(54) Title: METHOD AND SYSTEM FOR PROVIDING S2M SERVICE TO INBOUND ROAMERS OF A VISITED NETWORK USING A PASSIVE-MONITORING-BASED SOLUTION

(57) Abstract: The present invention provides a method for facilitating mobile communication of a subscriber roaming in an FPMN. The method includes assigning the FPMN MSISDN by an SG to the subscriber based on a subscription activation request received from the subscriber. The SG is deployed at either the FPMN or an MVNO of the FPMN. The method further includes associating by the SG, the FPMN MSISDN with an HPMN MSISDN. The method further includes detecting passively by the SG, the subscriber's registration with the 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 the HPMN MSISDN based on an MSISDN change request from the subscriber. The method further includes facilitating by the SG, mobile communication of the subscriber in the FPMN using the default MSISDN and the HPMN MSISDN.
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Field of Invention

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

Background of the Invention

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 home networks and the visited network may be either in the same country, or in different countries.

Procuring and using a local Mobile Station International Subscriber Directory Number (MSISDN) of a visited network allows inbound roamers to make local calls within the visited network at local rates, instead of the expensive roaming rates to which he would have been subject had he continued to use his home network MSISDN. With such an MSISDN affiliated with the inbound roamer's handset, even other local subscribers of the visited network can call such roaming subscribers at local rates. For those and other reasons, inbound roamers who frequent a particular visited network generally purchase Subscriber Identity Modules (SIM) cards of the visited network to benefit from local rates for their calling and communications while roaming within the visited network. But normally, in order to receive the local MSISDN, those inbound roamers need to swap their existing home network SIM cards with the visited network's SIM cards. So they would not ordinarily be able to receive or make calls and other non-call related services using their home network MSISDNs.

What is more, when such inbound roamers return to their home network, they cannot receive or make calls or engage in other other non-call-related services using the visited network's MSISDNs. So employing a prior art system, a visited network operator can provide both the visited network MSISDN and the home network
MSISDN within a special SIM in order to attract more inbound roamers from certain home networks.

There are one or more techniques known in the art that offer these services to the inbound roamers from one or more Home Public Mobile Networks (HPMNs) visiting in a participating visited mobile network with whom that HPMN has reached a technical arrangement (also referred to here as a "Friendly Public Mobile Network" or "FPMN," where the inbound roamer enjoys local rates on his FPMN MSISDN, and is also able to make or receive calls, messaging and other communications using his HPMN MSISDN. Normally, the FPMN is a public mobile network (PMN) that has a bilateral roaming agreement with the HPMN. But in this technique, the inbound roamer needs to obtain a special HPMN SIM card that has a corresponding special range HPMN International Mobile Subscriber Identity (IMSI). So it is really only meant for roamers who frequent a particular foreign country or outside-of-coverage area. Moreover, the technique requires all Signal Connection Control part (SCCP) signaling of these inbound roamers from different HPMNs to pass through a Signaling Gateway (SG) at the FPMN that handles provisioning of these services. So it also presents a risk point of failure for such inbound roamers in case of breakdown of the SG as all registered inbound roamers will be unable to receive calls or SMS.

Accordingly, there is a need in the art for a system, a method, and a computer program product, which assigns an FPMN MSISDN to each inbound roamer from one or more HPMNs, without changing their existing SIM cards, and without intruding in the signaling path of these inbound roamers at the FPMN.

Summary

The present invention is directed towards a method for facilitating mobile communication of a subscriber roaming in an FPMN. The method includes assigning the FPMN MSISDN by an SG to the subscriber, based on a subscription activation request received from the subscriber at the SG either directly or via an FPMN USSD gateway. The SG is deployed at either the FPMN or an MVNO of the FPMN, and the subscriber has an HPMN SIM with a corresponding HPMN IMSI and an HPMN MSISDN. The method further includes associating by the SG, the FPMN MSISDN
with the HPMN MSISDN. The method further includes detecting passively by the
SG, the subscriber's registration with the 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 the HPMN MSISDN, when an
MSISDN change request is received from the subscriber at the SG either directly or
via the FPMN 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 roaming in an FPMN. The system includes an
SG deployed at either the FPMN or an MVNO of the FPMN. The SG assigns the
FPMN MSISDN to the subscriber, based on a subscription activation request received
from the subscriber at the SG either directly or via an FPMN USSD gateway.
Moreover, the subscriber has an HPMN SIM with a corresponding HPMN IMSI and
an HPMN MSISDN. Further, the SG associates the FPMN MSISDN with the HPMN
MSISDN. Further, the SG detects passively the subscriber's registration with the
FPMN. Further, the SG sends a default MSISDN to an FPMN VLR. Further, the SG
modifies the default MSISDN to the HPMN MSISDN, when an MSISDN change
request is received from the subscriber at the SG either directly or via the FPMN
USSD gateway. Further, the SG facilitates 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 roaming in an FPMN by assigning the FPMN
MSISDN to the subscriber, based on a subscription activation request received from
the subscriber at an SG either directly or via an FPMN USSD gateway. The SG is
deployed at either the FPMN or an MVNO of the FPMN. Moreover, the subscriber
has an HPMN SIM with a corresponding HPMN IMSI and an HPMN MSISDN.
Further, the computer program product associates the FPMN MSISDN with the
HPMN MSISDN using the SG. Further, the computer program product detects the
subscriber's registration with the 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, the default MSISDN to 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.

5

**Brief Description of Drawings**

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

10 FIG. 1 illustrates a system for providing Single International Mobile Subscriber Identity (IMSI) with two MSISDNs (SI2M) service to inbound roamers of a Friendly Public Mobile Network (FPMN), in accordance with an embodiment of the present invention;

FIG. 2 represents a flowchart for facilitating mobile communication of an SI2M subscriber in the FPMN having an FPMN Mobile Station International Subscriber Directory Number (MSISDN) and a Home Public Mobile Network (HPMN) MSISDN, using a passive monitoring based solution, in accordance with an embodiment of the present invention;

FIG. 3 represents a flow diagram of SI2M service subscription activation at the FPMN using Short Message Service (SMS), in accordance with an embodiment of the present invention;

FIG. 4 represents a flow diagram for passively detecting the subscriber's registration with the 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 SI2M subscriber’s special range FPMN MSISDN, when the SI2M subscriber 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 SI2M subscriber's special range FPMN MSISDN, when the SI2M subscriber is passively detected to be registered with the PMN other than the FPMN, in accordance with a second embodiment of the present invention;
FIG. 7 represents a flow diagram for facilitating MT SMS on the SI2M subscriber'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 SI2M subscriber's special range FPMN MSISDN without routing the MT SMS via the SG, in accordance with a second embodiment of the present invention;

FIG. 9 represents a flow diagram for facilitating MT SMS on the SI2M subscriber'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 the SI2M subscriber in the FPMN, when the SI2M subscriber 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 SI2M subscriber, 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

FIGS. 12A, 12B, and 12C represent a flow diagram for facilitating MO SMS by the SI2M subscriber, when the recipient number is of the FPMN country, in accordance with a second embodiment of the present invention.

**Detailed Description**

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 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.
The present invention provides a system, a method, and a computer program product that allows a participating (or "friendly") visited network operator to provide a Single International Mobile Subscriber Identity (IMSI) with two MSISDNs (SI2M) service (of the present invention) to its inbound roamers visiting from different partner home networks. In the SI2M service each subscriber (or inbound roamer), who is roaming in the friendly visited network, is offered a Mobile Station International Subscriber Directory Number (MSISDN) of the friendly visited network. The friendly visited network operator can also cater to subscribers, who are subscribed to friendly visited network's SI2M service but are registered with some other network. So the subscribers who subscribe to the friendly visited network's SI2M service are hereinafter interchangeably referred to as SI2M subscribers. The SI2M service assigns friendly visited network MSISDN to SI2M subscriber, and allows the SI2M subscriber to make and receive calls, and send and receive Short Message Service (SMS) using his assigned friendly visited network MSISDN at tariffs less than normal roaming rates (i.e., roaming rates without the SI2M service).

In order to provide the SI2M service, the friendly visited network operator allocates pre-defined range of MSISDNs (i.e., special range MSISDNs) to a partner home network for inbound roamers coming from that partner home network, when these inbound roamers do not have existing friendly visited network MSISDNs. In an embodiment of the present invention, multiple partner home networks share this pre-defined range of MSISDNs to allow their subscribers roaming in the friendly visited network to avail the SI2M service. In another embodiment of the present invention, the friendly visited network operator offers the SI2M service to inbound roamers who already possess friendly visited network MSISDN. In this case, the SI2M service is provided on inbound roamers' respective existing friendly visited network MSISDN (i.e., no new special range friendly visited network MSISDN is required in such case).

In addition, the SI2M subscribers may also use their respective home network MSISDNs to initiate and receive calls/SMS while they are roaming in the friendly visited network. In other words, the friendly visited network operator allows its SI2M subscriber to swap his friendly visited network MSISDN with his partner home network MSISDN depending on his requirements. Hence the present invention facilitates mobile communication of SI2M inbound roamers using both their respective friendly visited network MSISDN and partner home network MSISDN.
without changing their partner home network's existing Subscriber Identity Module (SIM) card. The present invention also caters to both prepaid and postpaid inbound roamers of the friendly visited network.

In an embodiment of the present invention, the friendly visited network operator defines the tariff for calls/SMS on and from the friendly visited network MSISDN based on its special roaming agreements with the partner home network operators for offering the SI2M service. The special roaming agreements include billing agreements, which are described later in the context of the present invention.

In another embodiment of the present invention, the friendly visited network operator neither involves nor informs partner home networks about any special billing for offering the SI2M service. In yet another embodiment of the present invention, the friendly visited network operator charges its SI2M subscribers at local rates for mobile communication on and from the friendly visited network MSISDN. In addition, the friendly visited network operator may also offer various other Value Added Services (VASs) such as, but not limited to, Missed Call Alert (MCA) and Calling Line Identification (CLI) to its SI2M subscribers. Moreover, the present invention ensures that other mobile services, such as General Packet Radio System (GPRS), Wireless Access Protocol (WAP), and Multimedia Message Service (MMS) of these SI2M subscribers remain unaffected by the SI2M service.

The friendly visited network operator deploys a Signaling Gateway (SG) and a monitoring module, either at a Mobile Virtual Network Operator (MVNO) of the friendly visited network or in the friendly visited network itself, in order to allow its inbound roamers to avail SI2M service. FIG. 1 illustrates a system 100 that provides SI2M service to inbound roamers of a Friendly Public Mobile Network (FPMN) 102 (i.e., the friendly visited network), in accordance with an embodiment of the present invention. System 100 includes an SG 104 and a monitoring module 106 in FPMN 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 FPMN 102. System 100 further includes a first partner Home Public Mobile Network (P-HPMN1) 108 (i.e., the partner home network), and a second partner HPMN (P-HPMN2) 110. It will be apparent to a person skilled in the art that system 100 may include various other partner HPMNs. However, for the sake of
convenience, this embodiment considers only two partner HPMNs (i.e., P-HPMN1 108 and P-HPMN2 110). An operator of FPMN 102 offers the SI2M service to inbound roamers from these partner HPMNs. In one embodiment of the present invention, the partner HPMNs are national roaming partners of FPMN 102. In another embodiment of the present invention, the partner HPMNs are international roaming partners of FPMN 102. Hence FPMN 102, P-HPMN1 108, and P-HPMN2 110 may reside in the same country or in different countries.

In an embodiment of the present invention, a subscriber 112 of P-HPMN1 108 makes a registration attempt at FPMN 102 and a standard registration process follows where FPMN 102 and P-HPMN1 108 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 FPMN 102’s SI2M service either once he is registered with FPMN 102 or from a different network even before he registers with FPMN 102. However, in the latter case, subscriber 112 avails SI2M service only once he registers with FPMN 102. FPMN 102 operator can also cater to SI2M subscribers even when they move to a network different from FPMN 102. Once subscriber 112 subscribes to FPMN 102’s SI2M service, SG 104 assigns a special range FPMN MSISDN (i.e., the special range MSISDN of friendly visited network), hereinafter referred to as MSISDN-F, to subscriber 112 when he does not have an existing subscription with FPMN 102. Alternatively, in case subscriber 112 has an existing FPMN MSISDN, hereinafter interchangeably referred to as MSISDN-F’, SG 104 assigns MSISDN-F’ to subscriber 112. In an embodiment of the present invention, in case SG 104 is integrated with monitoring module 106, SG 104 passively (i.e., non-intrusively taps signaling path) detects subscriber 112’s registration with FPMN 102 using monitoring module 106. Monitoring module 106 taps national or international Signaling System #7 (SS7) links (corresponds to roaming signaling links) of subscriber 112 in FPMN 102, in order to monitor exchange of various MAP messages such as, 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 FPMN 102 and P-HPMN1 108 for subscriber 112’s registration with FPMN 102. (For the avoidance of doubt, whenever this specification refers to “SS7” links or signaling, what is meant is any
form of communications session information transfer over any protocol, whether it be SS7, Sigtran, or any other means.)

Additionally, in some cases, SG 104 does not even intercept the signaling path of subscriber 112’s Mobile Originated (MO) activities (like calls, SMS, and GPRS) in FPMN 102. Similarly, SG 104 is not involved for Mobile Terminated (MT) calls/SMS on SI2M subscriber 112’s P-HPMN1 MSISDN (i.e., the partner home network MSISDN), hereinafter referred to as MSISDN-H1. Hence even when SG 104 goes down, the MT roaming services on the MSISDN-H1 and MO roaming services remain unaffected. In one case for dealing with SG 104 failure scenario, each HPMN operator whose subscribers are subscribed to SI2M service in FPMN 102, need to configure their respective Short Message Service Centers (SMSCs) or SMS gateways to allow access by these SI2M subscribers using their respective SG 104’s assigned FPMN MSISDNs. Moreover, SG 104 does not even intercept SI2M subscriber 112’s signaling path for GPRS, WAP, and MMS services, in accordance with an embodiment of the present invention. Furthermore, FPMN 102 operator uses SG 104 to handle billing of its SI2M subscriber 112, in accordance with an embodiment of the present invention.

System 100 further includes in FPMN 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 FPMN 102, they are hereinafter referred to as STP-F 114, HLR-F 116, GMSC-F 118, SMSC-F 120, VLR-F 122, VMSC-F 124, and USSD-F 126, respectively. SG 104, STP-F 114, HLR-F 116, GMSC-F 118, SMSC-F 120, VLR-F 122, VMSC-F 124, and USSD-F 126 are interconnected, and communicate with each other over the SS7 links.

System 100 further includes in P-HPMN1 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 P-HPMN1 108, they are hereinafter referred to as STP-H1 128, HLR-H1 130, GMSC-H1 132, SMSC-H1 134,
VLR-H1 136, and VMSC-H1 138, respectively. STP-H1 128, HLR-H1 130, GMSC-H1 132, SMSC-H1 134, VLR-H1 136, and VMSC-H1 138 are interconnected, and communicate with each other over the SS7 links. Similarly, system 100 further includes in P-HPMN2 110, an STP-H2 140, a VLR-H2 142, and a VMSC-H2 144.

Network elements in FPMN 102 communicate with network elements in P-HPMN1 108 and P-HPMN2 110 via an International Service Carrier (ISC) (not shown in FIG. 1), when FPMN 102, P-HPMN1 108 and P-HPMN2 110 reside in different countries, and subscribers of P-HPMN1 108 and P-HPMN2 110 are roaming in FPMN 102. System 100 further includes in the ISC, a first International STP (ISTP) that communicates with STP-F 114, a second ISTP that communicates with STP-H1 128, and a third ISTP that communicates with STP-H2 140. It will be apparent to a person skilled in the art that FPMN 102, P-HPMN1 108, and P-HPMN2 110 may also include various other network elements (not shown in FIG. 1), depending on the architecture under consideration, or different network elements that still carry out the functions intended in this specification.

As described earlier, FPMN 102 can have a special agreement, arrangement, or participate in some open-market system with with some or every partner HPMN in order to provide SI2M service to inbound roammers from these partner HPMNs. In an embodiment of the present invention, that type of special agreement can entail a mutual understanding between FPMN 102 and P-HPMN1 108 operators to bill roammers from P-HPMN1 108 while they are subscribed to the SI2M service of FPMN 102. Alternatively, in another embodiment of the present invention, FPMN 102 operator does not establish any special billing agreement with partner HPMNs and charges its SI2M subscribers’ mobile activities (like calls and SMS) based on FPMN 102’s defined tariff for these roammers.

As mentioned earlier, subscriber 112 needs to first subscribe for the SI2M service in order to partake of the benefits offered by FPMN 102 operator. He can subscribe to the SI2M service by any means that mobile users register for new services, including without limitation by calling an inbound call center, by text message opting in to the service, by email, by an Internet or WAP page interaction, by interacting with a USSD session, or even by visiting a store or kiosk. And an
embodiment of the present invention also permits an as-needed convenient method for him to subscribe to the SI2M service.

Subscriber 112 (hereinafter interchangeably referred to as inbound roamer 112) has a P-HPMN1 SIM with a corresponding P-HPMN1 IMSI, hereinafter referred to as IMSI-H1, and MSISDN-H1. FIG. 2 represents a flowchart for facilitating mobile communication of SI2M subscriber 112 in FPMN 102 having the assigned MSISDN and MSISDN-H1, 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 FPMN 102. In one embodiment of the present invention, SG 104 uses monitoring module 106 to passively detect exchange of registration messages between FPMN 102 and P-HPMN1 108.

Thereafter at step 204, SG 104 assigns MSISDN-F (or MSISDN-F’) to subscriber 112 based on a received subscription activation request. This subscription activation request corresponds to subscriber 112’s request to avail FPMN 102’s SI2M service. In one embodiment of the present invention, SG 104 assigns MSISDN-F (or MSISDN-F’) to subscriber 112 temporarily. In another embodiment of the present invention, SG 104 assigns MSISDN-F (or MSISDN-F’) to subscriber 112 permanently. Moreover subscriber 112 can cancel such permanent or temporary assignment of MSISDN-F (or MSISDN-F’) anytime by sending a subscription deactivation request to SG 104. Thereafter, at step 206, SG 104 associates the assigned MSISDN with the MSISDN-H1 (and its corresponding IMSI-H1) of subscriber 112. In an embodiment of the present invention, SG 104 stores the association of the assigned MSISDN with MSISDN-H1 in a subscription database coupled to SG 104. In another embodiment of the present invention, the subscription database stores an association of the IMSI-H1 with an FPMN IMSI corresponding to the MSISDN-F. The FPMN IMSI is hereinafter interchangeably referred to as IMSI-F. In case subscriber 112 uses MSISDN-F’, IMSI-F is replaced with an existing FPMN IMSI (hereinafter referred to as IMSI-F’) corresponding to MSISDN-F’, in accordance with an embodiment of the present invention. In addition, the subscription database stores subscriber 112’s current location in FPMN 102, 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 deactivation request from subscriber 112, while he is in either P-HPMN1 108, the MVNO associated with FPMN 102, or a Visited Public Mobile Network (VPMN). The VPMN corresponds to a visited network that does not provide SI2M service to inbound roamers from P-HPMN1 108. In case subscriber 112 sends the subscription activation request from either P-HPMN1 108, the MVNO of FPMN 102, or the VPMN, steps 204 and 206 will be performed prior to step 202.

Furthermore, at step 208, SG 104 sends a default MSISDN to VLR-F 122. In an embodiment of the present invention, SG 104 sends MSISDN-F (or MSISDN-F') as the default MSISDN to VLR-F 122. SI2M subscriber 112 can anytime change this default MSISDN to a different MSISDN by sending an MSISDN change request message to set his default MSISDN to either assigned MSISDN (in case assigned MSISDN is not the last set default MSISDN) or MSISDN-H1. Hence at step 210, SG 104 modifies the default MSISDN to MSISDN-H1, when an MSISDN change request is received at SG 104 from SI2M subscriber 112. In one embodiment of the present invention, SG 104 directly receives the subscription activation request and MSISDN change request from subscriber 112. In another embodiment of the present invention, SG 104 receives the subscription activation and MSISDN change request from subscriber 112 via USSD-F 126. The subscription activation request, MSISDN change request and subscription deactivation request includes, but are not limited to, 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, or any of the other means, such as visiting a physical kiosk or operator office. As mentioned earlier, FPMN 102 operator can also offer the SI2M service to an inbound roamer of FPMN 102 who already has the MSISDN-F' defined at HLR-F 116. In order to deal with such inbound roamers, FPMN 102 operator records the MSISDN-F' for special billing requirements, which are described later in the context of the present invention.

Finally, at step 212, SG 104 facilitates SI2M subscriber 112’s mobile communication in FPMN 102 using either the default MSISDN (i.e. MSISDN-F or MSISDN-F' in case the default MSISDN is not changed) or MSISDN-H1, or both. In other words, subscriber 112’s MO and MT activities are facilitated in FPMN 102.
using the default MSISDN and MSISDN-H1 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 FPMN 102 using both the MSISDN-F/MSISDN-F' and MSISDN-H1, when the default MSISDN remains unchanged as the MSISDN-F or MSISDN-F'. In another embodiment of the present invention, in case SG 104 changes the default MSISDN to MSISDN-H1, SI2M subscriber 112 is able to make and receive calls/SMS in FPMN 102 using only MSISDN-H1.

As explained earlier, P-HPMN1 108's outbound roamers can subscribe or cancel or modify the SI2M service conveniently from any PMN. FIG. 3 represents a flow diagram of SI2M service subscription activation at FPMN 102 using SMS, in accordance with an embodiment of the present invention. In this embodiment, subscriber 112 is considered to be already registered with FPMN 102, and SG 104 passively detects this registration at VLR-F 122 (and VMSC-F 124) in FPMN 102. At step 302, SG 104 sends a welcome SMS to subscriber 112 via VMSC-F 124, in order to promote SI2M service.

For example, the welcome message may contain the following text:

"Dear customer, FPMN 102 welcomes you to country ‘Y’ (or zone ‘Z’ in the country ‘Y’). SMS ‘SI2M’ to 5678 and get a local number for ‘Y’ (or ‘Z’). You may also call 12345678 and say ‘SI2M’ to avail this service. Wishing you a pleasant stay in FPMN 102 ‘Y’ (or FPMN 102 ‘Z’)."

Subscriber 112 then sends the subscription activation request to VMSC-F 124 as a reply SMS in order to subscribe to FPMN 102's SI2M service. This subscription activation request needs to indicate an FPMN (like FPMN 102 in this embodiment of SI2M service subscription activation) for which subscriber 112 wants to have a corresponding FPMN MSISDN. The reply path of subscription activation/MSISDN change/welcome/reminder messages is SG 104. This allows subscriber 112 in FPMN 102 to send such messages via SG 104, rather than relaying it via SMSC-H1 134, thus reducing load on SMSC-H1 134. Furthermore, since SG 104 is deployed in FPMN 102, the signaling exchange is done within FPMN 102 (i.e. using SG 104), thereby eliminating need for any secure connection between SMSC-H1 134 and SG 104.
Thereafter at step 304, VMSC-F 124 relays the subscription activation request to SG 104 along with the indication of subscriber 112’s choice as FPMN 102 for employing the SI2M service. SG 104 then assigns MSISDN-F or MSISDN-F’ (and then associates MSISDN-F/MSISDN-F’ with MSISDN-H1) to subscriber 112 in FPMN 102, and sends a message containing the assigned MSISDN information to subscriber 112. In an embodiment of the present invention, SG 104 sends an SMS to SI2M subscriber 112 in order to inform him about the assigned MSISDN and any associated charging (e.g., subscription fee, expiration rule (i.e., number of days/months/years for which MSISDN-F is temporarily allotted to subscriber 112), tariff, etc.). SG 104 then sets a default MSISDN for subscriber 112 at VLR-F 122. Hence at step 306, SG 104 sends the default MSISDN in a standalone Insert Subscriber Data (ISD) message to VLR-F 122.

In an embodiment of the present invention, FPMN 102 operator can configure SG 104 to set the default MSISDN as the MSISDN-F or MSISDN-F’ for subscriber 112’s first time SI2M service subscription. Additionally at step 306, SG 104 sends an Intelligent Network (IN) trigger profile in the standalone ISD message to VLR-F 122. Finally, at step 308, VLR-F 122 returns an ISD-ACK message to SG 104.

If SI2M subscriber 112 confirms the assigned MSISDN or MSISDN-H1 as the default MSISDN in FPMN 102, subscriber 112’s reply path can be via SG 104. Thereafter, subscriber 112 uses the assigned MSISDN or MSISDN-H1 to perform mobile activities (like MO and MT call/SMS) while he is registered with FPMN 102.

Since subscriber 112 has the ability to change his default MSISDN anytime, he may send the MSISDN change request to SG 104 via VMSC-F 124. This MSISDN change is hereinafter interchangeably referred to as 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 MSISDN-H1 or assigned MSISDN) at VLR-F 122 is different from the last set default MSISDN, then SG 104 issues the standalone ISD message to VLR-F 122 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-F or MSISDN-F’) is changed to MSISDN-H1 at SG 104, in accordance with an embodiment of the present invention. Thus SG 104 sends the new default MSISDN with an optional IN trigger profile in the standalone ISD message to VLR-F
122. Alternatively, subscriber 112 sends the subscription activation request or MSISDN change request or subscription deactivation request to VMSC-F 124, which relays the request to VLR-F 122. VLR-F 122 then relays the received request to SG 104 via USSD-F 126, in accordance with an embodiment of the present invention. This embodiment can use USSD-F service key (e.g., below 100, not in the range of 70-80, or above 149). Moreover in this embodiment, SG 104 can send the standalone ISD message with the default MSISDN and optional IN trigger profile to VLR-F 122, which responds with ISD-ACK to SG 104.

In an embodiment of the present invention, subscriber 112 may subscribe to FPMN 102’s SI2M service even before he travels to FPMN 102 (e.g., from P-HPMN1 108 or any other VPMN) or may subscribe to SI2M service while he is visiting FPMN 102 for the second time. In such a case, whenever subscriber 112 registers with FPMN 102, SG 104 sends a reminder message to subscriber 112 indicating the last set default MSISDN allotted to him during his previous subscription to the SI2M service.

FIG. 4 represents a flow diagram for passively detecting inbound roamer 112’s registration with FPMN 102 using monitoring module 106, in accordance with an embodiment of the present invention. When inbound roamer 112 makes a registration attempt at FPMN 102, VLR-F 122 exchanges standard registration messages with HLR-H1 130, at steps 402 to 408. In an embodiment of the present invention, inbound roamer 112 registers with FPMN 102 using MSISDN-F’ corresponding to FPMN 102. In another embodiment of the present invention, inbound roamer 112 registers with FPMN 102 using MSISDN-H1. In an embodiment of the present invention, monitoring module 106 detects exchange of registration messages between VLR-F 122 and HLR-H1 130. In another embodiment of the present invention, monitoring module 106 detects a receipt of cancel location message from HLR-H1 130 to cancel inbound roamer 112’s registration with FPMN 102. Thereafter, at step 410, SG 104 sends the default MSISDN and optional IN trigger profile in the standalone ISD message to VLR-F 122, when inbound roamer 112 is already subscribed for FPMN 102’s SI2M service. Finally, at step 412, VLR-F 122 responds with ISD-ACK to SG 104. Optionally, at step 414 (illustrated in dashed lines in FIG. 4), SG 104 sends a reminder message to inbound roamer 112 via VMSC-F 124 that indicates his last set default MSISDN allotted to him during his previous subscription of the SI2M service.
Alternatively, in case inbound roamer 112 is registered with FPMN 102, but is not yet subscribed to the SI2M service, then a subscription process (permissibly like the one explained above) in conjunction with FIG. 3 follows prior to performing steps 410 and 412. Rest of the call flow of inbound roamer 112’s registration with FPMN 102 in such a case follows that explained above in conjunction with FIG. 4.

Furthermore, FPMN 102 operator may deploy a traffic redirection mechanism to redirect SI2M subscriber 112’s traffic to FPMN 102 in case SI2M subscriber 112 attempts to register at either VPMN or a competitor FPMN. In an embodiment of the present invention, FPMN 102 operator configures SG 104 to perform traffic redirection of SI2M subscriber 112 to FPMN 102 upon passively detecting SI2M subscriber 112’s registration attempt at the VPMN or the competitor FPMN.

In some cases, HLR-H1 130 may reset due to any failure (or update) at HLR-H1 130. This results in potentially affecting the SI2M service of subscriber 112 (and roaming services of other roammers of HLR-H1 130 in FPMN 102). In first case, when HLR-H1 130 resets, a RESET (HLR-number, IMSI-LIST) message is received at VLR-F 122 from HLR-H1 130. This removes the roaming profile of those inbound roamers of FPMN 102 from VLR-F 122; whose home network IMSIs match the IMSI-LIST (or HLR numbers stored in these roamers’ record at VLR-F 122 match the HLR number) received in the RESET message. Since subscriber 112 is also currently registered with VLR-F 122 for SI2M service, the IMSI-LIST contains IMSI-H1 of subscriber 112. Hence subscriber 112’s profile is also removed from VLR-F 122. In second case, VLR-F 122 receives a roaming number request (like Provide Roaming Number (PRN)) from HLR-H1 130 for an MT call on the IMSI-H1 but VLR-F 122 has no record for subscriber 112’s IMSI-H1. Hence in both cases, VLR-F 122 restores subscriber 112’s profile by exchanging various MAP messages, such as a RestoreData (IMSI-H1, VLR-F/VMSC-F), an ISD (MSISDN-H1), an ISD-ACK, and a RestoreData-ACK with HLR-H1 130. Monitoring module 106 detects exchange of these MAP messages, and in case subscriber 112 is subscribed to FPMN 102’s SI2M service, steps 410 to 414 are performed where SG 104 sends standalone ISD message to VLR-F 122, and then SG 104 optionally sends the reminder message to subscriber 112 via VMSC-F 124.
SG 104 and monitoring module 106 control MT calls/SMS on the assigned MSISDN of SI2M 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 Send Routing Information (SRI) and Send Routing Information For Short Message (SRI-SM)) on the special range MSISDN-F, 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 FPMN 102.

Hereinafter, all call and SMS flows explained in the context of the present invention consider that subscriber 112 is already subscribed to FPMN 102’s SI2M service. FIG. 5 represents a flow diagram for facilitating MT call on SI2M subscriber 112’s special range MSISDN-F, when SI2M inbound roamer 112 is passively detected to be registered with a PMN, in accordance with a first embodiment of the present invention. The PMN (hereinafter interchangeably referred to as an XPMN) corresponds to any visited network including FPMN 102. In an embodiment of the present invention, FPMN 102 operator applies this first embodiment when SI2M subscriber 112 is detected to be either absent from FPMN 102 or absent from the PMN configured at SG 104. In an embodiment of the present invention, monitoring module 106 detects the current location of SI2M subscriber 112. Moreover, FPMN 102 operator can get billing records of SI2M subscriber 112 for reconciliation purpose.

When B (i.e., a calling party in case of MT calls) makes a call to SI2M subscriber 112 (hereinafter interchangeably referred to as subscriber A) on his special range MSISDN-F, at step 502, GMSC-F 118 receives a call control request, such as ISDN User Part (ISUP) IAM (B, MSISDN-F) from B. Thereafter, at step 504, GMSC-F 118 sends a routing request message, such as a Send Routing Information (SRI) query on the special range MSISDN-F to SG 104, since SG 104 is the virtual HLR for SI2M subscriber 112’s special range MSISDN-F. Since SG 104 is present in FPMN 102 (or the MVNO of FPMN 102), any node in FPMN 102 (like GMSC-F 118) can route signaling messages (e.g., SRI, SRI-SM, etc.) on the special range MSISDN-F to SG 104 either via a Message Transfer Part (MTP) level routing or a
standard Global Title (GT) based routing. SG 104 then facilitates the MT call by replacing special range MSISDN-F with MSISDN-H1, and then sending MSISDN-H1 to HLR-H1 130. Hence at step 506, SG 104 sends the SRI message (or query) on the MSISDN-H1 to HLR-H1 130. Further at step 508, HLR-H1 130 sends a roaming number request on the IMSI-H1, such as PRN (IMSI-H1) message to a VLR-X 509 (i.e., subscriber 112’s current location) associated with the XPMN. At step 510, VLR-X 509 returns a roaming number, such as Mobile Station Roaming Number (MSRN) in a Provide Roaming Number (PRN)-ACK message to HLR-H1 130. Thereafter, at step 512, SG 104 receives MSRN in an SRI-ACK message from HLR-H1 130.

Further at step 514, SG 104 modifies the MSRN to a new roaming number, such as an MSRN’, and issues SRI-ACK message with the MSRN’ to GMSC-F 118. 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 ISUP Initial Address Message (IAM) (B, MSRN’) is received at SG 104 from GMSC-F 118, 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-F 118 to SG 104. Finally, at step 518, SG 104 modifies MSRN' back to MSRN, and then issues a call control signaling, such as IAM (B, MSRN) to a VMSC-X 519 associated with the XPMN.

Alternatively, in another embodiment of the present invention, the MT call on the special range MSISDN-F is routed from FPMN 102 to subscriber 112’s currently registered PMN without relaying the MT call via SG 104. Steps 502 to 512 are applicable even in this embodiment, where SG 104 modifies SRI message on the special range MSISDN-F to SRI message on the MSISDN-H1 before sending the SRI message to HLR-H1 130, and then later it receives MSRN in the SRI-ACK message from HLR-H1 130. However, upon receiving this SRI-ACK message, SG 104 does not modify MSRN to MSRN’, and relays the received SRI-ACK (MSRN) message to GMSC-F 118. Finally, GMSC-F 118 establishes a call ISUP IAM (B, MSRN) directly with VMSC-X 519. In an embodiment of the present invention, FPMN 102 operator applies this alternate embodiment when monitoring module 106 detects SI2M
subscriber 112 to be present either in FPMN 102 or at some other PMN configured at SG 104.

In yet another embodiment of the present invention, SI2M subscriber 112 while roaming in the PMN uses MSISDN-F', and the MT call on subscriber 112's MSISDN-F' is routed from FPMN 102 to subscriber 112's currently registered PMN via SG 104. In this case, GMSC-F 118 sends signaling messages, such as SRI (MSISDN-F') to HLR-F 116 (i.e., instead of SG 104) that has profile information (like MSISDN-F') of SI2M subscriber 112. Thereafter, SG 104 receives a roaming number request message on the IMSI-F', such as PRN (IMSI-F') message (i.e., instead of SRI (MSISDN-F) message) from HLR-F 116. SG 104 then modifies the IMSI-F' to MSISDN-H1 by determining association of the MSISDN-F'/IMSI-F' with the MSISDN-H1 from the subscription database, and sends MSISDN-H1 in the SRI message to HLR-H1 130. Thereafter, steps 508 to 512 are applicable even in this embodiment of MSISDN-F', where the MSRN is received at SG 104 from HLR-H1 130. However, instead of sending signaling message, such as SRI-ACK (MSRN') from SG 104 to GMSC-F 118 (i.e., at step 514), SG 104 sends PRN-ACK (MSRN') message to HLR-F 116, in case the assigned MSISDN is the MSISDN-F' of SI2M subscriber 112. Thereafter, HLR-F 116 sends SRI-ACK (MSRN') message to GMSC-F 118. 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 519 is same as that explained earlier at steps 516 and 518. In an embodiment of the present invention, FPMN 102 operator applies this case of routing the MT call on the MSISDN-F' via SG 104 when monitoring module 106 detects SI2M subscriber 112 to be either absent from FPMN 102 or absent from some PMN configured at SG 104. Moreover, FPMN 102 operator can get billing records of SI2M subscriber 112 for reconciliation purpose. Additionally, FPMN 102 operator may also monitor the MT call on the MSISDN-F' for legal interception and quality assurance purpose.

Alternatively, in another embodiment of the present invention, SI2M subscriber 112 can use MSISDN-F' in FPMN 102, and FPMN 102 operator routes the MT call on the MSISDN-F' directly from GMSC-F 118 to VMSC-X 519 (i.e., without involving SG 104). In this case, SG 104 does not modify MSRN to MSRN' when it receives SRI-ACK message from HLR-H1 130. In an embodiment of the
present invention, FPMN 102 operator applies this alternate case when monitoring module 106 detects SI2M subscriber 112 to be present either in FPMN 102 or at some PMN configured at SG 104.

A previous passage in this specification taught an embodiment in which subscriber 112’s MT call on the assigned MSISDN can be facilitated when subscriber 112 is registered with the PMN. Yet in another embodiment of the present invention, FPMN 102 operator serves only inbound roamers of FPMN 102 and terminates calls on the assigned MSISDN when subscriber 112 is present in the PMN other than FPMN 102. This is intended to help FPMN 102 operator to avoid roaming reroute charges for routing MT calls on the assigned MSISDN from FPMN 102 to the PMN.

FIG. 6 represents a flow diagram for terminating MT call on the special range MSISDN-F, when monitoring module 106 passively detects subscriber 112 to be registered with the PMN other than FPMN 102, in accordance with a second embodiment of the present invention. At step 602, when B makes a call to SI2M subscriber 112 on his special range MSISDN-F, GMSC-F 118 receives ISUP IAM (B, MSISDN-F) from B. Thereafter, at step 604, GMSC-F 118 sends SRI query on the special range MSISDN-F to SG 104. At step 606, SG 104 responds to the received SRI query with an absent subscriber in an SRI-ACK message, since SI2M subscriber 112 is not registered with FPMN 102. Additionally, SG 104 can initiate a missed call alert procedure when the received SRI (MSISDN-F) message contains B’s number. In an embodiment of the present invention, SG 104 sends a missed call alert message as an 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 for the call to subscriber A. In yet another embodiment of the present invention, SG 104 sends an SMS containing subscriber A’s MSISDN-H1 to B’s handset. This allows B to call back subscriber A on his MSISDN-H1.

Alternatively, in another embodiment of the present invention, SI2M subscriber 112 is not registered at FPMN 102, and B’s number is not known from the received SRI (MSISDN-F) message. In this case, SG 104 at step 608 responds to the received SRI (MSISDN-F) 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, FPMN 102 operator configures SG 104 to set the special FTN as S# that is temporarily associated with the special range IMSI-F and MSISDN-F of SI2M subscriber 112. SG 104 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-F 118 then routes the ongoing MT call via ISUP (i.e., either directly or via loopback) to SG 104. Hence at step 610, GMSC-F 118 routes ISUP IAM (B, OCN=MSISDN-F, S#) to SG 104, where OCN indicates Originally Called Number (OCN). SG 104 then releases the ongoing MT call with either a special announcement number, such as IAM (Ann#), or a release cause, such as REL (Rel-cause).

So at step 612, SG 104 sends IAM (Ann#) or REL (Rel-cause) to GMSC-F 118. 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 party, please call again later."

In an embodiment of the present invention, FPMN 102 operator configures SG 104 to send "subscriber A is not available", "busy", "not answering", etc. as the release cause message to GMSC-F 118. In another embodiment of the present invention, SG 104 disassociates S# from SI2M subscriber 112's special range MSISDN-F and IMSI-F, and then sends back S# to the pool of special FTNs 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, SI2M subscriber 112 can use MSISDN-F', and FPMN 102 operator can terminate MT calls on the MSISDN-F' when subscriber 112 is present in the PMN other than FPMN 102. In this case, GMSC-F 118 sends signaling messages, such as SRI (MSISDN-F') to HLR-F 116 (i.e., instead of SG 104). SG 104 then receives PRN (IMSI-F') message from HLR-F 116. Thereafter, SG 104 sends absent subscriber in the PRN-ACK message to HLR-F 116 (i.e., instead of GMSC-F 118). HLR-F 116 then relays absent subscriber in the SRI-ACK message to GMSC-F 118. Rest of the call flow where SG 104 initiates missed call alert procedure is same as that explained earlier in conjunction with FIG. 6. However, in this embodiment of terminating MT calls on the MSISDN-F', SG 104
determines B's number from the PRN (IMSI-F') message (i.e., instead of SRI (MSISDN-F) message) that is received at SG 104 from HLR-F 116.

Alternatively, in another embodiment of the present invention, SI2M subscriber 112, using the MSISDN-F', is not registered with FPMN 102 (i.e., registered with the PMN other than FPMN 102), and B's number is not known from the received PRN (IMSI-F') message. In this case, SG 104 responds to HLR-F 116 with S#. HLR-F 116 then relays S# in the SRI-ACK message to GMSC-F 118. The call flow for releasing the ongoing MT call on the MSISDN-F' is same as that explained earlier at steps 610 and 612, except that at steps 610 and 612 the ongoing MT call on the special range MSISDN-F is released. Furthermore, the call flow for the ongoing MT call on the MSISDN-F', where SG 104 initiates missed call alert procedure is same as that explained earlier in conjunction with FIG. 6.

SI2M subscriber 112 can also receive calls on his MSISDN-H1 while he is roaming in FPMN 102 or any other XPMN. This case does not require SG 104 to be involved, in accordance with an embodiment of the present invention. Hence the MT call on the MSISDN-H1 follows the standard MT call flow where the MT call on MSISDN-H1 is received at GMSC-H1 132, which routes the call to either VMSC-F 124 (i.e., in case subscriber 112 is in FPMN 102) or VMSC-X 519 (i.e., in case subscriber 112 is in the XPMN) after retrieving MSRN corresponding to MSISDN-H1 from VLR-F 122 or VLR-X 509. It will be apparent to a person skilled in the art that in case the XPMN corresponds to FPMN 102, all network elements in the XPMN are replaced with corresponding network elements in FPMN 102 (e.g., VLR-X 509 is replaced with VLR-F 122). In this case of MT call on the MSISDN-H1, HLR-H1 130 does not send MSISDN-H1 in the PRN (IMSI-H1) message to VLR-X 509. This is required for FPMN 102 operator that uses assigned MSISDNs for special billing on its SI2M inbound roamers from P-HPMN1 108. Similarly, it may also be required for P-HPMN1 108 operator that uses assigned MSISDNs for special billing on its SI2M outbound roamers in FPMN 102. In case the PRN message from HLR-H1 130 to VLR-F 122 contains the MSISDN-H1, it changes the MSISDN called party at FPMN 102's CDR. Thus based on FPMN 102 and P-HPMN1 108 operators' requirement, SI2M subscriber 112 at FPMN 102 can only have his MSISDN-F/MSISDN-F' at FPMN 102, and no change of caller ID (or MSISDN change) is allowed (unless IMSI-
H1 is in an identifiable special range), in accordance with an embodiment of the present invention.

Furthermore, apart from MT calls, SI2M subscriber 112 can also receive SMS on his special range MSISDN-F while he is roaming in the XPMN. FIG. 7 represents a flow diagram for facilitating MT SMS on SI2M inbound roamer 112's special range MSISDN-F, when a sender of the MT SMS belongs to P-HPMN1 108, in accordance with a first embodiment of the present invention. This embodiment considers relaying the MT SMS via SG 104. This indirect routing allows FPMN 102 operator to control legal interception, spam filtering, content control, etc., and also provide better quality assurance (e.g., SMS delivery to the XPMN of SI2M subscriber 112, despite P-HPMN1 108 not having a direct routing relationship with the XPMN of SI2M subscriber 112). Since the sender belongs to P-HPMN1 108, the sender’s SMS (i.e., MO-FwdSMS) is received at SMSC-H1 134. Hereinafter, all MT SMS flows 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-H1 134 receives an SMS from the sender B, destined for SI2M subscriber 112’s special range MSISDN-F, SMSC-H1 134 sends a routing request message for SMS on the special range MSISDN-F, such as SRI-SM (MSISDN-F) to SG 104, at step 702. FPMN 102 operator configures SG 104 to return IMSI-H1 to SMSC-H1 134, in accordance with one embodiment of the present invention. Returning the IMSI-H1 eliminates the need for FPMN 102 operator to create or assign another IMSI of FPMN 102 (i.e., IMSI-F). However, SMSC-H1 134 may consider the returned IMSI-H1 as fraud, since the IMSI-H1 belongs to a country different from the country of the special range MSISDN-F requested in the SRI-SM query. Also, it will be apparent to a person skilled in the art that international number portability is rare, and hence normally P-HPMN1 108 may consider the returned IMSI-H1 as fraud. In another embodiment of the present invention, FPMN 102 operator configures SG 104 to return the special range IMSI-F to SMSC-H1 134. This requires FPMN 102 operator to create IMSI-F for each assigned MSISDN allotted to SI2M subscribers of FPMN 102. This problem can be reduced by deploying a common pool of dummy IMSIs of FPMN 102 at SG 104. Since not all assigned MSISDNs receive MT SMS at
the same time, whenever the MT SMS is received on any of these MSISDNs, SG 104 picks a dummy IMSI corresponding to that MSISDN.

It will be apparent to a person skilled in the art that SMSC-H1 134 usually charges a sending party based on a Mobile Country Code (MCC)/ Mobile Network Code (MNC) of the returned IMSI for number portability handling in the country of the destination number. Since the MT SMS is received via SG 104, SG 104 can assign either the HPMN IMSI or FPMN IMSI to request the inter-working charge. In the former case, SG 104 uses the IMSI-F or dummy IMSI option, in accordance with an embodiment of the present invention. In the latter case, SG 104 uses the IMSI-H1 option, in accordance with an embodiment of the present invention. Thus FPMN 102 operator controls returning of IMSI upon receiving the SRI-SM query from SMSC-H1 134. Hence at step 704, SG 104 sends either IMSI-F or IMSI-H1 in an SRI-SM-ACK message to SMSC-H1 134. Additionally, at step 704, SG 104 imitates SMSC-H1 134 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-H1 134. This causes SMSC-H1 134 to issue MT-FwdSMS (B, IMSI-H1 or IMSI-F) to SG 104, at step 706. FPMN 102 operator configures SG 104 to modify subscriber 112’s special range MSISDN-F received in the SRI-SM (i.e. at step 702) to MSISDN-H1 so as to route the MT SMS to VMSC-X 519. At step 708, SG 104 applies this modification logic and thus sends SRI-SM (MSISDN-H1) message to HLR-H1 130.

Then at step 710, HLR-H1 130 returns SRI-SM-ACK (IMSI-H1, VMSC-X) message to SG 104. At step 712, SG 104 routes the MT SMS on the IMSI-H1 to VMSC-X 519. Further at step 714, VMSC-X 519 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-H1 134.

In case SI2M subscriber 112 uses MSISDN-F’ and the sender B of the MT SMS belongs to P-HPMN 108; when the MT SMS on SI2M subscriber 112’s MSISDN-F’ is received at SMSC-H1 134, it sends SRI-SM query on the MSISDN-F’ to HLR-F 116 (i.e., instead of SG 104) since HLR-F 116 is the virtual HLR for the MSISDN-F’. Thereafter, HLR-F 116 returns special SG 104’s GT and IMSI-F’ to SMSC-H1 134. SMSC-H1 134 then sends MT-FwdSMS (B, IMSI-F’) message to SG 104 for delivery of the MT SMS to subscriber A’s handset. Rest of the MT SMS flow
on SI2M subscriber 112’s MSISDN-F, 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.

Alternatively, as mentioned in a previous portion of this specification, FPMN 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 SI2M inbound roamer 112’s special range MSISDN-F without routing the MT SMS via SG 104, in accordance with a second embodiment of the present invention.

FPMN 102 operator configures SG 104 to allow such situation when the SI2M subscribers are at the XPMN. Since the sender B in this second embodiment may or may not be from P-HPMN1 108, SMSC sending the SMS from sender B is considered to be an originating SMSC 801, which is hereinafter referred to as SMSC-O 801. When SMSC-O 801 receives an SMS from the sender B, destined for SI2M subscriber 112’s special range MSISDN-F, SMSC-O 801 sends SRI-SM (MSISDN-F) to SG 104, at step 802. Further at step 804, SG 104 applies logic to modify special range MSISDN-F to MSISDN-H1, and then sends the modified SRI-SM (MSISDN-H1) message to HLR-H1 130. At step 806, HLR-H1 130 returns IMSI-H1 and VMSC-X 519 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 104) the MT SMS, such as an MT-FwdSMS (B, IMSI-H1) message to VMSC-X 519, at step 810. Finally, at step 812, VMSC-X 519 returns an MT-FwdSMS-ACK message to SMSC-O 801.

Alternatively, P-HPMN1 108 operator controls MT SMS on its outbound roamer 112’s special range MSISDN-F. FIG. 9 represents a flow diagram for facilitating MT SMS on SI2M inbound roamer 112’s special range MSISDN-F, when the sender B does not belong to P-HPMN1 108, in accordance with a third embodiment of the present invention. This is beneficial 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 third embodiment of MT SMS on the MSISDN-F, P-HPMN1 108 operator uses an SMS gateway 901 associated with P-HPMN1 108, hereinafter interchangeably referred to as SMS gateway-H1 901, to control MT SMS on the special range MSISDN-F. Steps 902 to 906 are similar to steps 702 to 706,
where SG 104 sends special SG 104's GT and IMSI-H1/IMSI-F in the SRI-SM-ACK
message to SMSC-H1 134 upon receiving SRI query from SMSC-H1 134, and then
SMSC-H1 134 sends MT-FwdSMS (B, IMSI-H1 or IMSI-F) to SG 104. However in
this case of SMS gateway control, SMSC-H1 134 is replaced with SMSC-O 801, and
SG 104 at step 904 sends special SG 104's GT and special range IMSI-F (and no
IMSI-H1) to SMSC-O 801, and thereafter at step 906, SMSC-O 801 routes the MT
SMS on the special range IMSI-F to SG 104.

SG 104 then applies logic to route the MT SMS to SMS gateway-H1 901. In
an embodiment of the present invention, P-HPMN1 108 operator checks whether
sender B’s home network has inter-working with P-HPMN1 108 using SMS gateway-
H1 901. In this case, SG 104 interfaces with SMS gateway-H1 901 via a secured
Internet Protocol (IP) connection (e.g., Virtual Private Network (VPN), Secure
Sockets Layer (SSL), etc.). Thus, when SG 104 receives the MT SMS, it determines
MSISDN-H1 corresponding to special range IMSI-F 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-H1 to SMS gateway-H1 901 via the secure IP
connection. At step 910, SMS gateway-H1 901 performs SMS fraud/spam filtering,
and inter-working check as described above. Thereafter, at step 912, SMS gateway-
H1 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 SI2M subscriber 112 uses MSISDN-F’ and the sender B of the MT
SMS does not belong to P-HPMN1 108, when MT SMS on SI2M subscriber 112's
MSISDN-F’ is received at SMSC-O 801, it sends SRI-SM query on the MSISDN-F’
to HLR-F 116 (i.e., instead of SG 104) since HLR-F 116 is the virtual HLR for the
MSISDN-F’. Thereafter, HLR-F 116 returns special SG 104’s GT and IMSI-F’ to
SMSC-O 801. The rest of the MT SMS flow on SI2M subscriber 112's MSISDN-F’
where SG 104 submits the MT SMS to SMS gateway-H1 901 is same as that
explained above in conjunction with FIG. 9.

SI2M subscriber 112 can also receive SMS on his MSISDN-H1 while he is
roaming in FPMN 102 or any other XPMN. This case does not require SG 104 to be
involved. Hence the MT SMS on the MSISDN-H1 follows the standard MT call flow where the MT SMS on MSISDN-H1 is received at HLR-H1 130, which returns IMSI-H1 and VMSC address of SI2M subscriber 112 to SMSC-O 801. SMSC-O 801 then forwards the MT SMS to either VMSC-F 124 (i.e., in case subscriber 112 is in FPMN 102) or VMSC-X 519 (i.e., in case subscriber 112 is in the XPMN).

In addition to MT calls and SMS, SI2M inbound roamer 112 can also make calls using his assigned MSISDN or MSISDN-H1. 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, FPMN 102 operator routes call control signaling of SI2M inbound roamer 112’s call at FPMN 102 via SG 104. This helps FPMN 102 operator to charge the call on a prepaid FPMN account, and achieve monitoring and billing control of SI2M inbound 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 CLI number (i.e., subscriber A’s MSISDN in the ongoing call) 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 local PrePaid System (PPS), i.e., the PPS associated with FPMN 102 to charge MO calls at local tariffs rather than roaming tariffs. FPMN 102 operator, in accordance with an embodiment of the present invention, defines a special tariff at the local PPS, in order to handle billing of SI2M inbound roamer 112’s MO call in FPMN 102. SI2M subscriber 112 gets a recharge card from FPMN 102 to refill balance of his prepaid account of FPMN 102. Alternatively, in a fourth embodiment of the present invention, FPMN 102 operator offers free MO calls in exchange for some local advertising services. Alternatively, in order to encourage SI2M inbound roamers to top-up, FPMN 102 operator offers first ‘X’ minutes of MO call for free in FPMN 102. FPMN 102
operator defines and configures these free ‘X’ minutes, in accordance with an
embodiment of the present invention.

FIG. 10 represents a flow diagram for facilitating MO call by SI2M inbound
roarer 112 in FPMN 102, when inbound roarer 112 is a prepaid subscriber of P-
HPMN1 108, in accordance with an embodiment of the present invention. This case
considers the signaling control via IN protocol, and call control signaling of SI2M
inbound roarer 112’s call at FPMN 102 is relayed via SG 104. FPMN 102 operator
configures a switch associated with FPMN 102 to route SI2M inbound roarer 112’s
MO call (i.e., call control signaling) to SG 104. This switch corresponds to VMSC-F
124, in accordance with an embodiment of the present invention. It will be apparent to
a person skilled in the art that in case SI2M subscriber 112 is present in the XPMN,
all network elements in FPMN 102 are replaced with corresponding network elements
in the XPMN (e.g., VMSC-F 124 is replaced with VMSC-X 519). Following are
several options of routing the call control signaling of SI2M inbound roarer 112’s
MO call via SG 104:

1. FPMN 102 is able to use IN/ISUP (including loopback) based on the
assigned MSISDN or the calling IMSI-H1 of SI2M subscriber 112 in
special range.

2. SG 104 dynamically inserts IN trigger profile (like CAMEL or INAP
or FPMN proprietary trigger profile) at VLR-F 122 by sending a
standalone ISD message to VLR-F 122 either after the successful
registration of SI2M subscriber 112 with FPMN 102, or when a restore
acknowledgement message, such as a RestoreData-ACK at FPMN 102
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-F 122, as described earlier in the context of the present invention.
This option does not require the assigned MSISDN or IMSI-H1 of
SI2M subscriber 112 to be in the special range.

Thus, when SI2M subscriber A makes a call to B number (i.e., a called party
number in case of MO calls), at step 1002 VMSC-F 124 sends a call control signaling
request, such as an IN InitialDP (IDP) (MSISDN-X, IMSI-H1, B, VMSC-F) to SG
104. MSISDN-X corresponds to SI2M subscriber 112's assigned MSISDN or
MSISDN-H1, i.e., whichever is set by SI2M subscriber 112 as the default MSISDN at
FPMN 102. When the IN Initial DP (IDP) (MSISDN-X, IMSI-H1, B, VMSC-F) is
received at SG 104, SG 104 modifies the received message to an IN IDP (MSISDN-F,
IMSI-F, B, SG), and then sends the modified message to a Signaling Control Point
(SCP)-F 1003 associated with FPMN 102 (or the local PPS in FPMN 102), at step
1004. In case subscriber 112 uses MSISDN-F', MSISDN-F and IMSI-F in the MO
call flow scenario are replaced with MSISDN-F' and IMSI-F', respectively. In one
embodiment of the present invention, SG 104 sets inbound roamer 112's CLI number
in the MO call to MSISDN-F when the B number is of FPMN 102 country. This
embodiment will be considered to explain the call flow for SI2M inbound roamer
112's MO call in conjunction with FIG. 10.

In another embodiment of the present invention, SG 104 sets inbound roamer
112's CLI number in the MO call to MSISDN-H1 when the B number is of a country
different from FPMN 102 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-F 1003 sends an IN RRB
(Answer, Disconnect) message to VMSC-F 124 via SG 104. In addition, at steps 1010
and 1012, SCP-F 1003 sends an IN Continue message to VMSC-F 124 via SG 104.

Further at steps 1014 and 1016, VMSC-F 124 returns an IN ERB (Answer) message
to SCP-F 1003 via SG 104. SCP-F 1003 applies special tariff on the MO call by SI2M
inbound roamer 112, based on the special SG 104's address. Thus, upon receiving the
IN ERB (Answer) message, SCP-F 1003 starts deducting balance from SI2M inbound
roamer 112's prepaid account. Later, when SI2M inbound roamer 112 disconnects the
ongoing call, VMSC-F 124 sends IN ERB (Disconnect) message to SCP-F 1003 via
SG 104, at steps 1018 and 1020. Finally, at steps 1022 and 1024, SCP-F 1003 returns
IN ReleaseCall message to VMSC-F 124 via SG 104.

In yet another embodiment of the present invention, FPMN 102 operator
directly routes call control signaling for inbound roamer 112's MO call to an SCP-H1
associated with P-HPMN1 108 (i.e., without involving SG 104). In this case, SI2M
subscriber 112 is considered to be roaming in FPMN 102 that supports Customized
Application for Mobile Enhanced Logic (CAMEL) agreement with P-HPMN1 108.
Upon receiving a call from subscriber A, VMSC-F 124 obtains caller ID information
from VLR-F 122 and the call set up follows standard CAMEL call. The IDP message from VMSC-F 124 to the SCP-H1 contains the caller ID (i.e., subscriber A's number), which may be different from MSISDN-H1. This allows SCP-H1 to apply a different charging tariff for subscriber 112's CAMEL call in FPMN 102. For example, when MSISDN-F is sent as the caller ID, the SCP-H1 applies a special SI2M rate defined by FPMN 102 operator.

Furthermore, SI2M inbound roamer 112 can also send SMS using his assigned MSISDN or MSISDN-H1 while roaming in FPMN 102. FIG. 11 represents a flow diagram for facilitating MO SMS by SI2M inbound roamer 112, when a recipient number of the MO SMS, hereinafter interchangeably referred to as recipient B's number, is of a country different from FPMN 102 country, in accordance with a first embodiment of the present invention. In this embodiment, routing the MO SMS is done via SG 104, which applies application logic to change MSISDN of SI2M inbound roamer 112 based on the recipient B's number. SI2M inbound roamer 112 uses any default MSISDN to initiate the MO SMS in FPMN 102. This MSISDN of SI2M inbound 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 P-HPMN1 108. Moreover, in this first embodiment of MO SMS, SMSC-H1 134 is considered to allow access for only MSISDN-H1 of SI2M subscriber 112. For example, a large network operator (like China Mobile) that has many SMSCs deployed in their network may restrict SI2M subscriber to only use MSISDN-H1 for sending MO SMS, since adding MSISDN-F/MSISDN-F* access control for each SMSC in such a situation could be a logistical challenge for such large network operator.

In an embodiment of the present invention, FPMN 102 operator configures STP-F 114 to route MO SMS via SG 104. This is done by configuring STP-F 114 to direct all roaming Signal Connection Control part (SCCP) messages with Called Party Address (CdPA) destined to any partner HPMN SMSC (such as, SMSC-H1 134 in case of inbound roamers from P-HPMN1 108) and Sub System Number (SSN) =8 to SG 104. By doing so, FPMN 102 operator controls MO SMS of SI2M inbound roamer 112 using SG 104. Only SCCP messages with CdPA as SMSC-H1 134 and SSN=8 are relayed via SG 104, in order to reduce signaling load and risk. In another
embodiment of the present invention, FPMN 102 operator configures the first
International STP associated with FPMN 102 to route MO SMS via SG 104. When
SI2M subscriber A sends an MO SMS to the recipient B, at step 1102 VMSC-F 124
sends a SendInfoForMOSMS message on the IMSI-H1 with SMSC-H1 134 address
to VLR-F 122. VLR-F 122 then returns inbound roamer 112’s sending number
(hereinafter interchangeably referred to as MSISDN-X) in a SendInfoForMOSMS-
ACK message to VMSC-F 124, at step 1104. Thereafter, at step 1106, VMSC-F 124
sends the MO SMS, such as MO-FwdSMS (MSISDN-X, B, SMSC-H1) to SG 104.
SG 104 then modifies MSISDN-X to inbound roamer 112’s MSISDN-H1 before
relaying the MO SMS to SMSC-H1 134, at step 1108. Thus, SMSC-H1 134 does not
need to extend its access control list to include FPMN 102 MSISDNs. Alternatively,
in case SG 104 determines that the MO SMS signaling is of non-SI2M subscriber, SG
104 bypasses the received MO SMS signaling to SMSC-H1 134 without any
modification. Finally, at steps 1110 and 1112, SMSC-H1 134 relays an MO
acknowledgement message, such as MO-FwdSMS-ACK to VMSC-F 124 via SG 104.

Alternatively, in another embodiment of the present invention, FPMN 102
operator handles MO SMS without routing it via SG 104, when SMSC-H1 134 allows
access for any MSISDN-X of SI2M subscriber 112. This case may be beneficial in
case either SMSC-H1 134 has an explicit interface to set up access control list, or P-
HPMN1 108 operator has less number of SMSCs to modify their access control lists.
Since FPMN 102 operator is facilitating the SI2M service for P-HPMN1 108; P-
HPMN1 108 operator or FPMN 102 operator adds assigned MSISDN ranges/numbers
to SMSC-H1 134’s access control list, in accordance with an embodiment of the
present invention. Thus, when VMSC-F 124 receives the SendInfoForMOSMS-ACK
(MSISDN-X) message from VLR-F 122, VMSC-F 124 directly routes the MO SMS
to SMSC-H1 134. Thereafter, SMSC-H1 134 returns MO-FwdSMS-ACK message to
VMSC-F 124, and thereby standard MO SMS delivery procedure applies.

Furthermore, P-HPMN1 108 operator may want SG 104 to perform automatic
translation of sender ID (i.e., the default MSISDN) to the last assigned MSISDN of
SI2M inbound roamer 112, when the recipient B’s number does not belong to P-
HPMN1 108. FIGS. 12A, 12B, and 12C represent a flow diagram for facilitating MO
SMS by SI2M inbound roamer 112, when the recipient B’s number is of FPMN 102
country, in accordance with a second embodiment of the present invention. Steps 1202 to 1206 are same as steps 1102 to 1106, where VMSC-F 124 sends MO-FwdSMS (MSISDN-X, B, SMSC-H1) message to SG 104 upon receiving the SendInfoForMOSMS-ACK (MSISDN-X) message from VLR-F 122. 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-H1, 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, FPMN 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-H1, B’, SMSC-H1) message to SMSC-H1 134, at step 1208.

Upon receiving the modified message, SMSC-H1 134 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, 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 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-H1 134.

In one embodiment of the present invention, SMSC-H1 134 attempts to direct MO SMS of SI2M inbound roamers 112 to VMSC-B 1215 via SG 104. Hence at step 1218, SMSC-H1 134 forwards the SMS on the MSISDN-H1 along with the IMSI-B’ and the SG 104’s address to SG 104. Thereafter, SG 104 modifies the sender ID (i.e., MSISDN-H1) to the assigned MSISDN, 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 the SI2M subscriber 112’s 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 the MSISDN-F/MSISDN-F’ of SI2M subscriber 112. Further at steps 1222 and 1224,
VMSC-B 1215 sends an MT-FwdSMS-ACK message to SMSC-H1 134 via SG 104. Finally, at steps 1226 and 1228, SMSC-H1 134 sends an MO-FwdSMS-ACK message to VMSC-F 124 via SG 104, in order to confirm VMSC-F 124 for delivery of the SMS to the recipient B’s handset.

In another embodiment of the present invention, SMSC-H1 134 attempts to submit the MO SMS of SI2M inbound roamer 112 via SMS gateway-H1 901 when P-HPMN1 108 has SMS gateway control for any outbound MO SMS by its SI2M subscriber 112. Hence at step 1230, SMSC-H1 134 submits the SMS on the MSISDN-H1 to SMS gateway-H1 901. Thereafter, at step 1232, SMS gateway-H1 901 returns a Submit-ACK message to SMSC-H1 134. SMS gateway-H1 901 should eventually send the SMS to SG 104 similar to that explained earlier at step 1218 where SMSC-H1 134 sends the MT-FwdSMS (MSISDN-H1, IMSI-B’, SG) message to SG 104. However in this embodiment SMS gateway-H1 901, instead of SMSC-H1 134, sends the SMS on the MSISDN-H1 to SG 104. SG 104 then modifies the MSISDN-H1 to the assigned MSISDN of SI2M subscriber 112, and the SG 104’s address in the received SMS back to VMSC-B address of the recipient B, and relays the modified SMS to VMSC-B 1215. Thereafter, VMSC-B 1215 sends the SI2M subscriber 112’s SMS to the recipient B’s handset. Further, at steps 1234 and 1236, SMSC-H1 134 sends the MO-FwdSMS-ACK message to VMSC-F 124 via SG 104, in order to confirm VMSC-F 124 for delivery of the SMS to the recipient B’s handset.

Since SI2M subscriber 112 can change his MSISDN from the assigned MSISDN to his MSISDN-H1, there is no way for FPMN 102 operator to apply a special tariff for calls and SMS of SI2M subscriber 112 in FPMN 102. Moreover, even the MSISDN-F is also not from a special range MSISDNs. In such case when FPMN 102 operator requires a special indication at FPMN 102 of the assigned MSISDN for billing purpose, (e.g., because even IMSI-H1 is not in a special IMSI range) then SI2M subscriber 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 SI2M subscriber 112 while he is roaming in the XPMN, FPMN 102 operator can opt for various billing options that are described hereinafter in the context of the present invention, or any other means for billing,
sharing billing information, or utilizing known financial clearing techniques in order to exchange information and create and render end-user bills for the SI2M service.

In one embodiment, FPMN 102 operator does not change the usual roaming rate for charging SI2M subscriber 112's mobile activities in the XPMN. Hence there is no change in the billing system (i.e., neither in FPMN 102 nor at P-HPMN1 108) for handling SI2M subscriber 112's billing. However, in this embodiment, FPMN 102 operator needs to inform P-HPMN1 108 operator (or data-clearing house) about not rejecting such MT Transferred Account Procedure (TAP) records associated with SI2M subscriber 112. In this first embodiment of billing, SI2M subscriber 112 gets the benefit of a local presence in the XPMN (e.g., in FPMN 102), and other local subscribers of FPMN 102 can easily reach SI2M subscriber 112 on his assigned MSISDN. VIP roamers subscribing to FPMN 102's SI2M service in the XPMN are also benefited.

In another billing embodiment, FPMN 102 operator offers free incoming call on subscriber 112's MSISDN-F/F' (i.e. his local number); however, other mobile activities are still at the usual roaming rate. Hence in this case, SI2M 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 FPMN 102), and also local calling by other local subscribers of FPMN 102 to SI2M subscriber 112. Since MT call on the assigned MSISDN is free for SI2M subscriber 112, FPMN 102 operator needs to ensure that MT billing record on the assigned MSISDN is removed, and hence not charged to SI2M subscriber 112. This embodiment is useful for VIP roamers subscribing to FPMN 102's SI2M service in the XPMN.

In yet another billing embodiment, FPMN 102 operator offers MO call by SI2M subscriber 112 to be charged against a local prepaid account of SI2M subscriber 112 while roaming in FPMN 102. Hence in this case, SI2M subscriber 112 gets the benefit of a local prepaid number of FPMN 102 without changing his P-HPMN1 108 SIM card, in addition to local calling by other local subscribers of FPMN 102 to SI2M 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 SI2M subscriber 112. In another embodiment of the present invention, the MT call on the assigned MSISDN is charged against local prepaid account of SI2M subscriber 112. MO SMS by SI2M 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, FPMN 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 SI2M subscriber 112 for low balance).

In yet another billing embodiment, FPMN 102 operator offers MO SMS by SI2M subscriber 112 to be charged against the local prepaid account of SI2M subscriber 112.

In yet another billing embodiment, FPMN 102 operator offers MO GPRS data services by SI2M subscriber 112 to be charged against the local prepaid account.

Similarly, yet another billing embodiment, FPMN 102 operator offers MO MMS by SI2M subscriber 112 to be charged against the local prepaid account.

In an embodiment of the present invention, FPMN 102 and P-HPMN1 108 operators settle billing using CDRs or TAP records in order to charge P-HPMN1 108 SI2M subscribers. In one embodiment of the present invention, FPMN 102 operator defines a special Inter-Operator Tariff (IOT) for P-HPMN1 108's SI2M subscribers (e.g., using special FPMN 102 numbers). FPMN 102 operator provides information about P-HPMN1 108's SI2M subscribers for special bill processing to either P-HPMN1 108's data-clearing house, or P-HPMN1 108 operator. Alternatively, in another embodiment of the present invention, FPMN 102 operator does not exchange the IOT with P-HPMN1 108 operator, and applies standard TAP for a wholesale IOT.

In yet another embodiment of the present invention, P-HPMN1 108 operator provides discount to SI2M subscribers of P-HPMN1 108 in case of retail roaming charge in FPMN 102, and P-HPMN1 108 operator claims this discount from FPMN 102 operator. In an embodiment of the present invention, P-HPMN1 108's SI2M subscribers pay a monthly subscription fee for SI2M service, and get the discount for each month of the SI2M service used. Different subscription fees may be charged from SI2M subscribers, depending upon whether the MSISDN-F/MSISDN-F' is assigned to these SI2M subscribers permanently or temporarily. In an embodiment of
the present invention, FPMN 102 operator charges the SI2M service subscription fee from SI2M subscribers of P-HPMN1 108. In another embodiment of the present invention, P-HPMN1 108 operator charges the SI2M service subscription fee from its SI2M subscribers. In yet another embodiment of the present invention, both FPMN 102 and P-HPMN1 108 operators charge the SI2M service subscription fee from P-HPMN1 108’s SI2M subscribers at same or different rates.

It will be apparent to a person skilled in the art that the SI2M 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 P-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.

<table>
<thead>
<tr>
<th>GSM MAP</th>
<th>ANSI-41D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location Update/ISD</td>
<td>REGNOT</td>
</tr>
<tr>
<td>Cancel Location</td>
<td>REGCAN</td>
</tr>
<tr>
<td>RegisterSS</td>
<td>FEATUREREQUEST</td>
</tr>
<tr>
<td>InterrogateSS</td>
<td>FEATUREREQUEST</td>
</tr>
<tr>
<td>SRI-SM</td>
<td>SMSREQ</td>
</tr>
<tr>
<td>SRI</td>
<td>LOCATION REQUEST</td>
</tr>
<tr>
<td>ForwardSMS</td>
<td>SMSDPP</td>
</tr>
<tr>
<td>ReadyForSMS</td>
<td>SMSNOTIFICATION</td>
</tr>
<tr>
<td>AlertServiceCenter</td>
<td>SMSNOTIFICATION</td>
</tr>
<tr>
<td>ReportSMSDelivery</td>
<td>SMDPP</td>
</tr>
<tr>
<td>ProvideRoamingNumber</td>
<td>ROUTING REQUEST</td>
</tr>
</tbody>
</table>
An FPMN operator uses one or more variations of the present invention to allow its inbound roamers from different partner HPMNs to subscribe to the SI2M service without the need to change their existing partner HPMN SIMs. Furthermore, when the inbound roamers are registered with the FPMN, the FPMN operator considers these roamers as local subscribers, and it provides such roamers with the call-related and non call-related services on their HPMN MSISDN and the assigned MSISDNs at tariffs less than normal roaming rates. This attracts more inbound roamers to register for SI2M service in the FPMN. Moreover, the present invention also allows outbound roamers of partner HPMNs to use FPMN operator's SI2M service even though they are roaming in any other visited network. SI2M subscribers (or inbound roamers) can change their MSISDNs, according to their requirements and FPMN operator's feasibility to allow such MSISDN change. The present invention further allows the FPMN operator to charge different categories of SI2M subscribers (e.g., normal and VIP roamers) by defining different tariffs.

Additionally, the FPMN operator offers SI2M service to inbound 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 FPMN and partner HPMN operators as more roamers of these partner HPMNs tend to register with the FPMN. Furthermore, the SI2M service also provides fail-over support to the inbound roamers 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 SI2M inbound roamers remain unaffected. The present invention caters to both prepaid and postpaid inbound roamers of the FPMN. In addition, the present invention allows FPMN operator to offer various other VASs such as, but not limited to, MCA and CLI to its SI2M inbound 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, 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 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.

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 roaming in an FPMN. The computer program product further includes a computer usable program code for assigning the FPMN MSISDN by an SG to the subscriber, based on a subscription activation request received from the subscriber at the SG either directly or via an USSD gateway associated with the FPMN, wherein the SG is associated with either the FPMN or an MVNO associated with the FPMN, 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 FPMN MSISDN 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 the 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 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.

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

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 roaming in an FPMN. 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.

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 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

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>3G</td>
<td>Third generation of mobile</td>
</tr>
<tr>
<td>ACM</td>
<td>ISUP Address Completion Message</td>
</tr>
<tr>
<td>ANM</td>
<td>ISUP Answer Message</td>
</tr>
<tr>
<td>ANSI-41</td>
<td>American National Standards Institute #41</td>
</tr>
<tr>
<td>CAMEL</td>
<td>Customized Application for Mobile Enhanced Logic</td>
</tr>
<tr>
<td>CC</td>
<td>Country Code</td>
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<tr>
<td>CDMA</td>
<td>Code Division Multiple Access</td>
</tr>
<tr>
<td>CdPA</td>
<td>Called Party Address</td>
</tr>
<tr>
<td>CgPA</td>
<td>Calling Party Address</td>
</tr>
<tr>
<td>CLI</td>
<td>Calling Line Identification</td>
</tr>
<tr>
<td>ERB</td>
<td>CAP Event Report Basic call state model</td>
</tr>
<tr>
<td>FPMN</td>
<td>Friendly Public Mobile Network</td>
</tr>
<tr>
<td>FTN</td>
<td>Forward-To Number</td>
</tr>
<tr>
<td>GMSC</td>
<td>Gateway MSC</td>
</tr>
<tr>
<td>GMSC-F</td>
<td>GMSC in FPMN</td>
</tr>
<tr>
<td>GMSC-H</td>
<td>GMSC in HPMN</td>
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<tr>
<td>GPRS</td>
<td>General Packet Radio System</td>
</tr>
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<td>GSM</td>
<td>Global System for Mobile</td>
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<tr>
<td>GT</td>
<td>Global Title</td>
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<td>HLR</td>
<td>Home Location Register</td>
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<td>HLR-F</td>
<td>FPMN HLR</td>
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<tr>
<td>HLR-H</td>
<td>HPMN HLR</td>
</tr>
<tr>
<td>HPMN</td>
<td>Home Public Mobile Network</td>
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<tr>
<td>IAM</td>
<td>Initial Address Message</td>
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<tr>
<td>IDP</td>
<td>Initial DP IN/CAP message</td>
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<tr>
<td>IMSI</td>
<td>International Mobile Subscriber Identity</td>
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<td>IMSI-H</td>
<td>HPMN IMSI</td>
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<td>IN</td>
<td>Intelligent Network</td>
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<td>IP</td>
<td>Internet Protocol</td>
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<td>ISC</td>
<td>International Service Carrier</td>
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<td>ISD</td>
<td>MAP Insert Subscriber Data</td>
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<td>ISTP</td>
<td>International STP</td>
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<td>ISUP</td>
<td>ISDN User Part</td>
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<td>MAP Location Update</td>
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<td>Mobile Application Part</td>
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<td>MCC</td>
<td>Mobile Country Code</td>
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<td>MMS</td>
<td>Multimedia Message Service</td>
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<td>MNC</td>
<td>Mobile Network Code</td>
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<tr>
<td>MO</td>
<td>Mobile Originated</td>
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<tr>
<td>MSC</td>
<td>Mobile Switching Center</td>
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<tr>
<td>MSISDN</td>
<td>Mobile Station International Subscriber Directory Number</td>
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<td>MSISDN-F</td>
<td>FPMN MSISDN</td>
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<td>MSISDN-H</td>
<td>HPMN MSISDN</td>
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<td>MSRN</td>
<td>Mobile Station Roaming Number</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
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<tr>
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<tr>
<td>MSRN-F</td>
<td>FPMN MSRN</td>
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<tr>
<td>MSRN-H</td>
<td>HPMN MSRN</td>
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<td>MT</td>
<td>Mobile Terminated</td>
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<tr>
<td>MTP</td>
<td>Message Transfer Part</td>
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<tr>
<td>PRN</td>
<td>MAP Provide Roaming Number</td>
</tr>
<tr>
<td>RNA</td>
<td>Roaming Not Allowed</td>
</tr>
<tr>
<td>RR</td>
<td>Roaming Restricted due to unsupported feature</td>
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<tr>
<td>RRB</td>
<td>CAP Request Report Basic call state model</td>
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<tr>
<td>SCCP</td>
<td>Signal Connection Control part</td>
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<tr>
<td>SCP</td>
<td>Signaling Control Point</td>
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<td>SCP-H</td>
<td>HPMN SCP</td>
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<tr>
<td>SQ</td>
<td>Signaling Gateway</td>
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<tr>
<td>SIM</td>
<td>Subscriber Identity Module</td>
</tr>
<tr>
<td>SMS</td>
<td>Short Message Service</td>
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<tr>
<td>SMSC</td>
<td>Short Message Service Center</td>
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<td>SMSC-F</td>
<td>FPMN SMSC</td>
</tr>
<tr>
<td>SMSC-H</td>
<td>HPMN SMSC</td>
</tr>
<tr>
<td>SRI</td>
<td>MAP Send Routing Information</td>
</tr>
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<td>SRI-SM</td>
<td>MAP Send Routing Information For Short Message</td>
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<td>Signaling System #7</td>
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<td>Sub System Number</td>
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<td>Signal Transfer Point</td>
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<td>FPMN STP</td>
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<tr>
<td>STP-H</td>
<td>HPMN STP</td>
</tr>
<tr>
<td>TR</td>
<td>Traffic Redirection</td>
</tr>
<tr>
<td>TT</td>
<td>Translation Type</td>
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<tr>
<td>USSD</td>
<td>Unstructured Supplementary Service Data</td>
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<tr>
<td>VAS</td>
<td>Value Added Service</td>
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<tr>
<td>VLR</td>
<td>Visited Location Register</td>
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<td>VLR-F</td>
<td>FPMN VLR</td>
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<tr>
<td>VLR-H</td>
<td>HPMN VLR</td>
</tr>
<tr>
<td>VMSC</td>
<td>Visited Mobile Switching Center</td>
</tr>
<tr>
<td>VPMN</td>
<td>Visited Public Mobile Network</td>
</tr>
<tr>
<td>WAP</td>
<td>Wireless Access Protocol</td>
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</table>
I Claim:

1. A method for facilitating mobile communication of a subscriber roaming in a Friendly Public Mobile Network (FPMN), the method comprising:

   assigning an FPMN Mobile Station International Subscriber Directory Number (MSISDN), by a network element, to the subscriber, based on a subscription activation request received from the subscriber at the network element either directly or via an Unstructured Supplementary Service Data (USSD) gateway associated with the FPMN, wherein the network element is associated with one of: the FPMN and a Mobile Virtual Network Operator (MVNO) associated with the FPMN, and wherein the subscriber has a Home Public Mobile Network (HPMN) Subscriber Identity Module (SIM) with a corresponding HPMN International Mobile Subscriber Identity (IMSI) and an HPMN MSISDN;

   associating, by the network element, the FPMN MSISDN with the HPMN MSISDN;

   detecting, passively by the network element, the subscriber’s registration with the FPMN;

   sending, by the network element, a default MSISDN to a Visited Location Register (VLR) associated with the FPMN;

   modifying, by the network element, the default MSISDN to the HPMN MSISDN, when an MSISDN change request is received from the subscriber at the network element either directly or via the FPMN USSD gateway; and

   facilitating, by the network element, 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 the network element passively detects the subscriber’s registration with the FPMN by using a monitoring module that taps roaming signaling links associated with the subscriber in the FPMN, the monitoring module being coupled to the network element.

3. The method of claim 1, further comprising:
Redirecting, by the network element, the subscriber's traffic to the FPMN upon detecting passively the subscriber's registration attempt with one of a VPMN and a competitor FPMN.

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

5. The method of claim 1, wherein the FPMN MSISDN is at least one selected from a group consisting of a special range FPMN number and the subscriber's existing FPMN number.

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

7. The method of claim 1, further comprising:
   storing the association of the FPMN MSISDN with the HPMN MSISDN in a subscription database coupled to the network element;
   storing an association of the HPMN IMSI with an FPMN IMSI corresponding to the FPMN MSISDN in the subscription database; and
   maintaining the subscriber's current location in the FPMN in the subscription database.

8. The method of claim 1, wherein the subscriber's Mobile Originated (MO) communication using the FPMN MSISDN is received at the network element.

9. The method of claim 8, wherein a switch associated with the FPMN is configured to route the MO call to the network element, wherein the routing at the switch is based on one selected from a group consisting of:
   the FPMN MSISDN,
   the HPMN IMSI, and
   an IN trigger profile dynamically inserted by the network element 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 network element facilitates the MO call by applying one selected from a group consisting of:

   setting the subscriber’s Calling Line Identification (CLI) in the MO call to the FPMN MSISDN when a called party number is of the FPMN country;

   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 FPMN 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 network element via a roaming STP associated with the FPMN.

12. The method of claim 11, wherein the network element facilitates the MO SMS by applying at least one selected from a group consisting of:

   setting the subscriber’s sending number in the MO SMS to the FPMN MSISDN when a recipient number is of the FPMN country;

   setting the subscriber’s sending number to the HPMN MSISDN when the recipient number is of a country different from the FPMN country;

   routing the MO SMS to an HPMN SMSC via the network element 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, wherein the subscriber’s Mobile Terminated (MT) communication at the FPMN MSISDN is received at the network element.
14. The method of claim 13, wherein the MT call on the FPMN MSISDN is directed from the FPMN to a PMN, via the network element, when the subscriber is passively detected by the network element to be registered with the PMN.

15. The method of claim 13, wherein the network element 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 FPMN MSISDN.

16. The method of claim 13, wherein the network element sends an absent subscriber to an FPMN GMSC upon receiving a routing request message on the FPMN MSISDN when the subscriber is passively detected by the network element to be registered with a PMN other than the FPMN, and wherein the routing request message is received when a calling party calls the subscriber on the FPMN MSISDN.

17. The method of claim 16, further comprising:
   sending a missed call alert message by the network element to at least one selected from a group consisting of the subscriber and the calling party.

18. The method of claim 13, wherein the network element releases the MT call on the FPMN MSISDN by:
   sending a special Forward-To Number (FTN) to an FPMN GMSC upon receiving a routing request message on the FPMN MSISDN when the subscriber is passively detected by the network element to be registered with a PMN other than the FPMN; and
   releasing the call on the FPMN number with one selected from a group consisting of a special announcement number and a release cause.

19. The method of claim 13, wherein the network element facilitates the MT SMS by applying at least one 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 one of the HPMN IMSI and an FPMN
IMSI corresponding to the FPMN MSISDN when a sender of the MT SMS belongs to the HPMN;

modifying the subscriber's FPMN 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

routing the MT SMS on the HPMN MSISDN to an HPMN SMS gateway via a secured IP connection, upon receiving the MT SMS on the FPMN IMSI when the sender of the MT SMS is determined not to belong to the HPMN.

20. The method of claim 1, wherein the MSISDN change request and a subscription deactivation request is at least one selected from a group consisting of a Short Message Service (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.

21. The method of claim 1, wherein the network element is a signaling gateway (SG).

22. A method for facilitating mobile communication of a subscriber roaming in an FPMN, the method comprising:

assigning the FPMN MSISDN, by a network element, to the subscriber, based on a subscription activation request received from the subscriber at the network element either directly or via an USSD gateway associated with the FPMN, wherein the network element is associated with one selected from a group consisting of the FPMN and an MVNO associated with the FPMN;

associating, by the network element, the FPMN MSISDN with the subscriber's existing MSISDN;

detecting, passively by the network element, the subscriber's registration with the FPMN;

sending, by the network element, a default MSISDN to a VLR associated with the FPMN;
modifying the default MSISDN, by the network element, to the subscriber's existing MSISDN when an MSISDN change request is received from the subscriber at the network element either directly or via the FPMN USSD gateway; and

facilitating, by the network element, mobile communication of the subscriber in the FPMN using at least one of the default MSISDN and the subscriber's existing MSISDN.

23. A system for facilitating mobile communication of a subscriber roaming in an FPMN, the system comprising:

a network element for assigning the FPMN MSISDN to the subscriber based on a subscription activation request received from the subscriber at the network element, either directly or via an USSD gateway associated with the FPMN, wherein the network element is associated with one selected from a group consisting of the FPMN and an MVNO associated with the FPMN, wherein the subscriber has an HPMN SIM with a corresponding HPMN IMSI and an HPMN MSISDN;

the network element further associating the FPMN MSISDN with the HPMN MSISDN;

the network element further detecting passively the subscriber's registration with the FPMN;

the network element further sending a default MSISDN to a VLR associated with the FPMN;

the network element further modifying the default MSISDN to the HPMN MSISDN, when an MSISDN change request is received from the subscriber at the network element either directly or via the FPMN USSD gateway; and

the network element further facilitating mobile communication of the subscriber in the FPMN using at least one of the default MSISDN and the HPMN MSISDN.

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

25. A computer program product comprising a computer usable medium including
a computer usable program code for facilitating mobile communication of a
subscriber roaming in an FPMN, the computer program product comprising:

   computer usable program code for assigning the FPMN MSISDN, by
   network element, to the subscriber based on a subscription activation request
   received from the subscriber at the network element, either directly or via an
   USSD gateway associated with the FPMN, wherein the network element is
   associated with one of: the FPMN and an MVNO associated with the FPMN,
   and wherein the subscriber has an HPMN SIM with a corresponding HPMN
   IMSI and an HPMN MSISDN;

   computer usable program code for associating, by the network
   element, the FPMN MSISDN with the HPMN MSISDN;

   computer usable program code for detecting, passively by the network
   element, the subscriber’s registration with the FPMN;

   computer usable program code for sending, by the network element, a
   default MSISDN to a VLR associated with the FPMN;

   computer usable program code for modifying, by the network element,
   the default MSISDN to the HPMN MSISDN; and

   computer usable program code for facilitating, by the network, 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.

26. A method for facilitating mobile communication of a subscriber roaming in a
Friendly Public Mobile Network (FPMN), the method comprising:

assigning an FPMN Mobile Station International Subscriber Directory
Number (MSISDN), via a network element, to the subscriber, based on a
subscription activation request received from the subscriber at the either
directly or via an Unstructured Supplementary Service Data (USSD) gateway
associated with the FPMN, wherein the network element is associated with
one of: the FPMN and a Mobile Virtual Network Operator (MVNO)
associated with the FPMN, and wherein the subscriber has a Home Public
Mobile Network (HPMN) Subscriber Identity Module (SIM) with a corresponding HPMN International Mobile Subscriber Identity (IMSI) and an HPMN MSISDN;

associating the FPMN MSISDN with the HPMN MSISDN;

detecting, passively, the subscriber's registration with the FPMN;

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

modifying the default MSISDN to the HPMN MSISDN, when an MSISDN change request is received from the subscriber either directly or via the FPMN USSD gateway; and

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

202
Detect passively by an SG, an HPMN subscriber's registration with an FPMN

204
Assign one FPMN MSISDN by the SG to the subscriber based on a subscription activation request

206
Associate by the SG, the FPMN MSISDN with an HPMN MSISDN of the subscriber

208
Send a default MSISDN from the SG to an FPMN VLR

210
Modify by the SG, the default MSISDN to the HPMN MSISDN, when an MSISDN change request is received at the SG from the subscriber either directly or via an FPMN USSD gateway

212
Facilitate by the SG, mobile communication of the subscriber in the FPMN using either the default MSISDN, or HPMN MSISDN, or both

Stop

FIG. 2
SMS procedure of SI2M service subscription activation

124
VMSC-F

122
VLR-F

104
SG

112
302: Welcome message for SI2M service promotion

304: Subscription activation request

306: ISD (default MSISDN, IN trigger profile)

308: ISD-ACK

FIG. 3
GSM Location Update of an SI2M inbound roamer at an FPMN

124 VMSC-F

122 VLR-F

104 SG

106 Monitoring Module

130 HLR-H1

402: LUP (IMSI-H1, VLR-F/VMSC-F)

404: ISD (MSISDN-H1)

406: ISD-ACK

408: LUP-ACK

410: ISD (default MSISDN, IN trigger profile)

412: ISD-ACK

414: Welcome SMS and reminder of MSISDN:F

FIG. 4
MT call on a special range MSISDN-F of the SI2M inbound roamer where the MT call is routed via an SG

FIG. 5
MT call on the special range MSISDN-F when the SI2M subscriber is not present in the FPMN

- 602: IAM (B, MSISDN-F)
- 604: SRI (MSISDN-F)
- 606: SRI-ACK (Absent-subscriber)
  - If B's number is known from SRI, initiate a Missed Call Alert procedure to B or A or both, and optionally send A's MSISDN-H1 to B when A is not in the FPMN country
- 608: SRI-ACK (FTN=S#)
- 610: IAM (B, OCN=MSISDN-F, S#)
  - If B's number is not known from the SRI, capture B's number via ISUP IAM and play announcement. Then initiate a Missed Call Alert procedure to B or A or both, and optionally send A's MSISDN-H1 to B when A is not in the FPMN country
- 612: IAM (Ann#) or REL (Rel-cause)

FIG. 6
MT SMS on the special range MSISDN-F when a sender of the MT SMS belongs to an HPMN

FIG. 7
MT SMS on the special range MSISDN-F without routing the MT SMS via the SG

801: SMSC-O
802: SRI-SM (MSISDN-F)
804: SRI-SM (MSISDN-H1)
806: SRI-SM-ACK (IMSI-H1, VMSC-X)
808: SRI-SM-ACK (VMSC-X, IMSI-H1)
810: MT-FwdSMS (B, IMSI-H1)
812: MT-FwdSMS-ACK

FIG. 8
MT SMS on the special range MSISDN-F when the sender does not belong to the HPMN

801: SMSC-O
116: HLR-F
104: SG
130: HLR-H1
901: SMS gateway-H1

902: SRI-SM (MSISDN-F)
904: SRI-SM-ACK (SG, IMSI-F)
906: MT-FwdSMS (B, IMSI-F)
908: SubmitSMS (B, MSISDN-H1)
910: SMS filtering, fraud and interworking check
912: SubmitSMS-ACK
914: MT-FwdSMS-ACK

FIG. 9
MO call by the inbound roamer when the inbound roamer is a prepaid subscriber of the HPMN

1002: IDP (MSISDN-X, IMSI-H1, B, VMSC-F)

1008: RRB (Answer, Disconnect)

1012: Continue

1014: ERB (Answer)

1018: ERB (Disconnect)

1024: ReleaseCall

1004: IDP (MSISDN-F, IMSI-F, B, SG)

1006: RRB (Answer, Disconnect)

1010: Continue

1016: ERB (Answer)

1020: ERB (Disconnect)

1022: ReleaseCall

Start accounting

Stop accounting

FIG. 10
MO SMS by the inbound roamer when the recipient number of the MO SMS is of a country different from the FPMN country

1102: SendInfoForMOSMS (IMSI-H1, SMSC-H1)
1104: SendInfoForMOSMS-ACK (MSISDN-X)
1106: MO-FwdSMS (MSISDN-X, B, SMSC-H1)
1108: MO-FwdSMS (MSISDN-H1, B, SMSC-H1)
1110: MO-FwdSMS-ACK
1112: MO-FwdSMS-ACK

FIG. 11
MO SMS by the inbound roamer when the recipient number does not belong to the HPMN

1202: SendInfoForMOSMS (IMSI-H1, SMSC-H1)

1204: SendInfoForMOSMS-ACK (MSISDN-X)

1206: MO-FwdSMS (MSISDN-X, B, SMSC-H1)

1208: MO-FwdSMS (MSISDN-H1, B', SMSC-H1)

1210: SRI-SM (B')

1212: SRI-SM (B)

1214: SRI-SM-ACK (IMSI-B, VMSC-B)

1216: SRI-SM-ACK (IMSI-B', SG)

FIG. 12A
FIG. 12B

1218: MT-FwdSMS (MSISDN-H1, IMSI-B', SG)

Sending SMS to VMSC-B via the SG

1220: MT-FwdSMS (MSISDN-F, IMSI-B, VMSC-B)

1222: MT-FwdSMS-ACK

1224: MT-FwdSMS-ACK

1226: MO-FwdSMS-ACK

1228: MO-FwdSMS-ACK