI-F1') message (i.e., instead of SRI (MSISDN-F1') message) from HLR-F1 130. SG 104 then modifies the IMSI-F1' to MSISDN-H by determining association of the MSISDN-F1'/IMSI-F1' with the MSISDN-H from the subscription database, and sends MSISDN-H in the SRI message to HLR-H 116. Thereafter, steps 508 to 512 are applicable even in this case of existing MSISDN-F1', where the MSRN is received at SG 104 from HLR-H 116. However, instead of sending signaling message, such as SRI-ACK (MSRN') from SG 104 to GMSC-F1 132 (i.e., at step 514), SG 104 sends PRN-ACK (MSRN') message to HLR-F1 130. Thereafter, HLR-F1 130 sends SRI-ACK (MSRN') message to GMSC-F1 132. The rest of the call flow where SG 104 modifies the received IAM (B, MSRN') to IAM (B, MSRN), and sends the modified IAM (B, MSRN) to VMSC-X 303 can be similar to that explained earlier at steps 516 and 518. In an embodiment of the present invention, HPMN 102 operator applies this case when monitoring module 106 detects SIMM subscriber 112 to be either absent from FPMN1 108 of the MSISDN-F1' or absent from some PMN

configured at SG 104. Moreover, HPMN 102 operator can get billing records of SIMM subscriber 112 for reconciliation purpose.

Alternatively, in another embodiment of the present invention, SIMM subscriber 112 uses MSISDN-F1', and HPMN 102 operator routes the MT call on the MSISDN-F1' directly from GMSC-F1 132 to VMSC-X 303 without involving SG 104. In this case, SG 104 does not modify MSRN to MSRN' when it receives SRI-ACK message from HLR-H 116. In an embodiment of the present invention, HPMN 102 operator applies this alternate case when monitoring module 106 detects SIMM subscriber 112 to be present either in FPMN1 108 or at some PMN configured at SG 104.

Those previous embodiments considered the scenario in which subscriber 112's MT call on the assigned MSISDN is facilitated when subscriber 112 is registered with the PMN. But in another embodiment of the present invention, HPMN 102 operator serves its SIMM outbound roamer 112 only in FPMN1 108 in case he is using MSISDN-F1 of FPMN1 108 to receive calls, and terminates calls on the assigned MSISDN in case SIMM outbound roamer 112 is present in the PMN other than FPMN1 108. This helps HPMN 102 operator to avoid roaming reroute charge for routing MT calls on the assigned MSISDN from FPMN1 108 to the PMN.

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FIG. 6 represents a flow diagram for terminating MT call on SIMM outbound roamer 112's special range MSISDN-F1, when SIMM outbound roamer 112 is passively detected to be registered with the PMN other than FPMN1 108, in accordance with a second embodiment of the present invention. At step 602, when B makes a call to SIMM subscriber 112 on his special range MSISDN-F1, GMSC-F1 132 receives ISUP IAM (B, MSISDN-F) from B. Thereafter, at step 604, GMSC-F1 132 sends SRI query on the special range MSISDN-F1 to SG 104. At step 606, SG 104 responds to the received SRI query with an absent subscriber in an SRI-ACK message, since SIMM subscriber 112 is not registered with FPMN1 108. Additionally, SG 104 can initiate a missed call alert procedure when the received SRI (MSISDN-F1) message contains B's number. In an embodiment of the present invention, SG 104 sends a missed call alert message as an

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SMS to subscriber A's handset, in order to inform the missed call from B. In another embodiment of the present invention, in case B's handset is a mobile phone, SG 104 sends the missed call alert message to B's handset, in order to inform the missed call to subscriber A. In yet another embodiment of the present invention, SG 104 sends an SMS
5 containing subscriber A's MSISDN-H to B's handset. This helps B to call back subscriber A on his MSISDN-H.

In yet another, alternative, embodiment of the present invention, SIMM subscriber 112 is not registered at FPMN1 108, and B's number is not known from the
10 received SRI (MSISDN-F1) message. In this case, SG 104 at step 608 responds to the received SRI (MSISDN-F1) message (i.e., step 604) with a special Forward-To Number (FTN) (i.e., instead of step 606). In an embodiment of the present invention, HPMN 102 operator configures SG 104 to set the special FTN as S# that is temporarily associated with the special range IMSI-F1 and MSISDN-F1 of SIMM subscriber 112. SG 104
15 selects S# from its pool of special FTNs. In an embodiment of the present invention, this pool of special FTNs is stored in the subscription database. GMSC-F1 132 then routes the ongoing MT call via ISUP (i.e., either directly or via loopback) to SG 104. Hence at step 610, GMSC-F1 132 routes ISUP IAM (B, OCN=MSISDN-F1, S#) to SG 104, where OCN indicates Originally Called Number (OCN). SG 104 then releases the ongoing MT
20 call with either a special announcement number, such as IAM (Ann#), or a release cause, such as REL (Rel-cause). Hence at step 612, SG 104 sends IAM (Ann#) or REL (Rel-cause) to GMSC-F1 132. In one exemplary case, SG 104 plays an announcement "The called party you are trying to reach is not available at the moment" to B. In another exemplary case, SG 104 plays an announcement "We are unable to reach your called
25 party, please call again later". In an embodiment of the present invention, HPMN 102 operator configures SG 104 to send "subscriber A is not available", "busy", "not answering", etc. as the release cause message to GMSC-F1 132. In another embodiment of the present invention, SG 104 disassociates S# from SIMM subscriber 112's special range MSISDN-F1 and IMSI-F1, and then sends back S# to the pool of special FTNs
30 maintained at SG 104. SG 104 can then initiate the missed call alert procedure as explained above in the context of the present invention.

In yet another embodiment of the present invention, SIMM subscriber 112 uses MSISDN-F1', and HPMN 102 operator terminates MT calls on the MSISDN-F1' when subscriber 112 is present in the PMN other than FPMN1 108. In this case, GMSC-F1 132
5 sends signaling messages, such as SRI (MSISDN-F1') to HLR-F1 130 (i.e., instead of SG 104). SG 104 then receives PRN (IMSI-F1') message from HLR-F1 130. Thereafter, SG 104 sends absent subscriber in the PRN-ACK message to HLR-F1 130 (i.e., instead of GMSC-F1 132). HLR-F1 130 then relays absent subscriber in the SRI-ACK message to GMSC-F1 132. Rest of the call flow where SG 104 initiates missed call alert procedure is
10 same as that explained earlier in conjunction with FIG. 6. However, in this case of MSISDN-F1', SG 104 determines B's number from the PRN (IMSI-F1') message (instead of SRI (MSISDN-F1) message) that is received at SG 104 from HLR-F1 130.

Alternatively, in another embodiment of the present invention, SIMM subscriber
15 112, using the MSISDN-F1', is not registered with FPMN1 108 (i.e., registered with the PMN other than FPMN1 108), and B's number is not known from the received PRN (IMSI-F1') message. In this case, SG 104 responds to HLR-F1 130 with S#. HLR-F1 130 then relays S# in the SRI-ACK message to GMSC-F1 132. The call flow for releasing the ongoing MT call on the MSISDN-F1' is same as that explained earlier at steps 610 and
20 612, except that at steps 610 and 612 the ongoing MT call on the special range MSISDN-F1 is released. Furthermore, the call flow for the ongoing MT call on the MSISDN-F1', where SG 104 initiates missed call alert procedure is same as that explained earlier in conjunction with FIG. 6.

25 SIMM subscriber 112 can also receive calls on his MSISDN-H while he is roaming in FPMN1 108 or any other visited network. This case does not require SG 104 to be involved for handling MT calls on the MSISDN-H. Hence the MT call on the MSISDN-H follows the standard MT call flow where the MT call on MSISDN-H is received at GMSC-H 118, which routes the call to either VMSC-F1 138 (i.e., in case
30 subscriber 112 is in FPMN1 108) or VMSC-X 303 (i.e., in case subscriber 112 is in the XPMN) after retrieving MSRN corresponding to MSISDN-H from VLR-F1 136 or VLR-

X 307. It will be apparent to a person skilled in the art that in case the XPMN corresponds to FPMN1 108, all network elements in the XPMN are replaced with corresponding network elements in FPMN1 108 (e.g., VLR-X 307 is replaced with VLR-F1 136). In this case of MT call on the MSISDN-H, HLR-H 116 does not send MSISDN-H in the PRN (IMSI-H) message to VLR-X 307, in accordance with an embodiment of the present invention. In case the XPMN corresponds to FPMN1 108, VLR-X 307 is replaced with VLR-F1 136. This is required for HPMN 102 operator that uses assigned MSISDNs for special billing on its SIMM outbound roamers from HPMN 102. In case the PRN message from HLR-H 116 to VLR-F1 136 contains the MSISDN-H, it changes the MSISDN called party at FPMN1 108's CDR. Thus based on HPMN 102 and FPMN1 108 operators' requirement, SIMM subscriber 112 at FPMN1 108 can only have his assigned MSISDN at FPMN1 108, and no change of caller ID (or MSISDN change) is allowed, in accordance with an embodiment of the present invention.

15 Furthermore, apart from MT calls, SIMM subscriber 112 can also receive SMS or data (non-voice call) communications on his special range MSISDN-F1 while he is roaming in the XPMN. FIG. 7 represents a flow diagram for facilitating MT SMS on SIMM outbound roamer 112's special range MSISDN-F1, when a sender of the MT SMS belongs to HPMN 102, in accordance with a first embodiment of the present invention. 20 This embodiment considers relaying the MT SMS via SG 104. This indirect routing allows HPMN 102 operator to control legal interception, spam filtering, content control, etc., and also provide better quality assurance (e.g., better SMS delivery to the XPMN of SIMM subscriber 112, despite FPMN1 108 not having a direct routing relationship with the XPMN of SIMM subscriber 112). Since the sender belongs to HPMN 102, the sender's SMS (i.e., MO-FwdSMS) is received at SMSC-H 120. Hereinafter, all MT SMS flow consider that the sender of the SMS is same as calling party B (i.e., in case of MT calls), and hence the sender is interchangeably referred to as sender B.

When SMSC-H 120 receives an SMS from the sender B, destined for SIMM subscriber 112's special range MSISDN-F1, SMSC-H 120 sends a routing request message for SMS on the special range MSISDN-F1, such as SRI-SM (MSISDN-F1) to 30

SG 104, at step 702. Thereafter at step 704, SG 104 returns the special range IMSI-F1 in an SRI-SM-ACK message to SMSC-H 120. Additionally, at step 704, SG 104 imitates SMSC-H 120 with a special SG 104's GT as subscriber 112's VMSC address by sending this special SG 104's GT in the SRI-SM-ACK message to SMSC-H 120. This causes
5 SMSC-H 120 to issue MT-FwdSMS (B, IMSI-F1) to SG 104, at step 706. HPMN 102 operator configures SG 104 to modify subscriber 112's special range MSISDN-F1 received in the SRI-SM (i.e. at step 702) to MSISDN-H so as to route the MT SMS to VMSC-X 303. Hence at step 708, SG 104 applies this logic and thus sends SRI-SM (MSISDN-H) message to HLR-H 116. Thereafter, at step 710, HLR-H 116 returns SRI-
10 SM-ACK (IMSI-H, VMSC-X) message to SG 104. At step 712, SG 104 routes the MT SMS on IMSI-H to VMSC-X 303. Further at step 714, VMSC-X 303 returns an acknowledgement message, such as MT-FwdSMS-ACK to SG 104. Finally, at step 716, SG 104 relays the received acknowledgement message to SMSC-H 120.

15 In case SIMM subscriber 112 uses MSISDN-F1' and the sender B of the MT SMS belongs to HPMN 102, when MT SMS on SIMM subscriber 112's MSISDN-F1' is received at SMSC-H 120, it sends SRI-SM query on the existing MSISDN-F1' to HLR-F1 130 (i.e., instead of SG 104) since HLR-F1 130 is the virtual HLR for the MSISDN-F1'. Thereafter, HLR-F1 130 returns special SG 104's GT and IMSI-F1' to SMSC-H
20 120. SMSC-H 120 then sends MT-FwdSMS (B, IMSI-F1') message to SG 104 for delivery of the MT SMS to subscriber A's handset. Rest of the MT SMS flow on SIMM subscriber 112's MSISDN-F1' where the MT SMS is delivered to subscriber A's handset via SG 104 is same as that explained above in conjunction with FIG. 7.

25 Alternatively, as mentioned earlier, HPMN 102 operator routes the MT SMS on subscriber 112's special range MSISDN without involving SG 104. FIG. 8 represents a flow diagram for facilitating MT SMS on SIMM outbound roamer 112's special range MSISDN-F1 without routing the MT SMS via SG 104, in accordance with a second embodiment of the present invention. In an embodiment of the present invention, HPMN
30 102 operator configures SG 104 to allow such situation when the SIMM subscribers are at the XPMN. Since the sender B in this second embodiment may or may not be from

HPMN 102, SMSC sending the SMS from sender B is considered to be an originating SMSC, hereinafter referred to as SMSC-O 801. When SMSC-O 801 receives an SMS from the sender B, destined for SIMM subscriber 112's special range MSISDN-F1, SMSC-O 801 sends SRI-SM (MSISDN-F1) to SG 104, at step 802. Thereafter at step 5 804, SG 104 applies logic to modify special range MSISDN-F1 to MSISDN-H, and then sends the modified SRI-SM (MSISDN-H) message to HLR-H 116. At step 806, HLR-H 116 returns IMSI-H and VMSC-X 303 address of subscriber 112 in an SRI-SM-ACK message to SG 104. Thereafter, at step 808, SG 104 relays the received SRI-SM-ACK message to SMSC-O 801. SMSC-O 801 then directly routes (i.e., without relaying via SG 10 104) the MT SMS, such as an MT-FwdSMS (B, IMSI-H) message to VMSC-X 303, at step 810. Finally, at step 812, VMSC-X 303 returns an MT-FwdSMS-ACK message to SMSC-O 801.

Alternatively, the HPMN 102 operator can control MT SMS on its outbound 15 roamer 112's special range MSISDN. FIG. 9 represents a flow diagram for facilitating MT SMS on SIMM outbound roamer 112's special range MSISDN-F1, when the sender does not belong to HPMN 102, in accordance with a third embodiment of the present invention. This is useful for some HPMN operators (e.g., China Mobile) that want to have control on SMS fraud, SMS spam filtering or other SMS content. In this 20 embodiment, HPMN 102 operator uses an SMS gateway 901 associated with HPMN 102, hereinafter interchangeably referred to as SMS gateway-H 901 to control MT SMS on the special range MSISDN-F1. Steps 902 to 906 are similar to steps 702 to 706, where SG 104 sends special SG 104's GT and IMSI-F1 in the SRI-SM-ACK message to SMSC-H 120 upon receiving SRI query from SMSC-H 120, and then SMSC-H 120 sends MT- 25 FwdSMS (B, IMSI-F1) to SG 104. However in this case of SMS gateway control, SMSC-H 120 is replaced with SMSC-O 801.

SG 104 then applies logic to route the MT SMS to SMS gateway-H 901. Thus, when SG 104 receives the MT SMS, it determines MSISDN-H corresponding to special 30 range IMSI-F1 using the association of IMSIs and MSISDNs stored in the subscription database. Thereafter, at step 908, SG 104 submits the MT SMS on the MSISDN-H to

SMS gateway-H 901. At step 910, SMS gateway-H 901 performs SMS fraud/spam filtering, and inter-working check as described above. Thereafter, at step 912, SMS gateway-H 901 sends a SubmitSMS-ACK message to SG 104. Finally at step 914, SG 104 confirms delivery of MT SMS to subscriber A's handset by sending MT-FwdSMS-ACK message to SMSC-O 801.

In case SIMM subscriber 112 uses MSISDN-F1' and the sender B of the MT SMS does not belong to HPMN 102, when MT SMS on SIMM subscriber 112's MSISDN-F1' is received at SMSC-O 801, it sends SRI-SM query on MSISDN-F1' to HLR-F1 130 (i.e., instead of SG 104) since HLR-F 130 is the virtual HLR for MSISDN-F1'. Thereafter, HLR-F1 130 returns special SG 104's GT and IMSI-F1' to SMSC-O 801. Rest of the MT SMS flow on SIMM subscriber 112's MSISDN-F1' where SG 104 submits the MT SMS to SMS gateway-H 901 is same as that explained above in conjunction with FIG. 9.

SIMM subscriber 112 can also receive SMS on his MSISDN-H while he is roaming in FPMN1 108 or any other XPMN. This case does not require SG 104 to be involved. Hence the MT SMS on the MSISDN-H follows the standard MT call flow where the MT SMS on MSISDN-H is received at HLR-H 116, which returns IMSI-H and VMSC address of SIMM subscriber 112 to SMSC-O 801. SMSC-O 801 then forwards the MT SMS to either VMSC-F1 138 (i.e., in case subscriber 112 is in FPMN1 108) or VMSC-X 303 (i.e., in case subscriber 112 is in the XPMN).

In addition to MT calls and SMS, SIMM outbound roamer 112 can also make calls using his any of his assigned MSISDNs or MSISDN-H while roaming in FPMN1 108. It will be apparent to a person skilled in the art that in case of MO call, a VMSC of a calling party number usually obtains a caller ID information from its associated VLR by sending a SendInfoForOutgoingCall message to this VLR, and the call set up proceeds normally, i.e., from the calling party's VMSC to a GMSC of a called party number. Furthermore, HPMN 102 operator routes call control signaling of SIMM outbound roamer 112's call at HPMN 102 via SG 104. This helps HPMN 102 operator to achieve

monitoring and billing control of SIMM outbound roamer 112, in accordance with a first embodiment of the present invention. Also, SG 104 can perform the caller ID manipulation, as described earlier in the context of the present invention. When the call control signaling is via SG 104, SG 104 applies application logic to change the Calling Line Identification (CLI) number (i.e., subscriber A's MSISDN) based on a called number, in accordance with a second embodiment of the present invention. Similarly, the application logic can be defined for the MO SMS, which is described later in the context of the present invention.

In a third embodiment of the present invention, when the call control signaling is via SG 104, SG 104 applies application logic to interface a PrePaid System (PPS), i.e., the PPS associated with HPMN 102 to charge MO calls at local tariffs rather than roaming tariffs. HPMN 102 operator, in accordance with an embodiment of the present invention, defines a special tariff at the PPS, in order to handle billing of SIMM outbound roamer 112's MO call in FPMN1 108.

FIG. 10 represents a flow diagram for facilitating Mobile Originated (MO) call by SIMM outbound roamer 112 in FPMN1 108, when SIMM outbound roamer 112 is a prepaid subscriber of HPMN 102, in accordance with an embodiment of the present invention. This case considers the signaling control via IN protocol, and call control signaling of SIMM outbound roamer 112's call at FPMN1 108 is relayed via SG 104. HPMN 102 operator configures a switch associated with FPMN1 108 to route SIMM outbound roamer 112's MO call (i.e., call control signaling) to SG 104. This switch corresponds to VMSC-F1 138, in accordance with an embodiment of the present invention. It will be apparent to a person skilled in the art that in case SIMM outbound roamer 112 is present in the XPMN, all network elements in FPMN1 108 are replaced with corresponding network elements in the XPMN (e.g., VMSC-F1 138 is replaced with VMSC-X 303). Following are several options of routing the call control signaling of SIMM outbound roamer 112's MO call via SG 104:

1. FPMN1 108 is able to use IN/ISUP (including loopback) based on the assigned MSISDN, or the calling IMSI-H of SIMM outbound roamer 112 in special range.
2. SG 104 dynamically inserts IN trigger profile (like CAMEL or INAP or FPMN1 proprietary trigger profile) at VLR-F1 136 by sending a standalone ISD message to VLR-F1 136 either after the successful registration of SIMM subscriber 112 with FPMN1 108, or when a restore acknowledgement message, such as a RestoreData-ACK at FPMN1 108 is detected by monitoring module 106. This process is similar to the standalone ISD message that is used to define the default MSISDN at VLR-F1 136, as described earlier in the context of the present invention. This option does not require the assigned MSISDN or IMSI-H of SIMM subscriber 112 to be in the special range.

Thus, when SIMM subscriber A makes a call to B number (i.e., a called party number in case of MO calls), at step 1002 VMSC-F1 138 sends a call control signaling request, such as an IN InitialDP (MSISDN-X, IMSI-H, B, VMSC-F) to SG 104. MSISDN-X corresponds to either any assigned MSISDN or MSISDN-H, i.e., whichever is set by SIMM subscriber 112 as the default MSISDN at FPMN1 108. When the IN IDP (MSISDN-X, IMSI-H, B, VMSC-F1) is received at SG 104, SG 104 modifies the received message to an IN IDP (MSISDN-H, IMSI-H, B, SG), and then sends the modified message to an SCP-H 1003 associated with HPMN 102 (or the local PPS in HPMN 102), at step 1004. In case outbound roamer 112 uses MSISDN-F1'; MSISDN-F1 and IMSI-F1 in the MO call flow scenario are replaced with MSISDN-F1' and IMSI-F1', respectively. In one embodiment of the present invention, SG 104 sets outbound roamer 112's CLI in the MO call to MSISDN-F1 (or MSISDN-F1') when the B number is of FPMN1 108 country. This embodiment will be considered to explain the call flow for SIMM outbound roamer 112's MO call described in conjunction with FIG. 10. In another embodiment of the present invention, SG 104 sets outbound roamer 112's CLI in the MO call to MSISDN-H when the B number is of a country different from FPMN1 108 country. SG in the modified IN IDP message corresponds to the special SG 104's address

(or GT), in accordance with an embodiment of the present invention. Thereafter, at steps 1006 and 1008, SCP-H 1003 sends an IN RRB (Answer, Disconnect) message to VMSC-F1 138 via SG 104. In addition, at steps 1010 and 1012, SCP-H 1003 sends an IN Continue message to VMSC-F1 138 via SG 104. Further at steps 1014 and 1016, VMSC-F1 138 returns an IN ERB (Answer) message to SCP-H 1003 via SG 104. SCP-H 1003 applies special tariff on the MO call by SIMM outbound roamer 112, based on the special SG 104's address. Thus, upon receiving the IN ERB (Answer) message, SCP-H 1003 starts deducting balance from SIMM outbound roamer 112's prepaid account. Whenever SIMM outbound roamer 112 disconnects the ongoing call, VMSC-F1 138 sends IN ERB (Disconnect) message to SCP-H 1003 via SG 104, at steps 1018 and 1020. Finally, at steps 1022 and 1024, SCP-H 1003 returns IN ReleaseCall message to VMSC-F1 138 via SG 104.

Alternatively, in another embodiment of the present invention HPMN 102 operator directly routes call control signaling for outbound roamer 112's MO call to SCP-H 1003 (i.e., without involving SG 104). In this case, SIMM subscriber 112 is considered to be roaming in the XPMN that supports Customized Application for Mobile Enhanced Logic (CAMEL) agreement with HPMN 102. Upon receiving a call from subscriber A, VMSC-X 303 obtains caller ID information from VLR-X 307 and the call set up follows standard CAMEL call. The IDP message from VMSC-X 303 to SCP-H 1003 contains the caller ID (i.e., subscriber A's number), which may be different from MSISDN-H. This allows SCP-H 1003 to apply a different charging tariff for subscriber 112's CAMEL call in the XPMN. For example, when MSISDN-F1 or MSISDN-F1' is sent as the caller ID, the SCP-H 1003 applies a special SIMM rate defined by HPMN 102 operator.

Furthermore, SIMM outbound roamer 112 can also send SMS using his MSISDN-X or MSISDN-H while roaming in the XPMN. FIG. 11 represents a flow diagram for facilitating MO SMS by SIMM outbound roamer 112, when a recipient number of the MO SMS is of a country different from FPMN1 108 country, in accordance with a first embodiment of the present invention. In this embodiment, we will consider routing the MO SMS via SG 104, which applies application logic to change

MSISDN of SIMM outbound roamer 112 based on the recipient B's number. This MSISDN of SIMM outbound roamer 112 is hereinafter interchangeably referred to as a sending number in case of MO SMS. In an embodiment of the present invention, the recipient B's number belongs to HPMN 102. Moreover, in this first embodiment of MO SMS, SMSC-H 120 is considered to allow access for only MSISDN-H of SIMM subscriber 112. For example, a large network operator (like China Mobile) that has many SMSCs deployed in their network may restrict SIMM subscriber to only use MSISDN-H for sending MO SMS, since adding assigned MSISDN access control for each SMSC in such a situation could be a logistical challenge for the large network operator.

In an embodiment of the present invention, HPMN 102 operator configures STP-H 114 to route MO SMS via SG 104. In another embodiment of the present invention, HPMN 102 operator configures STP-F1 128 to route MO SMS via SG 104. This is done by configuring STP-F1 128 or STP-H 114 to direct all roaming SCCP messages with CdPA destined to HPMN SMSC (such as, SMSC-H 120 in case of outbound roamers from HPMN 102) and Sub System Number (SSN)=8 to SG 104. By doing so, HPMN 102 operator controls MO SMS of SIMM outbound roamer 112 using SG 104. Only SCCP messages with CdPA as SMSC-H 120 and SSN=8 are relayed via SG 104, in order to reduce signaling load and risk. In another embodiment of the present invention, HPMN 102 operator configures the first ISTP associated with FPMN1 108 to route MO SMS via SG 104. In yet another embodiment of the present invention, HPMN 102 operator configures the second ISTP associated with HPMN 102 to route MO SMS via SG 104. When SIMM subscriber A sends an MO SMS to the recipient B, at step 1102 VMSC-X 303 sends a SendInfoForMOSMS message on the IMSI-H with SMSC-H 120 address to VLR-X 307. VLR-X 307 then returns outbound roamer 112's sending number (hereinafter interchangeably referred to as MSISDN-X) in a SendInfoForMOSMS-ACK message to VMSC-X 303, at step 1104. Thereafter, at step 1106, VMSC-X 303 sends the MO SMS, such as MO-FwdSMS (MSISDN-X, B, SMSC-H) to SG 104. SG 104 then modifies MSISDN-X to outbound roamer 112's MSISDN-H before relaying the MO SMS to SMSC-H 120, at step 1108. Thus, SMSC-H 120 does not need to extend its access control list to include the XPMN MSISDNs. Alternatively, in case SG 104

determines that the MO SMS signaling is of non-SIMM subscriber, SG 104 bypasses the received MO SMS signaling to SMSC-H 120 without any modification. Finally, at steps 1110 and 1112, SMSC-H 120 relays an MO acknowledgement message, such as MO-FwdSMS-ACK to VMSC-X 303 via SG 104.

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Alternatively, in another embodiment of the present invention, HPMN 102 operator handles MO SMS or data (non-voice call) communications without routing it via SG 104, when SMSC-H 120 allows access for any MSISDN-X of SIMM subscriber 112. This case may be beneficial in case either SMSC-H 120 has an explicit interface to set up access control list, or HPMN 102 operator has less number of SMSCs to modify their access control lists. Thus, when VMSC-X 303 receives the SendInfoForMOSMS-ACK (MSISDN-X) message from VLR-X 307, VMSC-X 303 directly routes the MO SMS to SMSC-H 120. Thereafter, SMSC-H 120 returns MO-FwdSMS-ACK message to VMSC-X 303, and thereby normal MO SMS delivery procedure applies.

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Furthermore, HPMN 102 operator may want SG 104 to perform automatic translation of sender ID (i.e., the default MSISDN) to last assigned MSISDN of SIMM outbound roamer 112, when the recipient B's number does not belong to HPMN 102. In an embodiment of the present invention, the sender ID corresponds to MSISDN-F2 and SIMM subscriber 112 is at FPMN1 108. FIGS. 12A, 12B, and 12C represent a flow diagram for facilitating MO SMS by SIMM outbound roamer 112, when the recipient number is of FPMN1 108 country, in accordance with a second embodiment of the present invention. Steps 1202 to 1206 are same as steps 1102 to 1106, where VMSC-X 303 sends MO-FwdSMS (MSISDN-X, B, SMSC-H) message to SG 104 upon receiving the SendInfoForMOSMS-ACK (MSISDN-X) message from VLR-X 307. Thereafter, in this second embodiment of MO SMS, when the MO SMS is received at SG 104, SG 104 modifies the sender ID to MSISDN-H, and the recipient B's number to a special number (like B' which is selected from a pool of special numbers). In an embodiment of the present invention, HPMN 102 operator allocates this pool of special numbers to SG 104, and SG 104 stores the pool in its subscription database. SG 104 then sends the modified MO-FwdSMS (MSISDN-H, B', SMSC-H) message to SMSC-H 120, at step 1208.

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Upon receiving the modified message, SMSC-H 120 sends an SRI-SM query on B' to SG 104, in order to route the received message towards SG 104, at step 1210. SG 104 then determines the mapping between B and B', and thereafter at step 1212, SG 104
5 sends the SRI-SM query on B to an HLR 1213 of the recipient B, hereinafter referred to as HLR-B 1213. At step 1214, HLR-B 1213 returns an IMSI-B of the recipient B and the recipient B's current VMSC 1215 address, hereinafter referred to as VMSC-B 1215 address, in an SRI-SM-ACK message to SG 104. SG 104, thereafter modifies the SRI-SM-ACK message by replacing the IMSI-B with a dummy IMSI-B' (corresponding to
10 the special number B'), and replacing the VMSC-B address with SG 104's address, and at step 1216, SG 104 sends the modified SRI-SM-ACK message to SMSC-H 120.

In one embodiment of the present invention, SMSC-H 120 attempts to direct MO SMS of SIMM outbound roamer 112 to VMSC-B 1215 via SG 104. Hence at step 1218,
15 SMSC-H 120 forwards the SMS on the MSISDN-H along with the IMSI-B' and the SG 104's address to SG 104. Thereafter, SG 104 modifies the sender ID (i.e., MSISDN-H) to MSISDN-F1 (or MSISDN-F1'), IMSI-B' to IMSI-B, and the SG 104's address in the received SMS back to VMSC-B address of the recipient B, and it relays the modified SMS to VMSC-B 1215, at step 1220. VMSC-B 1215 then sends SIMM subscriber 112's
20 SMS to the recipient B's handset. Therefore, when the recipient B receives the SMS on his handset, he thinks as if the SMS is coming from MSISDN-F1/MSISDN-F1' of SIMM subscriber 112. Further at steps 1222 and 1224, VMSC-B 1215 sends an MT-FwdSMS-ACK message to SMSC-H 120 via SG 104. Finally, at steps 1226 and 1228, SMSC-H 120 sends an MO-FwdSMS-ACK message to VMSC-X 303 via SG 104, in order to
25 confirm VMSC-X 303 for delivery of the SMS to the recipient B's handset.

In another embodiment of the present invention, SMSC-H 120 sends the MO SMS of SIMM outbound roamer 112 to SMS gateway-H 901 via SG 104 when HPMN 102 has SMS gateway control for any outbound MO SMS by its SIMM subscriber 112.
30 Hence at step 1230, SMSC-H 120 sends MT-FwdSMS on the MSISDN-H with IMSI-B' and SG 104's address to SG 104. SG 104 then modifies MSISDN-H to MSISDN-F1 (or

MSISDN-F1') of SIMM subscriber 112. Hence at step 1232, SG 104 sends SubmitSMS on the MSISDN-F1 to SMS gateway-H 901. SMS gateway-H 901 eventually sends the SMS to the recipient B's handset. Thereafter, at step 1234, SMS gateway-H 901 returns a Submit-ACK message to SG 104. SG 104 then sends an MT-FwdSMS-ACK message to SMSC-H 120, at step 1236. Further, at steps 1238 and 1240, SMSC-H 120 sends the MO-FwdSMS-ACK message to VMSC-X 303 via SG 104, in order to confirm VMSC-X 303 for delivery of the SMS to the recipient B's handset.

Since SIMM outbound roamer 112 can change his MSISDN from the assigned MSISDN to his MSISDN-H, there is no way for FPMN1 108 operator to apply a special tariff for calls and SMS of SIMM outbound roamer 112 in FPMN1 108. Moreover, even the MSISDN-F1 is also not from special range MSISDNs. In such case when FPMN1 108 operator requires a special indication at FPMN1 108 of the assigned MSISDN for billing purpose (e.g., because even IMSI-H is not in a special IMSI range), then SIMM outbound roamer 112 is not allowed to change the default MSISDN (i.e., MSISDN change request is not entertained in such a situation).

In order to handle billing of SIMM subscriber 112 while he is roaming in the XPMN, HPMN 102 operator can opt for various billing options that are described hereinafter in the context of the present invention. In an embodiment of the present invention, HPMN 102 operator does not change the usual roaming rate for charging SIMM subscriber 112's mobile activities in the XPMN. Hence there is no change in the billing system (i.e., neither in HPMN 102 nor at the XPMN) for handling SIMM subscriber 112's billing. However, in this embodiment, HPMN 102 operator needs to inform the XPMN operator (or data-clearing house) about not rejecting such MT Transferred Account Procedure (TAP) records associated with SIMM subscriber 112. In this case, SIMM subscriber 112 gets the benefit of a local presence in the XPMN (e.g., in FPMN1 108), and other local subscribers of FPMN1 108 can easily reach SIMM subscriber 112 on his assigned MSISDN. VIP roamers subscribing to HPMN 102's SIMM service in the XPMN are also benefited.

In yet a different embodiment of billing for the SIMM service of the present invention, HPMN 102 operator offers free incoming call on SIMM subscriber 112's MSISDN-F1/MSISDN-F1' (i.e., his local number); however, other mobile activities are still at the usual roaming rate. Hence in this case, SIMM subscriber 112 gets the benefit of free incoming call on his local MSISDN, in addition to getting the local presence in the XPMN (e.g., in FPMN1 108), and also local calling by other local subscribers of FPMN1 108 to SIMM subscriber 112. Since MT call on the assigned MSISDN is free for SIMM subscriber 112, HPMN 102 operator needs to ensure that MT billing record on the assigned MSISDN is removed, and hence not charged to SIMM subscriber 112. This embodiment is useful for VIP roamers subscribing to HPMN 102's SIMM service in the XPMN.

In a third embodiment of billing for SIMM service under the present invention, HPMN 102 operator offers MO call by SIMM subscriber 112 to be charged against a local prepaid account of SIMM subscriber 112 while roaming in the XPMN. Hence in this case, SIMM subscriber 112 gets the benefit of a local prepaid number of the XPMN without changing his HPMN 102 SIM card, in addition to local calling by other local subscribers of the XPMN to SIMM subscriber 112. Hence it becomes useful for low revenue generating roamers, since they are able to control their expenses better by maintaining check on their prepaid recharges. For postpaid roamers, the recharging is done by deducting via event-based MO-TAP record. In one embodiment of the present invention, the MT call on the assigned MSISDN is free for SIMM subscriber 112. In another embodiment of the present invention, the MT call on the assigned MSISDN is charged against local prepaid account of SIMM subscriber 112. MO SMS by SIMM subscriber 112 is still charged at the usual roaming rate, in accordance with an embodiment of the present invention. In another embodiment of the present invention, HPMN 102 operator configures the billing system to automatically switch to the usual roaming rate in case the balance in the local prepaid account gets empty (e.g., after warning SIMM subscriber 112 for low balance).

In fourth embodiment of SIMM billing under the present invention, HPMN 102 operator offers MO SMS by SIMM subscriber 112 to be charged against the local prepaid account of SIMM subscriber 112. In fifth embodiment of billing, HPMN 102 operator offers MO GPRS data services by SIMM subscriber 112 to be charged against the local prepaid account. Similarly, in sixth embodiment of billing, HPMN 102 operator offers MO MMS by SIMM subscriber 112 to be charged against the local prepaid account.

In an embodiment of the present invention, HPMN 102 and the XPMN operators settle billing using CDRs or TAP records in order to charge HPMN 102 SIMM subscribers. In one embodiment of the present invention, FPMN1 108 operator defines a special Inter-Operator Tariff (IOT) for HPMN 102's SIMM subscribers (e.g., using special FPMN numbers). HPMN 102 operator provides information about HPMN 102's SIMM subscribers for special bill processing to either FPMN1 108's data-clearing house, or FPMN1 108 operator. Alternatively, in another embodiment of the present invention, FPMN1 108 operator does not exchange the IOT with HPMN 102 operator, and applies normal TAP for a wholesale IOT. In yet another embodiment of the present invention, HPMN 102 operator provides discount to SIMM subscribers in case of retail roaming charge in FPMN1 108, and HPMN 102 operator claims this discount from FPMN1 108 operator. In an embodiment of the present invention, HPMN 102's SIMM subscribers pay a monthly subscription fee for SIMM service, and get the discount for each month of the SIMM service used. Different subscription fees may be charged from SIMM subscribers, depending upon whether the one or more MSISDNs are assigned to these SIMM subscribers permanently or temporarily.

It will be apparent to a person skilled in the art, that the SIMM service can also be applied to Code Division Multiple Access (CDMA)/ American National Standards Institute # 41D (ANSI-41D), and various other technologies such as, but not limited to, VoIP, WiFi, 3GSM and inter-standard roaming. In one exemplary case, a CDMA roaming subscriber travels with an HPMN CDMA handset. In another exemplary case, CDMA roaming subscriber travels with an HPMN GSM SIM and a GSM handset. In yet another exemplary case, GSM roaming subscriber travels with an HPMN CDMA RUIM

and a CDMA handset. To support these variations, SG 104 will have a separate SS7 and network interfaces, corresponding to both the FPMN and HPMN networks. It will also be apparent to a person skilled in the art that these two interfaces in different directions may not have to be the same technologies. Moreover, there could be multiple types of interface in both directions.

An exemplary list of the mapping between GSM MAP and ANSI-41D is described in the table below as a reference.

GSM MAP	ANSI-41D
Location Update/ISD	REGNOT
Cancel Location	REGCAN
RegisterSS	FEATUREREQUEST
InterrogateSS	FEATUREREQUEST
SRI-SM	SMSREQ
SRI	LOCATION REQUEST
ForwardSMS	SMSDPP
ReadyForSMS	SMSNOTIFICATION
AlertServiceCenter	SMSNOTIFICATION
ReportSMSDelivery	SMDPP
ProvideRoamingNumber	ROUTING REQUEST

An HPMN operator uses one or more variations of the present invention to allow its outbound roamers to roam in different partner FPMNs and allow them to subscribe to the SIMM service, without the need to change their existing HPMN SIMs. Furthermore, when the outbound roamers are registered with the FPMN, the FPMN operator considers these roamers as local subscribers, and HPMN operator provides such roamers with the call-related and non call-related services on their HPMN MSISDNs and different FPMN MSISDNs at tariffs less than normal roaming rates. This compels more outbound roamers of the HPMN to register for SIMM service in the FPMN. Moreover, the present invention also allows HPMN's outbound roamers to use SIMM service even though they are roaming in any other visited network (i.e. even non-FPMN). SIMM outbound roamers can change their MSISDNs, according to their requirements and the HPMN operator's feasibility to allow such MSISDN change. The present invention further allows the

HPMN operator to charge different categories of SIMM outbound roamers (e.g., normal and VIP roamers) by defining different tariffs.

5 Additionally, the HPMN operator offers SIMM service to outbound roamers who already possess FPMN MSISDNs. Such roamers can use their existing FPMN MSISDNs and they are charged at tariff less than their existing tariff. Overall, the present invention increases the roaming revenue for both the HPMN and partner FPMN operators as more roamers of the HPMN tend to register with the SIMM service in the partner FPMNs. Furthermore, the SIMM service also provides fail-over support to the outbound roamers
10 when registered at the FPMN. This means that even in case the SG fails, at least the normal roaming services (e.g., calls/SMS on and from HPMN MSISDN) of the SIMM outbound roamers remain unaffected. The present invention caters to both prepaid and postpaid outbound roamers of the HPMN. In addition, the present invention allows HPMN operator to offer various other VASs such as, but not limited to, MCA and CLI to
15 its SIMM outbound roamers.

The present invention can take the form of an entirely hardware embodiment, an entirely software embodiment, or an embodiment containing both hardware and software elements. In accordance with an embodiment of the present invention, software,
20 including but not limited to, firmware, resident software, and microcode, implements the invention.

Furthermore, the invention can take the form of a computer program product, accessible from a computer-usable or computer-readable medium providing program
25 code for use by, or in connection with, a computer or any instruction execution system. For the purposes of this description, a computer-usable or computer readable medium can be any apparatus that can contain, store, communicate, propagate, or transport the program for use by or in connection with the instruction execution system, apparatus, or device.

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The medium can be an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system (or apparatus or device) or a propagation medium. Examples of a computer-readable medium include a semiconductor or solid state memory, magnetic tape, a removable computer diskette, a random access memory (RAM), a read-only memory (ROM), a rigid magnetic disk and an optical disk. Current examples of optical disks include compact disk – read only memory (CDROM), compact disk – read/write (CD-R/W) and Digital Versatile Disk (DVD).

A computer usable medium provided herein includes a computer usable program code, which when executed, facilitates mobile communication of a subscriber associated with an HPMN. The computer program product further includes a computer usable program code for assigning one or more FPMN MSISDNs by an SG to the subscriber, based on a subscription activation request received from the subscriber at the SG either via an USSD gateway or via an SMSC, both associated with the HPMN, wherein the SG is associated with either the HPMN or an MVNO of the HPMN, and wherein the subscriber has an HPMN SIM with a corresponding HPMN IMSI and an HPMN MSISDN. The computer program product further includes a computer usable program code for associating by the SG, the assigned MSISDNs with the HPMN MSISDN. The computer program product further includes a computer usable program code for detecting passively by the SG, the subscriber's registration with an FPMN. The computer program product further includes a computer usable program code for sending by the SG, a default MSISDN to a VLR associated with the FPMN. The computer program product further includes a computer usable program code for modifying by the SG, the default MSISDN to either any of the assigned MSISDNs or the HPMN MSISDN. The computer program product further includes a computer usable program code for facilitating by the SG, mobile communication of the subscriber in the FPMN using the default MSISDN and the HPMN MSISDN.

The components of present system described above include any combination of computing components and devices operating together. The components of the present system can also be components or subsystems within a larger computer system or

network. The present system components can also be coupled with any number of other components (not shown), such as other buses, controllers, memory devices, and data input/output devices, in any number of combinations. In addition, any number or combination of other processor-based components may be carrying out the functions of the present system.

It should be noted that the various components disclosed herein may be described using computer aided design tools and/or expressed (or represented), as data and/or instructions embodied in various computer-readable media, in terms of their behavioral, register transfer, logic component, transistor, layout geometries, and/or other characteristics. Computer-readable media in which such formatted data and/or instructions may be embodied include, but are not limited to, non-volatile storage media in various forms (e.g., optical, magnetic or semiconductor storage media) and carrier waves that may be used to transfer such formatted data and/or instructions through wireless, optical, or wired signaling media or any combination thereof.

Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise," "comprising," and the like are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense; that is to say, in a sense of "including, but may not be limited to." Words using the singular or plural number also include the plural or singular number respectively. Additionally, the words "herein," "hereunder," "above," "below," and words of similar import refer to this application as a whole and not to any particular portions of this application. When the word "or" is used in reference to a list of two or more items, it covers all of the following interpretations: any of the items in the list, all of the items in the list and any combination of the items in the list.

The above description of illustrated embodiments of the present system is not intended to be exhaustive or to limit the present system to the precise form disclosed. While specific embodiments of, and examples for, the present system are described herein for illustrative purposes, various equivalent modifications are possible within the

scope of the present system, as those skilled in the art will recognize. The teachings of the present system provided herein can be applied to other processing systems and methods. They may not be limited to the systems and methods described above.

5 The elements and acts of the various embodiments described above can be combined to provide further embodiments. These and other changes can be made in light of the above detailed description.

Other Variations

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 Provided above for the edification of those of ordinary skill in the art, and not as a limitation on the scope of the invention, are detailed illustrations of a scheme for facilitating mobile communication of a subscriber associated with an HPMN. Numerous variations and modifications within the spirit of the present invention will of course occur to those of ordinary skill in the art in view of the embodiments that have been disclosed. For example, the present invention is implemented primarily from the point of view of GSM mobile networks as described in the embodiments. However the present invention may also be effectively implemented on GPRS, 3G, CDMA, WCDMA, WiMax etc., or any other network of common carrier telecommunications in which end users are normally configured to operate within a "home" network to which they normally subscribe, but have the capability of also operating on other neighboring networks, which may even be across international borders.

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 The examples under the system of present invention detailed in the illustrative examples contained herein are described using terms and constructs drawn largely from GSM mobile telephony infrastructure. However use of these examples should not be interpreted as limiting the invention to those media. The system and method can be of use and provided through any type of telecommunications medium, including without limitation: (i) any mobile telephony network including without limitation GSM, 3GSM, 3G, CDMA, WCDMA or GPRS, satellite phones or other mobile telephone networks or systems; (ii) any so-called WiFi apparatus normally used in a home or subscribed

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network, but also configured for use on a visited or non-home or non-accustomed network, including apparatus not dedicated to telecommunications such as personal computers, Palm-type or Windows Mobile devices; (iii) an entertainment console platform such as Sony Playstation, PSP or other apparatus that are capable of sending and receiving telecommunications over home or non-home networks, or even (iv) fixed-line devices made for receiving communications, but capable of deployment in numerous locations while preserving a persistent subscriber id such as the eye2eye devices from Dlink; or telecommunications equipment meant for voice over IP communications such as those provided by Vonage or Packet8.

In describing certain embodiments of the system under the present invention, this specification follows the path of a telecommunications call, from a calling party to a called party. For the avoidance of doubt, such a call can be a normal voice call, in which the subscriber telecommunications equipment is also capable of visual, audiovisual or motion-picture display. Alternatively, those devices or calls can be for text, video, pictures or other communicated data.

In the foregoing specification, specific embodiments of the present invention have been described. However one of ordinary skill in the art will appreciate that various modifications and changes can be made without departing from the scope of the present invention as set forth in the claims below. Accordingly, the specification and the figures are to be regarded in an illustrative rather than a restrictive sense, and all such modifications are intended to be included within the scope of present invention. The benefits, advantages, solutions to problems, and any element(s) that may cause any benefit, advantage, or solution to occur, or to become more pronounced, are not to be construed as a critical, required, or essential feature or element of any or all of the claims.

APPENDIX

Acronym	Description
3G	Third generation of mobile
ACM	ISUP Address Completion Message
ANM	ISUP Answer Message
ANSI-41	American National Standards Institute #41
CAMEL	Customized Application for Mobile Enhanced Logic
CC	Country Code
CDMA	Code Division Multiple Access
CdPA	Called Party Address
CgPA	Calling Party Address
CLI	Calling Line Identification
ERB	CAP Event Report Basic call state model
FPMN	Friendly Public Mobile Network
FTN	Forward-To Number
GMSC	Gateway MSC
GMSC-F	GMSC in FPMN
GMSC-H	GMSC in HPMN
GPRS	General Packet Radio System
GSM	Global System for Mobile
GT	Global Title
HLR	Home Location Register
HLR-F	FPMN HLR
HLR-H	HPMN HLR
HPMN	Home Public Mobile Network
IAM	Initial Address Message
IDP	Initial DP IN/CAP message
IMSI	International Mobile Subscriber Identity
IMSI-H	HPMN IMSI
IN	Intelligent Network
IP	Internet Protocol
ISC	International Service Carrier
ISD	MAP Insert Subscriber Data
ISTP	International STP
ISUP	ISDN User Part
LUP	MAP Location Update
MAP	Mobile Application Part
MCC	Mobile Country Code
MMS	Multimedia Message Service
MNC	Mobile Network Code
MO	Mobile Originated
MSC	Mobile Switching Center
MSISDN	Mobile Station International Subscriber Directory Number

MSISDN-F	FPMN MSISDN
MSISDN-H	HPMN MSISDN
MSRN	Mobile Station Roaming Number
MSRN-F	FPMN MSRN
MSRN-H	HPMN MSRN
MT	Mobile Terminated
MTP	Message Transfer Part
PRN	MAP Provide Roaming Number
RNA	Roaming Not Allowed
RR	Roaming Restricted due to unsupported feature
RRB	CAP Request Report Basic call state model
SCCP	Signal Connection Control part
SCP	Signaling Control Point
SCP-H	HPMN SCP
SG	Signaling Gateway
SIM	Subscriber Identity Module
SMS	Short Message Service
SMSC	Short Message Service Center
SMSC-F	FPMN SMSC
SMSC-H	HPMN SMSC
SRI	MAP Send Routing Information
SRI-SM	MAP Send Routing Information For Short Message
SS7	Signaling System #7
SSN	Sub System Number
STP	Signal Transfer Point
STP-F	FPMN STP
STP-H	HPMN STP
TR	Traffic Redirection
TT	Translation Type
USSD	Unstructured Supplementary Service Data
VAS	Value Added Service
VLR	Visited Location Register
VLR-F	FPMN VLR
VLR-H	HPMN VLR
VMSC	Visited Mobile Switching Center
VPMN	Visited Public Mobile Network
WAP	Wireless Access Protocol

Technical references (each of which is incorporated by reference herein):

- GSM 902 on MAP specification
Digital cellular telecommunications system (Phase 2+)
- 5 Mobile Application Part (MAP) Specification
(3GPP TS 09.02 version 7.9.0 Release 1998)
- GSM 340 on SMS
Digital cellular telecommunications system (Phase 2+)
- 10 Technical realization of the Short Message Service (SMS)
(GSM 03.40 version 7.4.0 Release 1998)
- GSM 378 on CAMEL
Digital cellular telecommunications system (Phase 2+)
- 15 Customized Applications for Mobile network Enhanced Logic (CAMEL) Phase 2
Stage 2
(GSM 03.78 version 6.7.0 Release 1997)
- GSM 978 on CAMEL Application protocol
Digital cellular telecommunications system (Phase 2+)
- 20 Customized Applications for Mobile network Enhanced Logic (CAMEL)
CAMEL Application Part (CAP) specification
(GSM 09.78 version 7.1.0 Release 1998)
- 25 Signalling procedures and the Mobile Application Part (MAP)
(Release 1999)
- Q1214-Q1218 on Intelligent Networks
Q701-704 on SS7 MTP
- 30 Q711-Q714 on SS7 SCCP
Q760-Q769 on SS7 ISUP

Jiang 2003 SIMM Roaming: Providing Multiple MSISDNs in a SIM with a single IMSI for multiple roaming partners

- 5 Jiang 2003 MIMM/MISM Roaming: Providing Multiple IMSIs and Multiple/Single MSISDNs in a SIM for multiple roaming partners

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Jiang 2006 IR 73 TR: IR 73 Compliant passive traffic steering

Jiang 2005 DCG-O: Dynamic Camel Gateway for outbound roamers

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Jiang 2005 DCG-I: Dynamic Camel Gateway for inbound roamers

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I Claim:

1. A method for facilitating mobile communication of a subscriber associated with a Home Public Mobile Network (HPMN), the method comprising:

5 assigning, via a Signaling Gateway (SG), one or more Mobile Station International Subscriber Directory Numbers (MSISDNs) to the subscriber, based on a subscription activation request received from the subscriber at the SG via one selected from a group consisting of a Short Message Service Center (SMSC) and an Unstructured Supplementary Service Data (USSD) gateway, each associated with the HPMN,

 wherein the SG is associated with one of: the HPMN and a Mobile Virtual Network Operator (MVNO) associated with the HPMN, and

 wherein the subscriber has an HPMN Subscriber Identity Module (SIM) with a corresponding HPMN International Mobile Subscriber Identity (IMSI) and an HPMN MSISDN;

 associating, via the SG, the assigned MSISDNs with the HPMN MSISDN; passively detecting, via the SG, the subscriber's registration with a Friendly Public Mobile Network (FPMN);

 sending, via the SG, a default MSISDN to a Visited Location Register (VLR) associated with the FPMN;

 modifying, via the SG, the default MSISDN to one selected from a group consisting of the assigned MSISDNs and the HPMN MSISDN, when an MSISDN change request is received from the subscriber at the SG via one of the HPMN SMSC and the HPMN USSD gateway; and

 facilitating, via the SG, mobile communication of the subscriber in the FPMN using at least one of the default MSISDN and the HPMN MSISDN.

2. The method of claim 1, wherein passively detecting further comprises:

using a monitoring module that taps roaming signaling links associated with the subscriber in the HPMN, the monitoring module being coupled to the SG.

5 3. The method of claim 1 further comprising:

 redirecting, via the SG, the subscriber's traffic to the FPMN upon passively detecting the subscriber's registration attempt with a VPMN.

10 4. The method of claim 1, wherein the subscriber registers with the FPMN using one selected from a group consisting of a FPMN MSISDN, the HPMN MSISDN, and another partner FPMN.

15 5. The method of claim 1, wherein the assigned MSISDNs are at least one selected from a group consisting of special range FPMN numbers and the subscriber's existing FPMN numbers.

20 6. The method of claim 1, wherein the SG receives the subscription activation request from one selected from a group consisting of the HPMN, the FPMN, another partner FPMN, an MVNO associated with the HPMN, and a VPMN.

25 7. The method of claim 1 further comprising:

 storing the association of the assigned MSISDNs with the HPMN MSISDN in a subscription database coupled to the SG;

 storing an association of the HPMN IMSI with one or more IMSIs corresponding to the assigned MSISDNs in the subscription database; and

 maintaining the subscriber's current location in the FPMN in the subscription database.

30 8. The method of claim 1, further comprising:

 receiving, at the SG, a Mobile Originated (MO) communication using the assigned MSISDNs of the subscriber.

9. The method of claim 8, wherein a switch associated with the FPMN is configured to route the MO call to the SG, wherein the routing at the switch is based on one selected from a group consisting of:

5 the subscriber's assigned MSISDN,

 the subscriber's HPMN IMSI, and

 an IN trigger profile dynamically inserted by the SG at the FPMN VLR, upon detecting one selected from a group consisting of the subscriber's registration with the FPMN and a restore acknowledgement message at the FPMN VLR.

10. The method of claim 8, wherein the SG facilitates the MO call by applying a logic selected from a group consisting of:

 setting the subscriber's Calling Line Identification (CLI) in the MO call to an MSISDN of the FPMN that is of the same country as called party number;

 setting the subscriber's CLI in the MO call to the HPMN MSISDN when the called party number is of a country different from the FPMN country; and

 interfacing with a prepaid system associated with the HPMN to handle billing of the subscriber based on a special tariff defined at the prepaid system for the MO call.

11. The method of claim 8, wherein the MO SMS is routed through the SG via one selected from a group consisting of a first roaming STP associated with the HPMN, and a second roaming STP associated with the FPMN.

12. The method of claim 11, wherein the SG facilitates the MO SMS by applying a logic selected from a group consisting of:

 setting the subscriber's sending number in the MO SMS to an MSISDN of the FPMN that is of the same country as a recipient number;

 setting the subscriber's sending number in the MO SMS to the HPMN MSISDN when the recipient number is of a country different from the FPMN;

routing the MO SMS to the HPMN SMSC via the SG when the recipient number belongs to the HPMN; and

routing the MO SMS via the HPMN SMSC to one of: a Visited Mobile Switching Center (VMSC) of the recipient number and an HPMN SMS gateway, when the recipient number does not belong to the HPMN.

13. The method of claim 1, further comprising:

receiving, at the SG, a Mobile Terminated (MT) communication of the subscriber at the assigned MSISDNs.

14. The method of claim 13, wherein the MT call at the assigned MSISDNs is directed from the FPMN to a PMN via the SG, when the subscriber is detected passively, via the SG, as being registered with the PMN, and the assigned MSISDN corresponds to the FPMN MSISDN.

15. The method of claim 13, wherein the SG facilitates the MT call by sending the HPMN MSISDN to an HPMN HLR upon receiving one selected from a group consisting of a routing request message and a roaming number request message on the assigned MSISDN.

16. The method of claim 13, wherein the SG sends an absent subscriber to a FPMN GMSC, upon receiving a routing request message on the assigned MSISDN, when the subscriber is detected passively, via the SG, as being registered with a PMN other than the FPMN, and the assigned MSISDN corresponds to the FPMN MSISDN, wherein the routing request message is received when a calling party calls the subscriber on the assigned MSISDN.

17. The method of claim 16 further comprising:

sending a missed call alert message by the SG to at least one selected from a group consisting of the subscriber and the calling party.

18. The method of claim 13, wherein the SG releases the MT call on the assigned MSISDN by:

5 sending a special Forward-To Number (FTN) to an FPMN GMSC upon receiving a routing request message on the assigned MSISDN, when the subscriber is passively detected by the SG to be registered with a PMN other than the FPMN, and the assigned MSISDN corresponds to the FPMN MSISDN; and

 releasing the call on the assigned MSISDN with one of: a special announcement number and a release cause.

10 19. The method of claim 13, wherein the SG facilitates the MT SMS by applying at least one logic selected from a group consisting of:

 routing the MT SMS on the HPMN IMSI to the subscriber's current VMSC upon receiving the MT SMS on an FPMN IMSI corresponding to the assigned MSISDN, when a sender of the MT SMS belongs to the HPMN;

15 modifying the subscriber's assigned MSISDN in a routing request message for SMS to the HPMN MSISDN so as to route the MT SMS to the subscriber's current VMSC, when the sender of the MT SMS belongs to the HPMN; and

20 routing the MT SMS on the HPMN MSISDN to an HPMN SMS gateway upon receiving the MT SMS on the FPMN IMSI, when the sender of the MT SMS does not belong to the HPMN.

20. The method of claim 1, wherein the MSISDN change request is at least one selected from a group consisting of a Short Message Service (SMS) message, an
25 USSD message, a customer care call, a Wireless Application Protocol (WAP) interaction, a World Wide Web (WWW) interaction, and an Interactive Voice Response (IVR) message.

30 21. A method for facilitating mobile communication of a subscriber associated with an HPMN, the method comprising:

assigning one or more MSISDNs, via a Signaling Gateway (SG), to the subscriber, based on a subscription activation request received from the subscriber at the SG via one selected from a group consisting of a Short Message Service Center (SMSC) and an Unstructured Supplementary Service Data (USSD) gateway, each associated with the HPMN,

wherein the SG is associated with one selected from a group consisting of the HPMN and an MVNO associated with the HPMN, and

wherein the subscriber has an HPMN SIM with a corresponding IMSI and an HPMN MSISDN;

associating, via the SG, the assigned MSISDNs with the HPMN MSISDN;

passively tapping, via the SG, roaming signaling links associated with the subscriber in the HPMN so as to detect a registration of the subscriber;

sending, via the SG, a default MSISDN;

modifying, via the SG, the default MSISDN to one selected from a group consisting of the assigned MSISDNs and the HPMN MSISDN, when an MSISDN change request is received from the subscriber at the SG via one of the HPMN SMSC and the HPMN USSD gateway; and

facilitating, via the SG, mobile communication of the subscriber using at least one selected from a group consisting of the default MSISDN and the HPMN MSISDN.

22. A system for facilitating mobile communication of a subscriber associated with an HPMN, the system comprising:

a SG for assigning one or more MSISDNs to the subscriber, based on a subscription activation request received from the subscriber at the SG via one of an SMSC and an USSD gateway, each associated with the HPMN,

wherein the SG is associated with one selected from a group consisting of the HPMN and an MVNO associated with the HPMN, and

wherein the subscriber has an HPMN SIM with a corresponding HPMN IMSI and an HPMN MSISDN;

the SG associating the assigned MSISDNs with the HPMN MSISDN;
the SG passively detecting the subscriber's registration with an FPMN;
the SG sending a default MSISDN to a VLR associated with the FPMN;
the SG modifying the default MSISDN to one selected from a group
5 consisting of the assigned MSISDNs and the HPMN MSISDN, when an MSISDN
change request is received from the subscriber at the SG via one of the HPMN
SMSC and the HPMN USSD gateway; and
the SG facilitating mobile communication of the subscriber in the FPMN
using at least one selected from a group consisting of the default MSISDN and the
10 HPMN MSISDN.

23. The system of claim 22, wherein the SG passively detects by using a monitoring
module that taps roaming signaling links associated with the subscriber in the
HPMN, the monitoring module being coupled to the SG.

24. A computer program product comprising a computer usable medium including a
computer usable program code stored therein for facilitating mobile
communication of a subscriber associated with an HPMN, the computer program
product comprising:

20 computer usable program code for assigning one or more MSISDNs, via a
SG, to the subscriber, based on a subscription activation request received from the
subscriber at the SG via one selected from a group consisting of an SMSC and an
USSD gateway, each associated with the HPMN,

25 wherein the SG is associated with one selected from a group
consisting of the HPMN and an MVNO associated with the HPMN, and

wherein the subscriber has an HPMN SIM with a corresponding
HPMN IMSI and an HPMN MSISDN;

computer usable program code for associating, via the SG, the assigned
MSISDNs with the HPMN MSISDN;

30 computer usable program code for passively detecting, via the SG, the
subscriber's registration with a FPMN;

computer usable program code for sending, via the SG, a default MSISDN to a VLR associated with the FPMN;

computer usable program code for modifying, via the SG, the default MSISDN to one selected from a group consisting of the assigned MSISDNs and the HPMN MSISDN; and

computer usable program code for facilitating, via the SG, mobile communication of the subscriber in the FPMN using at least one selected from a group consisting of the default MSISDN and the HPMN MSISDN.

25. A method for facilitating mobile communication of a subscriber associated with a Home Public Mobile Network (HPMN), the method comprising:

receiving an association, via a Signaling Gateway (SG), of one or more Mobile Station International Subscriber Directory Numbers (MSISDNs) to the subscriber, based on a subscription activation request received from the subscriber at the SG via one selected from a group consisting of a Short Message Service Center (SMSC) and an Unstructured Supplementary Service Data (USSD) gateway, each associated with the HPMN,

wherein the SG is associated with one of: the HPMN and a Mobile Virtual Network Operator (MVNO) associated with the HPMN, and

wherein the subscriber has an HPMN Subscriber Identity Module (SIM) with a corresponding HPMN International Mobile Subscriber Identity (IMSI) and an HPMN MSISDN;

receiving an association, via the SG, of the assigned MSISDNs with the HPMN MSISDN;

receiving a passive detection, via the SG, of the subscriber's registration with a Friendly Public Mobile Network (FPMN);

sending, via the SG, a default MSISDN to a Visited Location Register (VLR) associated with the FPMN;

receiving, via the SG, a modified default MSISDN to one selected from a group consisting of the assigned MSISDNs and the HPMN MSISDN, when an

MSISDN change request is received from the subscriber at the SG via one of the HPMN SMSC and the HPMN USSD gateway; and

facilitating, via the SG, mobile communication of the subscriber in the FPMN using at least one of the default MSISDN and the HPMN MSISDN.