(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
21 February 2013 (21.02.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/025806 A1

(51) International Patent Classification:
G06F 15/16 (2006.01)

(21) International Application Number:
PCT/US2012/050952

(22) International Filing Date:
15 August 2012 (15.08.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/523,731 15 August 2011 (15.08.2011) US

(71) Applicant *(for all designated States except US)*: **ROAMWARE, INC.** [US/US]; 20401 Stevens Creek Blvd., Cupertino, California 95014 (US).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **JIANG, John Yue Jun** [GB/US]; 4114 Sugar Maple Drive, Danville, California 94506 (US).

(74) Agents: **CHESSER, Wilburn L.** et al.; Arent Fox, LLP, 1050 Connecticut Avenue, N.W., Suite 400, Washington, District of Columbia 20036-5339 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) **Title**: METHOD AND SYSTEM FOR PROVIDING CLOUD SUBSCRIBER IDENTITY MODULE (SIM)

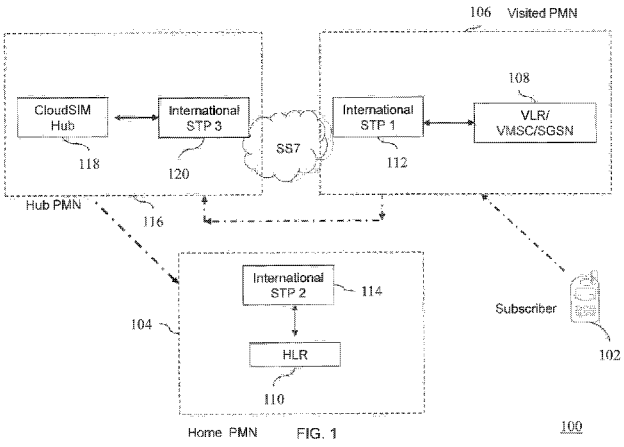

FIG. 1

(57) **Abstract**: The present invention provides a method and system for mobile communication where upon detecting a change in registration of a subscriber of a 5 client network at a visited operator, the subscribers client networks IMSI is switched to a hub operators IMSI. The hub operator is selected from a cloudSIM hub ecosystem, depending on the location of the subscriber. Thereafter, a cloudSIM hub converts between the signaling on the hub operators IMSI to signaling on the client operators IMSI. Further, the cloudSIM hub relays the converted signaling between 10 the visited operator and the client operator.

WO 2013/025806 A1

METHOD AND SYSTEM FOR PROVIDING CLOUD SUBSCRIBER IDENTITY MODULE (SIM)

Related Applications

This application claims priority from United States Provisional Patent Application 61/523,731 entitled "Dual IMSI Ecosystem", filed August 15, 2011, which is incorporated herein by this reference in its entirety.

Field of the Invention

The present invention generally relates to mobile communication. More specifically, the invention relates to handling mobile communication while roaming.

Background of the Invention

Roaming traffic contributes a significant percentage of an operator's revenue and even a better percentage of the operator's margin. With increasing competition and regulatory control, operators are being more pressured to increase their roaming revenue. Over the last few years, revenues to the network operators from home subscribers have consistently declined due to increased competition and resulting pricing pressures. On the other hand, revenues from roamers have consistently grown in the same period due to increased mobile penetration in local markets and an increase in travel.

As the global mobile roaming market business model is evolving, the industry understands the strategic importance of roaming to operator's revenues and profit margins and is adapting various newly proposed regulations. The operators understand that they must develop strategies for driving the number of roamers and roaming usage, while lowering tariff rates.

Amongst the roaming business, the average margins on inbound roaming revenue is around 80% and the average margins on outbound roaming revenue is around 20%. The key challenge lying before the operators is to maximize the outbound roaming revenues. While analyzing the outbound roaming revenues, it should be noted that on an average 40% of the outbound roaming revenues are contributed from Mobile Originated (MO) calls made by outbound roamers. Of these

MO calls, almost 70% calls are back home and 10% are to other markets outside the current roaming destination of the subscribers. The revenue earned by the operator from these calls is minimal considering the revenue distribution between the current roaming network of the roamers and the destination network to where the call is made.

The roaming charges levied to a roamer for the outgoing calls made also constitute Inter Operator Tariffs and retail markups. The operators are increasingly coming under price pressure to offer better retail rates compared to wholesale tariff. The IOTs carry about 80% margin today whereas retail roaming charges carry only 20% margin. While the operators rely heavily on IOT discounting while setting up roaming agreements to maximize their roaming margins, the exception to the rule is outgoing international calls to other networks, the international outgoing calls continue to be expensive.

The key drivers constituting outbound roaming revenue are hence the Inter Operator Tariff, Termination Rates and Retail Markup. The operator can leverage the retail markup by selecting a "preferred partner" network that offers lesser IOT and lesser termination fees. There could also be an ecosystem of such preferred partner networks who offer each other discounted tariffs.

In accordance with the foregoing, there is a need in the art of a system, a method, for creating a solution that gives an operator the ways to leverage the ecosystem of preferred partner networks to enable a subscriber use a preferred network's IMSI while roaming, with the aim of maximizing the margin that accrues to the home operator. While the focus of the invention is on roaming, the methods can also be applied similarly to international calls too.

Summary

The present invention is directed towards a method and system for mobile communication where upon detecting a change in registration of a subscriber of a client network at a visited operator, the subscriber's client network's IMSI is switched to a hub operator's IMSI. The hub operator is selected from a cloudSIM hub ecosystem, depending on the location of the subscriber. Thereafter, a cloudSIM hub

converts between the signaling on the hub operator's IMSI to signaling on the client operator's IMSI. Further, the cloudSIM hub relays the converted signaling between the visited operator and the client operator.

The present invention provides a cloudSIM service that is an ecosystem that leverages mobile operators to offer discounted tariff to partner networks and client networks which have subscribed to the cloudSIM service and are a part of cloudSIM ecosystem. Each cloudSIM hub allocates a series of IMSIs which can be allocated by the client operator to its subscribers. Each client operator subscriber opting for this service is allocated a special multi-IMSI SIM card which consists of the client operator IMSI and a series of roaming IMSIs of hub partner operators of cloudSIM ecosystem as selected by the client operators. The roaming IMSIs are pre-provisioned in multi-IMSI SIM card.

The system and method of the present invention, in its various embodiments also facilitate addition of any additional IMSIs by downloading them using OTA platform. The additional IMSIs can also be added through a SIM applet (STK) that intelligently selects the right network for the service without any manual intervention from the end subscriber thus making the entire roamer experience seamless.

The system and method of the present invention, in its various embodiments provide the cloudSIM ecosystem that has multiple hub partner networks and client networks that subscribe to the cloudSIM service. The service offering that leverages Roamware's partnership with leading signaling and voice service providers around the world, to re-route the call via a cloudSIM hub that is deployed within the carrier cloud either in each hub operator or a central location for a group of hub operators. The subscriber's client network IMSI is switched with an IMSI from a hub operator depending on the location of the subscriber. The user experience for the roaming subscriber is not affected in any way, and he continues to enjoy normal roaming service while traveling.

Brief Description of Drawings

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

FIG. 1 illustrates a system for implementing cloudSIM service, in accordance with a first embodiment of the present invention;

FIG. 2 illustrates a system for implementing cloudSIM service, in accordance with a second embodiment of the present invention; and

FIG. 3 represents a flowchart depicting method for enabling mobile communication using the cloudSIM service, in accordance with an 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 and a method for facilitating mobile communication for a subscriber of a Home Public Mobile Network (HPMN) roaming in a Visited Public Mobile Network (VPMN). In accordance with various embodiments, the present invention provides a method and system providing the subscriber a facility to use IMSI of a different operator other than his home operator's IMSI to offer better tariffs.

FIG. 1 illustrates a system 100 for implementing cloudSIM service, in accordance with an embodiment of the present invention. A subscriber 102 of HPMN 104 (from home country) is roaming in a VPMN 106 (from visiting country). The subscriber 102 is connected to a VPMN VLR 108, when it is roaming outside HPMN 102. In one embodiment of the invention, VPMN VLR 108 is integrated with a VMSC in VPMN 106. Notwithstanding, both VPMN VLR and VMSC may have different logical addresses. Subscriber profile data corresponding to subscriber 102 is stored in HPMN HLR 110. The signaling corresponding to subscriber 102 is routed using an international STP 1 112 at VPMN 106 and international STP 2 114 at HPMN 104. The signaling between HPMN 104 and VPMN 106 is carried using SS7 signaling architecture 116. The signals exchanged between HPMN 104 and VPMN 106 are MAP based signals. Other network elements of HPMN 104 (e.g., MSC/VLR) communicate with various other network elements of VPMN 106 (e.g., HLR, VLR etc.) via the SS7 link. It will also be apparent to a person skilled in the art that various components of HPMN 104 communicate with VPMN 106 using various signaling techniques including, but not limited to, SS7, SIP, IP, ISUP etc.

The HPMN 104 subscribes to the cloudSIM service as client operator to enable provisioning of multiple IMSIs to its subscriber 102. The visited operator in VPMN 106 is the current location of the subscriber. The multiple IMSIs that are provisioned on subscriber's SIM belong to a hub PMN that is a part of cloudSIM ecosystem. In this embodiment, hub PMN 116 provides its IMSI to subscriber's SIM. The hub PMN 116 includes a cloudSIM hub 118 that interfaces with international STP 3 120 to manage the signaling across networks. The hub operator is either an MVNO, an MNO having its own set of IMSIs.

It will be apparent to a person skilled in the art that cloudSIM hub 118 can be present either on-net hub PMN 116 or off-net hub PMN 116. In other words, the cloudSIM hub 118 can be deployed in hub PMN 116 or at a central location that is serving multiple hub PMNs that are a part of cloudSIM ecosystem.

The cloudSIM ecosystem service leverages Roamware's ecosystem of cloudSIM hubs to offer special discounted tariff to the client operators who want to be a part of cloudSIM ecosystem. Each cloudSIM hub allocates a series of IMSIs which can be allocated by the client operator to its subscribers. Each client operator subscriber opting for this service is allocated a special multi-IMSI SIM card which consists of the client operator IMSI and a series of roaming IMSIs corresponding to the cloudSIM hubs as selected by the client operators. The roaming IMSIs are pre-provisioned in SIM card but any additional IMSIs can also be downloaded using OTA platform, in cases where the subscriber wants to avail coverage offered by an additional cloudSIM hub.

In order to explain how subscriber's 102 call is managed by the cloudSIM service, we take a use case scenario. Assume that subscriber 102 from UK (HPMN) roams into a destination VPMN 106 as Belgium. Now, when subscriber registers into an operator in Belgium, the SIM Toolkit Application (STK) in subscriber's SIM card detects subscriber's location as Belgium and then selects the right roaming IMSI which works in Belgium and makes that IMSI as active IMSI of subscriber. In this case, the active roaming IMSI could be an EU network IMSI (e.g. Italy) provided by the cloudSIM Hub in EU region and that IMSI works in any country in EU region. As a result client operator (i.e., HPMN 104) of subscriber 102 gets benefit of EU regulation on regional roaming and gets a discounted wholesale roaming rate. Subsequently, all signaling for that roaming subscriber flows via the cloudSIM hub network and cloudSIM hub (deployed in cloud SIM hub network) takes care of swapping of EU IMSI (roaming IMSI) with home (UK) IMSI and relay the signaling to the client network's (HPMN 104) HLR or SMSC or SCP so that the subscriber can use all the relevant services offered by home network. The billing settlement between the client operator and the hub operator of the chosen roaming IMSI is brokered via Roamware. The hub operator can also do billing settlement with the visited network.

In accordance with various embodiments of the invention, cloudSIM hub 118 converts one or more signaling parameters of signaling associated with the hub operator's IMSI to one or more signaling parameters of the signaling associated with the client operator's IMSI. The one or more signaling parameter could include MSISDN of the subscriber. In some cases, the subscriber's MSISDN is changed while

communicating with the visited operator. Other signaling parameters include MAP signaling, call signaling, subscriber's MSISDN, CAMEL/SIP/TCAP transaction, data sessions and data traffic.

In accordance with another embodiment of the invention, subscriber 102 may also register directly with a cloudSIM hub operator rather than a visited operator. FIG. 2 illustrates a system for implementing cloudSIM service, in accordance with a second embodiment of the present invention. In this case, subscriber 102 registers with a VLR / GMSC of hub PMN 116. To explain call handling in this embodiment, another use case example is taken. In a second use case scenario, let us assume us subscriber 102 from UK (HPMN) roams into a hub PMN as Mexico. Now, when subscriber registers into an operator in Mexico, the SIM STK in subscriber's SIM card detects subscriber's location as Mexico and selects the right roaming IMSI which works in Mexico and make that IMSI as active IMSI of subscriber. In this case, the active roaming IMSI will be a Mexican IMSI provided by Roamware's local cloudSIM Hub in Mexico region and this IMSI works in Mexico only. As a result the client operator gets benefit of local IMSI and can get discounted wholesale roaming rate. Subsequently, all signaling for that roaming subscriber flows via Roamware's cloudSIM hub installed in Mexico, which takes care of swapping of roaming (Mexico) IMSI with home (UK) IMSI and relay the signaling to the client network (UK) HLR or SMSC or SCP so that the subscriber can use all the relevant services offered by home Network. Again, in this case too, the billing settlement between the client operator and the hub operator of the chosen roaming IMSI is brokered via Roamware.

FIG. 3 represents a flowchart depicting method for enabling mobile communication using cloudSIM service, in accordance with an embodiment of the present invention. At step 302, subscriber's SIM STK or a network application detects a change in registration of a subscriber of a client network at a visited operator. Thereafter, at step 304, the subscriber's SIM STK switches from subscriber's client network's IMSI to a hub operator's IMSI. In accordance with an embodiment of the present invention, the change in subscriber's IMSI is based on at least one of a roaming location of the subscriber, class of the subscriber and a predefined logic. The subscriber's IMSI is changed via a configuration file. The configuration file can be

changed via OTA communication. Alternatively, the subscriber's IMSI is changed by SIM STK application that communicates with network application via USSD, or SMS or any other bearer. Once the IMSI is switched, subsequently, at step 306, cloudSIM hub converts between the signaling on hub operator's IMSI to signaling on client operator's IMSI. Further at step 308, cloudSIM hub relays the converted signaling between the visited operator and the client operator.

The special multi-IMSI SIM cards are typically pre-provisioned with a set of roaming IMSIs for a set of destinations as chosen by the client operator initially. Now, if the client operator wants to offer few more destinations to its subscriber, the client operator just needs to update the contract with Roamware with additional destinations and Roamware can do an OTA campaign to download additional IMSIs in cloudSIM subscribers' SIM cards. This avoids the issues for SIM swapping.

In some cases, the subscriber's IMSI is changed to a default IMSI via the configuration file. The default IMSI is selected from a sequence of IMSIs in preference order or random order, until one IMSI is successfully registered with the visited network. In accordance with an embodiment of the present invention, the configuration file indicates to dynamically obtain an IMSI. In this case, the SIM is first registered with the default IMSI for the roaming location and then the SIM will request an IMSI via a USSD or SMS or other bearer channel (e.g. WiFi, GPRS, LTE etc.) for a dynamically assigned IMSI for the roaming location. The request then comes to the default IMSI hub, which then consults a central worldwide system or a system responsible for the IMSI assignment of the location (corresponding with the home IMSI) for a dynamically assigned IMSI for the roaming location for the subscriber. Thereafter, the IMSI is sent via OTA via USSD, SMS or other bearer channel in response to the IMSI request. The SIM then re-registers with the newly assigned IMSI.

In order to manage the billing, the cloudSIM service is set up a wholesale broker by Roamware, whose IMSI hub partners' IMSI and rates are resold with markup to client operators (including MNO, MVNO, and MVNE etc.). The subscriber is billed based on rates received from the hub operator of cloudSIM ecosystem. In order to handle billing for TAP and NRTRDE, cloudSIM hub charges a markup for

the leg from the roaming partner IMSI to cloudSIM hub IMSI with roaming partner rate. Further for the leg from cloudSIM hub IMSI to client operator with markup from cloudSIM hub.

In accordance with various embodiments of the present invention, cloudSIM hub performs the following activities to provision cloudSIM service.

- Reserves sequential blocks of IMSI(s) for client operators.
- If it is not possible to allocate a large contiguous range (covering the entire IMSI range of sponsored network), then multiple small contiguous ranges are assigned but minimum block size is maintained at 5,000.
- Reserves a block of GT's to represent serving MSC/VLR in international networks (4 to 5 GT's are required).
- Reserves a Global Title per network element of client operators.
- The dual IMSI SIM card of the subscriber has hub operator's Global Title allocated for SMSC of leveraging operator as service center address against the roaming IMSI (hub operator's IMSI).
- The SMSC address in the SIM card against hub allocated IMSI is a hub allocated SMSC GT.
- For every IMSI range reserved, hub GMSC is configured to route messages with SCCP Called Party address with Numbering Plan E.214 (MGT) to cloudSIM hub.
- For every GTC allocated for representing client operator's network nodes, GMSC is configured to route messages with Called Party Address with allocated GT to cloudSIM hub.
- For every GT allocated for representing visited international network's MSC/VLR, GMSC is configured to route messages with Called Party Address' initial (12) digits matching (partial match) reserved Global Titles to cloudSIM hub.
- The SSN-149 is required to be allowed for cloudSIM hub point code for GPRS services.
- The public IP addresses for the cloudSIM hub behaves as GGSN and SGSN.
- The client operator's APNs is configured in hub network's DNS and the GGSN IP is configured as cloudSIM hub. Alternatively, the client operator

provides a wildcard (like *.ve.mnc.mcc.gprs) in order to make provisioning easier.

- For common APNs such as blackberry.net, the data traffic is routed through cloudSIM hub GGSN. Given the specific nature of Blackberry authentication and charging implementation, cloudSIM hub is required to ask Research In Motion to charge all blackberry traffic on ICCID and SFID, and not the IMSI received in the application level messages for Blackberry.
- The cloudSIM hub has the ability to query hub operator's DNS.
- Signaling interconnection is required between client operator and cloudSIM hub.
- Data interconnection is required between client operator and cloudSIM hub
- The cloudSIM hub segregates the service usage records for usage made on local or roaming using cloudSIM hub IMSIs and generates TAP files towards Roamware's identified Data Clearing House (DCH).

In accordance with various embodiments of the present invention, the client operator requires the following logistic requirements in order to provision cloudSIM service to its subscriber.

- The client operator needs to provide special Multi-IMSI SIM cards for its cloudSIM subscribers. The subscriber's local number should not change. The multi-IMSI SIM card contains client operator's IMSI along with one or more IMSIs for different regions/destination.
- The client operator need to open its routing for GT's published by Roamware for each of its hub of who's services are availed by the client operator to represent serving MSC/VLR in international networks.
- The cloudSIM SIM card should have corresponding cloudSIM hub's GT allocated for SMSC of leveraging operator as service center address against each IMSI provisioned from the cloudSIM service on the multi-IMSI SIM card.
- The SMSC address in the SIM card against hub allocated IMSI is configured to be a hub allocated SMSC GT.
- The SSN-149 is required to be allowed for cloudSIM hub's point code for GPRS services.

- The SSN-146 is required to be allowed for cloudSIM hub's point code for CAMEL services.
- The client operator provides a wildcard (like *.ve.mnc.mcc.gprs) in order to make provisioning easier.

In addition to the above, the client operator needs to enable SIM logistics that includes:

- SIM application
- Off-the-shelf OTA service for the deployment and configuration of the applet.

The cloudSIM service is essentially a SIM-based solution, which manages multiple IMSIs for the subscriber. The home IMSI is used in the subscriber's home country, and when roaming to any country where the operator has a bilateral agreement in place. The international IMSI is used when abroad for connection to the cloudSIM Hub or allowed bilateral roaming relationship of cloudSIM Hub. The switching between the two IMSIs is handled automatically by an intelligent application residing on the SIM Card, depending on location of the subscriber.

The SIM card is provisioned with multiple IMSI, with IMSI containing relevant information pertaining to supported networks (PLMNs), Access Control Class, Service Provider Name, Service Provider Display Information and Short Message Service Parameters etc. The SIM card is usually provisioned with the dual IMSI applet and home IMSI. It is also possible to download the dual IMSI applet using OTA. OTA is used as well to add/delete foreign IMSIs with their corresponding characteristics to enable usage abroad in selected networks. The OTA campaign is required whenever the subscriber opts for a new destination or opts out of existing supported destinations. The campaign can also be scheduled by the home operator depending on their rules and preference.

Each SIM card contains three standardized files used during location update while roaming. These files are

- List of preferred roaming partners
- Current registered network
- List of forbidden networks

Once the handset is powered on and the current location/network is detected, the SIM Card receives the necessary events from the mobile phone equipment informing the current location of the subscriber. Based on this location, the applet loaded on SIM processes the files provisioned to select the appropriate IMSI and subsequently use that IMSI to register with the appropriate network. In case, the coverage to appropriate network is lost, the file is re-scanned by the applet and the re-selection of appropriate network/IMSI combination is done. However if none of the available network is provisioned to be selected by foreign IMSIs the applet restores the identity to the home IMSI and uses the home IMSI to access the available network.

All throughout the user experience is seamless and non-intrusive. All the operations pertaining to SIM card management, applet download and IMSI management as well as network selection are transparent to the user thus making the entire roaming experience very easy. It will be apparent to a person skilled in the art that all services are available on home number and hence user experience does not change. In addition to this, in selected countries, subject to local regulations, local numbers may be available along with IMSIs which can be used by the end user of the service.

The cloudSIM ecosystem help the cloudSIM client networks to provide services to its outbound roamers across international borders at the costs much lower than incurred during traditional roaming arrangements. This is done by leveraging use of local/regional IMSIs made available through Roamware's global cloudSIM alliance. The operators are also benefited

- To offer a competitive roaming tariff to subscribers
- To overcome competition from international SIM card providers
- To tap additional revenue from M2M services which are of global nature e.g. Transportation, shipping etc.
- To increase outbound roaming footprint for CAMEL, GPRS or 3G.

The cloudSIM ecosystem also helps the cloudSIM hub operators on following parameters:

- Get additional inbound traffic from new networks / subscriber base of the client operators who would leverage the attractive service rates offered by the cloudSIM hubs.
- Get additional inbound traffic from cost conscious travellers who prefer to use alternate channels of communication.
- Tap additional revenue from M2M services which are of global nature e.g. transportation, shipping etc.
- Offer additional outbound traffic to their roaming partners and increase volume offered to these partners to leverage on additional discounts

The additional benefits from cloudSIM ecosystem for the cloudSIM hub operators are given below:

- One contract with Roamware to cover inbound roaming traffic globally from Roamware customers globally.
- Operational convenience of standard roaming operations usage transfer using tap files. All other operational items would be same as signing up a roaming partner.
- No risk of traffic being steered by roaming partners.

It will be apparent to a person skilled in the art, that the present invention 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 outbound roamer travels with an HPMN CDMA handset. In another exemplary case, the CDMA outbound roamer travels with an HPMN GSM SIM and a GSM handset. In yet another exemplary case, GSM outbound roamer travels with an HPMN CDMA RUIM and a CDMA handset. To support these variations, system 100 will have a separate SS7 and network interfaces, corresponding to both the HPMN and VPMN networks. It will also be apparent to a person skilled in the art that these two interfaces in different directions may not have to be the same technologies. Moreover, there could be multiple types of interface in both directions.

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

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

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).

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 proactive roaming tests, discoveries of roaming partner services and discoveries of frauds in roaming using simulated roaming traffic. 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.

Technical references

GSM 902 on MAP specification
Digital cellular telecommunications system (Phase 2+)
Mobile Application Part (MAP) Specification
(3GPP TS 09.02 version 7.9.0 Release 1998)

GSM 340 on SMS
Digital cellular telecommunications system (Phase 2+)
Technical realization of the Short Message Service (SMS)
(GSM 03.40 version 7.4.0 Release 1998)

GSM 378 on CAMEL,
GSM 978 on CAMEL Application Protocol,
GSM 379 on CAMEL Support of Optimal Routing (SOR),
GSM 318 on CAMEL Basic Call Handling

ITU-T Recommendation Q.1214 (1995), Distributed functional plane for intelligent network CS-1,
ITU-T Recommendation Q.1218 (1995), Interface Recommendation for intelligent network CS-1,
ITU-T Recommendation Q.762 (1999), Signaling system No. 7 – ISDN user part general functions of messages and signals,
ITU-T Recommendation Q.763 (1999), Signaling system No. 7 – ISDN user part formats and codes,
ITU-T Recommendation Q.764 (1999), Signaling system No. 7 – ISDN user part signaling procedures,
ITU-T Recommendation Q.765 (1998), Signaling system No. 7 – Application transport mechanism,
ITU-T Recommendation Q.766 (1993), Performance objectives in the integrated services digital network application,
ITU-T Recommendation Q.769.1 (1999), Signaling system No. 7 – ISDN user part enhancements for the support of Number Portability

APPENDIX

Acronym	Description
3G	Third generation of mobile
ACM	ISUP Address Completion Message
ANM	ISUP Answer Message
ANSI-41	American National Standards Institute #41
ATI	Any Time Interrogation
BCSM	Basic Call State Model
BSC	Base Station Controller
BOIC	Barring Outgoing International Calls
BOIC-EX-Home	Barring Outgoing International Calls except to home country
CAMEL	Customized Application for Mobile Enhanced Logic
CAP	Camel Application Part
CB	Call Barring
CC	Country Code
CDMA	Code Division Multiplexed Access
CdPA	Called Party Address
CDR	Call Detail Record
CF	Call Forwarding
CgPA	Calling Party Address
CIC	Circuit Identification Code
CLI	Calling Line Identification
CSD	Circuit Switched Data
CSI	Camel Subscription Information
DPC	Destination Point Code
DSD	Delete Subscriber Data
DTMF	Dual Tone Multi-Frequency
ERB	CAP Event Report Basic call state model
EU	European Union
FPMN	Friendly Public Mobile Network
FTN	Forward-To-Number
GLR	Gateway Location Register
GGSN	Gateway GPRS Support Node
GMSC	Gateway MSC
GMSC-F	GMSC in FPMN
GMSC-H	GMSC in HPMN
GPRS	General Packet Radio System
GSM	Global System for Mobile
GSMA	GSM Association
GSM SSF	GSM Service Switching Function
GsmSCF	GSM Service Control Function
GT	Global Title
GTP	GPRS Tunnel Protocol
HLR	Home Location Register

HPMN	Home Public Mobile Network
IN	Intelligent Network
IOT	Inter-Operator Tariff
GTT	Global Title Translation
IAM	Initial Address Message
IDP	Initial DP IN/CAP message
IDD	International Direct Dial
IMSI	International Mobile Subscriber Identity
IMSI-H	HPMN IMSI
IN	Intelligent Network
INAP	Intelligent Network Application Part
INE	Interrogating Network Entity
IP	Internet Protocol
IREG	International Roaming Expert Group
IRS	International Revenue Share
ISC	International Service Carrier
ISD	MAP Insert Subscriber Data
ISG	International Signal Gateway
IST	Immediate Service Termination
ISTP	International STP
ISTP-F	ISTP connected to FPMN STP
ISTP-H	ISTP connected to HPMN STP
ISUP	ISDN User Part
ITPT	Inbound Test Profile Initiation
ITR	Inbound Traffic Redirection
IVR	Interactive Voice Response
LU	Location Update
LUP	MAP Location Update
MAP	Mobile Application Part
MCC	Mobile Country Code
MCC	Mobile Country Code
MD	Missing Data
ME	Mobile Equipment
MGT	Mobile Global Title
MMS	Multimedia Message Service
MMSC	Multimedia Message Service Center
MMSC-F	FPMN MMSC
MMSC-H	HPMN MMSC
MNC	Mobile Network Code
MNP	Mobile Number Portability
MO	Mobile Originated
MOS	Mean Opinion Score
MS	Mobile Station
MSC	Mobile Switching Center
MSISDN	Mobile Station International Subscriber Directory Number
MSISDN-F	FPMN MSISDN
MSISDN-H	HPMN MSISDN

MSRN	Mobile Station Roaming Number
MSRN-F	FPMN MSRN
MSRN-H	HPMN MSRN
MT	Mobile Terminated
MTP	Message Transfer Part
NDC	National Dialing Code
NP	Numbering Plan
NPI	Numbering Plan Indicator
NRTRDE	Near Real Time Roaming Data Exchange
O-CSI	Originating CAMEL Subscription Information
OCN	Original Called Number
ODB	Operator Determined Barring
OPC	Origination Point Code
OR	Optimal Routing
ORLCF	Optimal Routing for Late Call Forwarding
OTA	Over The Air
OTPI	Outbound Test Profile Initiation
PDP	Protocol Data Packet
PDN	Packet Data Network
PDU	Packet Data Unit
PRN	MAP Provide Roaming Number
PSI	MAP Provide Subscriber Information
QoS	Quality of Service
RAEX	Roaming Agreement EXchange
RI	Routing Indicator
RIS	Roaming Intelligence System
RDN	Redirecting Number
RNA	Roaming Not Allowed
RR	Roaming Restricted due to unsupported feature
RRB	CAP Request Report Basic call state model
RSD	Restore Data
RTP	Real-Time Transport Protocol
SAI	Send Authentication Info
SC	Short Code
SCA	Smart Call Assistant
SCCP	Signal Connection Control part
SCP	Signaling Control Point
SF	System Failure
SG	Signaling Gateway
SGSN	Serving GPRS Support Node
SGSN-F	FPMN SGSN
SIM	Subscriber Identity Module
SIGTRAN	Signaling Transport Protocol
SME	Short Message Entity
SM-RP-UI	Short Message Relay Protocol User Information
SMS	Short Message Service
SMSC	Short Message Service Center
SMSC-F	FPMN SMSC

SMSC-H	HPMN SMSC
SoR	Steering of Roaming
SPC	Signal Point Code
SRI	MAP Send Routing Information
SRI-SM	MAP Send Routing Information For Short Message
SS	Supplementary Services
SS7	Signaling System #7
SSN	Sub System Number
SSP	Service Switch Point
STK	SIM Tool Kit Application
STP	Signal Transfer Point
STP-F	FPMN STP
STP-H	HPMN STP
TADIG	Transferred Account Data Interchange Group
TAP	Transferred Account Procedure
TCAP	Transaction Capabilities Application Part
VT-CSI	Visited Terminating CAMEL Service Information
TP	SMS Transport Protocol
TR	Traffic Redirection
TS	Traffic Steering
TE	Termination Ecosystem
TT	Translation Type
UD	User Data
UDH	User Data Header
UDHI	User Data Header Indicator
USSD	Unstructured Supplementary Service Data
VAS	Value Added Service
VIP	Very Important Person
VLR	Visited Location Register
VLR-F	FPMN VLR
VLR-H	HPMN VLR
VLR-V	VPMN VLR
VMSC	Visited Mobile Switching Center
VoIP	Voice over IP
VPMN	Visited Public Mobile Network
ATI	Access Transport Information
UDV	Unexpected Data Value
USI	User Service Information
WAP	Wireless Access Protocol

I Claim:

1. A method for mobile communication, the method comprising:

detecting change in registration of a subscriber of a client network at a visited operator;

switching from the subscriber's client network's IMSI to a hub operator's IMSI, wherein the hub operator is selected from a cloudSIM hub ecosystem depending on the location of the subscriber;

converting between the signaling on the hub operator's IMSI to signaling on the client operator's IMSI via a cloudSIM hub; and

relaying the converted signaling between the visited operator and the client operator via the cloudSIM hub.

2. The method of claim 1, wherein the cloud SIM hub converts one or more signaling parameters of signaling associated with the hub operator's IMSI to one or more signaling parameters of the signaling associated with the client operator's IMSI.
3. The method of claim 2, wherein the one or more signaling parameters comprises of MAP signaling, call signaling, subscriber's MSISDN, CAMEL/SIP/TCAP transaction, data sessions and data traffic.
4. The method of claim 1, wherein the hub operator is one of an MVNO, an MNO, having its own set of IMSIs.
5. The method of claim 1, wherein the cloud SIM hub is located either on-net the hub operator or off-net the hub operator.
6. The method of claim 1, wherein the change in subscriber's IMSI is based on at least one of a roaming location of the subscriber, class of the subscriber and a predefined logic.
7. The method of claim 1, wherein the subscriber's IMSI is changed via a configuration file.
8. The method of claim 7, wherein the configuration file can be changed by OTA.
9. The method of claim 1, wherein the subscriber's IMSI is changed to a default IMSI via a configuration file.

10. The method of claim 9, wherein the default IMSI is selected from a sequence of IMSIs in preference order or random order, until one IMSI is successfully registered with the visited network.

11. The method of claim 1, wherein the subscriber's IMSI is changed by SIM STK application that communicates with network application via one of USSD, SMS and other bearer.

12. The method of claim 1, wherein the subscriber is billed based on rates from the hub operator.

13. A system for mobile communication, the system comprising:

a CloudSIM hub ecosystem associated with a plurality of hub operators and client networks, wherein a subscriber of a client network registers with a visited operator;

a cloudSIM hub associated with a hub operator, facilitates switching from subscriber's client network's IMSI to a hub operator's IMSI, depending on the location of the subscriber;

the cloudSIM hub converting between the signaling on the hub operator's IMSI to signaling on the client operator's IMSI; and

the cloudSIM hub relaying the converted signaling between the visited operator and the client operator.

14. The system of claim 13, wherein the cloud SIM hub converts one or more signaling parameters of signaling associated with the hub operator's IMSI to one or more signaling parameters of the signaling associated with the client operator's IMSI.

15. The system of claim 14, wherein the one or more signaling parameters comprises of MAP signaling, call signaling, subscriber's MSISDN, CAMEL/SIP/TCAP transaction, data sessions and data traffic.

16. The system of claim 13, wherein the hub operator is one of an MVNO, an MNO having its own set of IMSIs.

17. The system of claim 13, wherein the cloudSIM hub is located either on-net the hub operator or off-net the hub operator.

18. The system of claim 13, wherein the change in subscriber's IMSI is based on at least one of a roaming location of the subscriber, class of the subscriber and a predefined logic.

19. The system of claim 13, wherein the subscriber's IMSI is changed via a configuration file.
20. The system of claim 19, wherein the configuration file can be changed by OTA.
21. The system of claim 1, wherein the subscriber's IMSI is changed to a default IMSI via a configuration file.
22. The system of claim 21, wherein the default IMSI is selected from a sequence of IMSIs in preference order or random order, until one IMSI is successfully registered with the visited network.
23. The system of claim 13, wherein the subscriber's IMSI is changed by SIM STK application that communicates with network application via one of USSD, SMS and other bearer.
24. The system of claim 13, wherein the subscriber is billed based on rates from the hub operator.

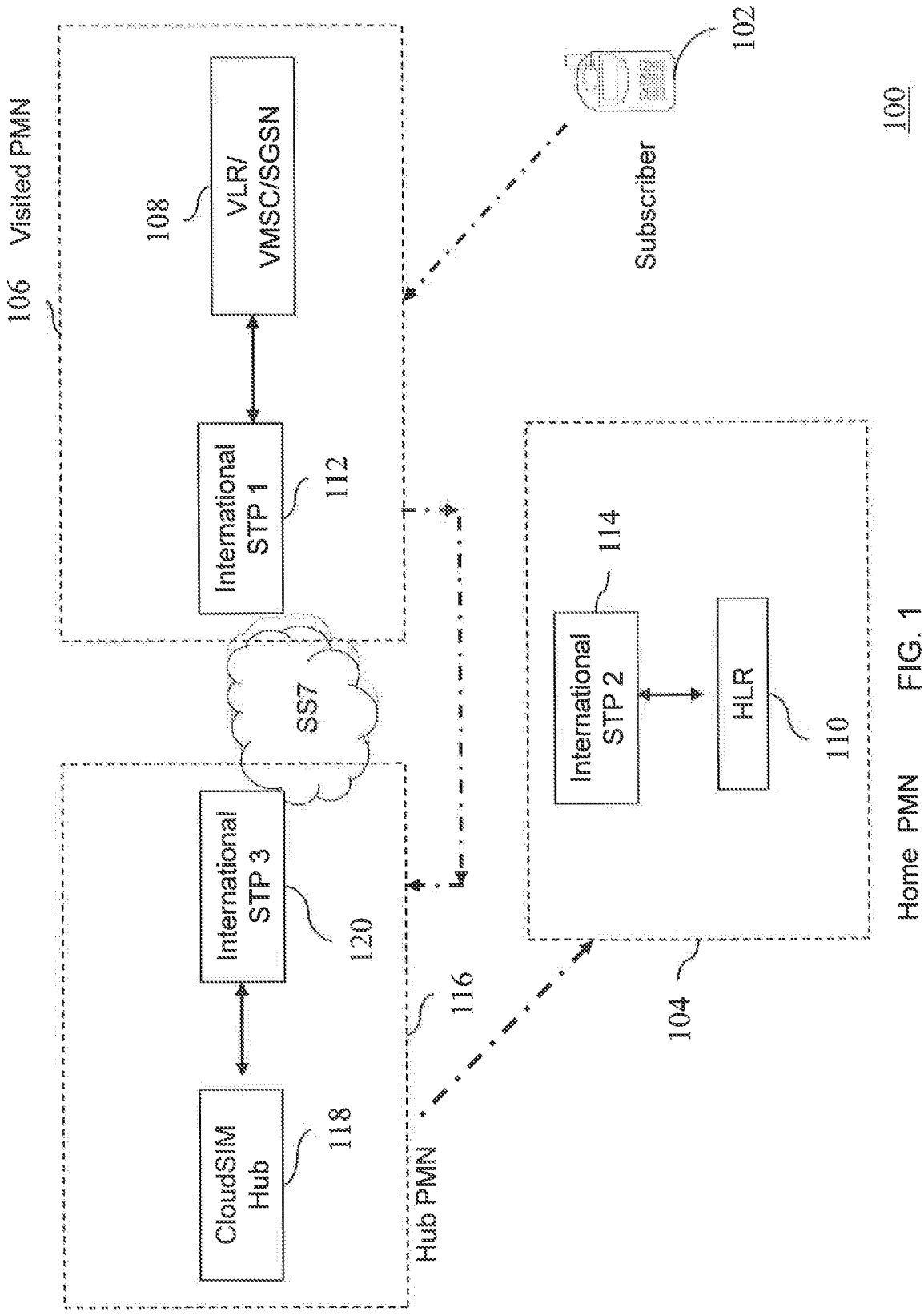
100
Visited PMN
106
108
VLR/
VMSC/SGSN
International
STP 1
112
SS7
International
STP 3
120
CloudSIM
Hub
118
Hub PMN
116
Subscriber
102
International
STP 2
114
HLR
110
Home PMN
104

FIG. 1

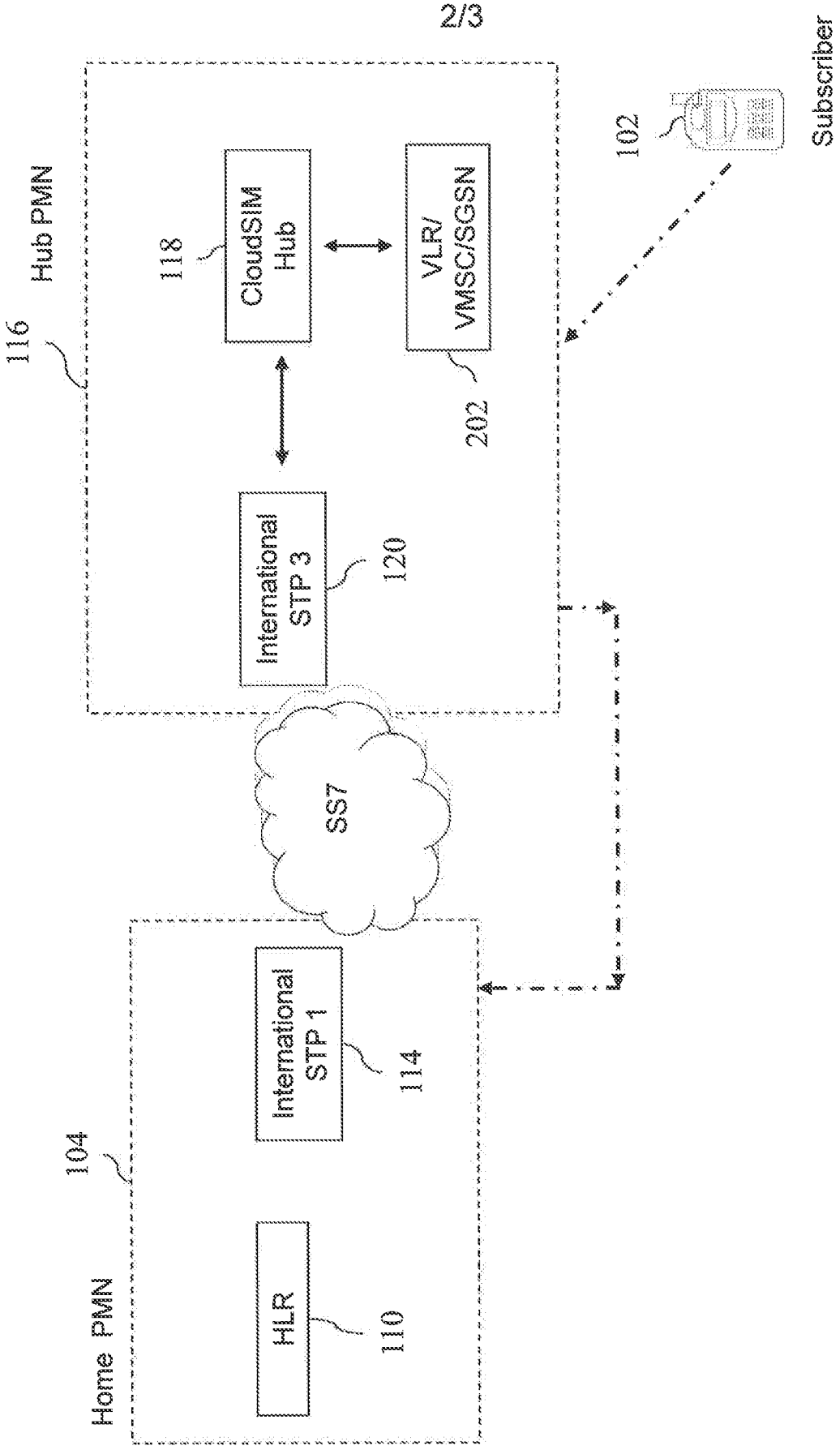
Hub PMN
116
118
CloudSIM Hub
VLR/ VMSC/SGSN
202
102
Subscriber
International STP 3
120
SS7
Home PMN
104
International STP 1
114
HLR
110

FIG. 2

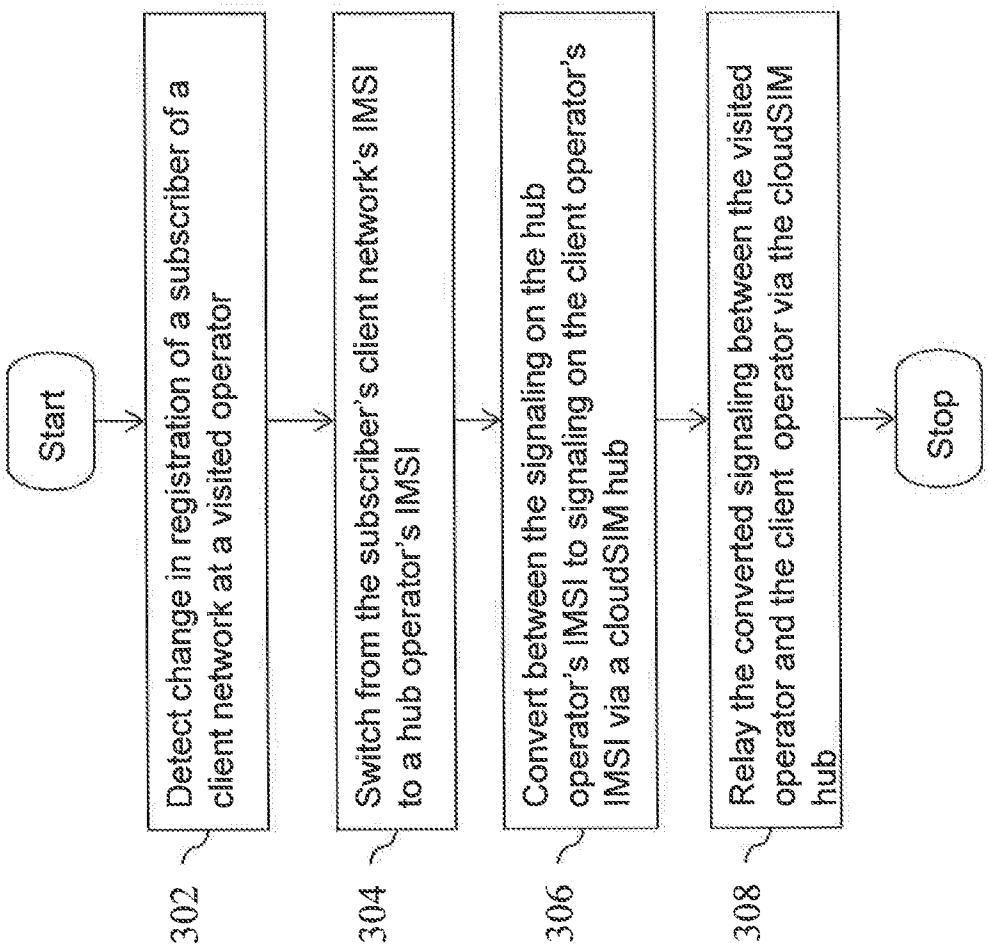
Start
Detect change in registration of a subscriber of a client network at a visited operator
302
Switch from the subscriber's client network's IMSI to a hub operator's IMSI
304
Convert between the signaling on the hub operator's IMSI to signaling on the client operator's IMSI via a cloudSIM hub
306
Relay the converted signaling between the visited operator and the client operator via the cloudSIM hub
308
Stop

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 12/50952

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G06F 15/16 (2012.01)
USPC - 726/4
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
USPC: 726/4

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 713/150,153,155,189-193; 455/403,410,411; 726/2-4 (keyword limited - see terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST (PGPB, USPT, USOC, EPAB, JPAB); GOOGLE; GoogleScholar; GooglePatents; Patbase
Search Terms: cloud, hub, routing, switching, network, visitor, subscriber, roaming SIM, IMSI, default, configuration, random, billing, payment, rate, STK, cloud SIM

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2010/0185537 A1 (Bari) 22 July 2010 (22.07.2010), entire document, especially; abstract, para. [0008]-[0010], [0064], [0065]	1 - 24
Y	US 2010/0128685 A1 (Jiang) 27 May 2010 (27.05.2010), entire document, especially; abstract, para. [0002], [0033]-[0036], [0057]-[0063], [0093], [0111], [0112]	1 - 24
A	US 2010/0048197 A1 (Jiang) 25 February 2010 (25.02.2010), entire document	1 - 24
A	US 2010/0136967 A1 (Du et al.) 03 June 2010 (03.06.2010), entire document	1 - 24

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 September 2012 (21.09.2012)	23 OCT 2012
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)