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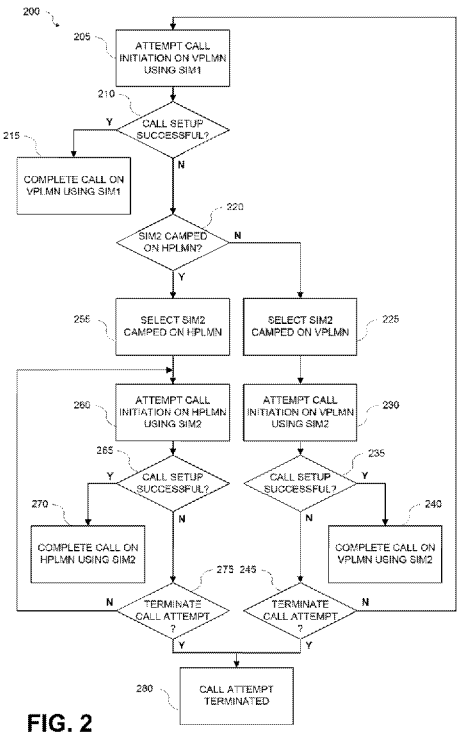

FIG. 2

(57) Abstract: A method for reducing call failure rates on a multi-subscriber identity module (SIM) mobile communication device includes: selecting a first SIM camped on a visiting public land mobile network (VPLMN); attempting call initiation on the first SIM; determining whether call setup on the first SIM on the VPLMN is successful; in response to determining that the call setup on the first SIM is unsuccessful, determining if a second SIM is camped on a home public land mobile network (HPLMN); and in response to determining that the second SIM is camped on the HPLMN, selecting the second SIM camped on the HPLMN; and attempting call initiation using the second SIM.

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REDUCING CALL FAILURE RATE IN MULTI-SUBSCRIBER IDENTITY MODULE CAPABLE DEVICES

BACKGROUND

[0001] Emergency calls on a subscription may fail for various reasons. For example, the core network may reject the call. Failures causes, for example, IMSI UNKNOWN IN VLR/ ILLEGAL ME can happen at the mobile switching center (MSC) while setting up the call. These failures may occur when the mobile communication device is initiating a call on the visiting public land mobile network (VPLMN).

[0002] In some countries, networks mandate that an international mobile subscriber identity (IMSI) be used for the emergency call. Further, a network may reject the emergency call if the IMSI does not belong to the network home location register (HLR) database.

[0003] In case of failure, the mobile communication device will retry the emergency call on the same subscription multiple times, either immediately or after certain time with no guarantee of success.

SUMMARY

[0004] Apparatuses and methods for reducing call failure rates in multi-SIM capable mobile communication devices are provided.

[0005] According to various embodiments there is provided a method for reducing call failure rates on a multi-subscriber identity module (SIM) mobile communication device. In some embodiments, the method may include: selecting a first SIM camped on a visiting public land mobile network (VPLMN); attempting call initiation on the first SIM; determining whether call setup on the first SIM on the VPLMN is successful; in response to determining that the call setup on the first SIM is unsuccessful, determining if a second SIM is camped on a home public land mobile network (HPLMN); and in response to determining that the second SIM is camped on the HPLMN, selecting the second SIM camped on the HPLMN; and attempting call initiation using the second SIM.

[0006] According to various embodiments there is provided a method for initiating a call on a multi-subscriber identity module (SIM) mobile communication device. In some embodiments, the method may include: determining whether at least

one of a plurality of SIMs is camped on a home public land mobile network (HPLMN); in response to determining that at least one of the plurality of SIMs is camped on the HPLMN, selecting the at least one SIM; and attempting call initiation using the selected SIM camped on the HPLMN.

[0007] According to various embodiments there is provided a method for initiating a call on a multi-subscriber identity module (SIM) mobile communication device. In some embodiments, the method may include: determining whether at least one of a plurality of SIMs is camped on a home public land mobile network (HPLMN); in response to determining that at least one of the plurality of SIMs is camped on the HPLMN, providing a notification that an HPLMN is available; in response to the notification that an HPLMN is available, receiving a selection of the at least one of a plurality of SIMs camped on the HPLMN; and attempting call initiation using the selected SIM camped on the HPLMN.

[0008] According to various embodiments there is provided a mobile communication device. In some embodiments, the mobile communication device may include: a communication unit configured to communicate with at least one communication network; and a control unit.

[0009] The control unit may be configured to: select a first SIM camped on a visiting public land mobile network (VPLMN); cause the communication unit to attempt call initiation on the first SIM; determine whether call setup on the first SIM on the VPLMN is successful; in response to determining that the call setup on the first SIM is unsuccessful, determine if a second SIM is camped on a home public land mobile network (HPLMN); and in response to determining that the second SIM is camped on the HPLMN, select the second SIM camped on the HPLMN and cause the communication unit to attempt call initiation using the second SIM.

[0010] Other features and advantages of the present inventive concept should be apparent from the following description which illustrates by way of example aspects of the present inventive concept.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Aspects and features of the present inventive concept will be more apparent by describing example embodiments with reference to the accompanying drawings, in which:

[0012] FIG. 1A is a block diagram illustrating a mobile communication device according to various embodiments;

[0013] FIG. 1B is a diagram illustrating a network environment for various embodiments;

[0014] FIG. 2 is a flowchart illustrating a method for reducing call failure rates according to various embodiments;

[0015] FIG. 3 is flowchart illustrating a method for reducing call failure rates according to various embodiments;

[0016] FIG. 4 is flowchart illustrating a method for reducing call failure rates according to various embodiments; and

[0017] FIG. 5 is flowchart illustrating a method for reducing call failure rates for emergency calls when the mobile communication device display is locked according to various embodiments.

DETAILED DESCRIPTION

[0018] While certain embodiments are described, these embodiments are presented by way of example only, and are not intended to limit the scope of protection. The apparatuses, methods, and systems described herein may be embodied in a variety of other forms. Furthermore, various omissions, substitutions, and changes in the form of the example methods and systems described herein may be made without departing from the scope of protection.

[0019] FIG. 1A is a block diagram illustrating a mobile communication device 100 according to various embodiments. As illustrated in FIG. 1A, the mobile communication device 100 may include a control unit 110, a communication unit 120, an antenna 130, a first SIM 140, a second SIM 150, an interface device 170, and a storage unit 180.

[0020] The mobile communication device 100 may be, for example but not limited to, a mobile telephone, smartphone, tablet, computer, etc., capable of

communications with one or more wireless networks. One of ordinary skill in the art will appreciate that the mobile communication device 100 may include one or more transceivers (communications units) and may interface with one or more antennas without departing from the scope of the present inventive concept.

[0021] The communication unit 120 may include, for example, but not limited to, one or more radio frequency (RF) modules 121. The RF module 121 may include, for example, but not limited to the first transceiver 122. An RF chain 135 may include, for example, but not limited to the antenna 130 and the RF module 121.

[0022] One of ordinary skill in the art will appreciate that embodiments of the mobile communication device 100 may include more than one communication unit and/or more than one antenna without departing from the scope of the present inventive concept.

[0023] A SIM (for example the first SIM 140 and/or the second SIM 150) in various embodiments may be a Universal Integrated Circuit Card (UICC) that is configured with SIM and/or universal SIM (USIM) applications, enabling access to global system for mobile communications (GSM) and/or universal mobile telecommunications system (UMTS) networks. The UICC may also provide storage for a phone book and other applications. Alternatively, in a Code Division Multiple Access (CDMA) network, a SIM may be a UICC removable user identity module (R-UIM) or a CDMA subscriber identity module (CSIM) on a card. A SIM card may have a CPU, ROM, RAM, EEPROM and I/O circuits. An Integrated Circuit Card Identity (ICCID) SIM serial number may be printed on the SIM card for identification. However, a SIM may be implemented within a portion of memory of the mobile communication device 100, and thus need not be a separate or removable circuit, chip, or card.

[0024] A SIM used in various embodiments may store user account information, an IMSI, a set of SIM application toolkit (SAT) commands, and other network provisioning information, as well as provide storage space for phone book database of the user's contacts. As part of the network provisioning information, a SIM may store home identifiers (e.g., a System Identification Number (SID)/Network Identification Number (NID) pair, a Home PLMN (HPLMN) code, etc.) to indicate the SIM card network operator provider.

[0025] The first SIM 140 may associate the communication unit 120 with a first subscription (Sub1) 192 associated with a first radio access technology (RAT) on a first communication network 190 and the second SIM 150 may associate the communication unit 120 with a second subscription (Sub2) 197 associated with a second RAT on a second communication network 195. When a RAT is active, the communication unit 120 receives and transmits signals on the active RAT. When a RAT is idle, the communication unit 120 receives but does not transmit signals on the idle RAT.

[0026] For convenience, the various embodiments are described in terms of dual-SIM, dual-standby (DSDS) mobile communication devices. However, one of ordinary skill in the art will appreciate that the present inventive concept may be extended to Multi-SIM Multi-Standby (MSMS) and/or Multi-SIM Multi-Active (MSMA) mobile communication devices without departing from the scope of protection.

[0027] The first communication network 190 and the second communication network 195 may be operated by the same or different service providers, and/or may support the same or different RATs, for example, but not limited to, GSM, CDMA, WCDMA, and Long Term Evolution (LTE).

[0028] The interface device 170 may include an input device 172, for example, but not limited to a keyboard, touch panel, or other human interface device, and a display device 174, for example, but not limited to, a liquid crystal display (LCD), light emitting diode (LED) display, or other video display. One of ordinary skill in the art will appreciate that other input and display devices may be used without departing from the scope of the present inventive concept.

[0029] The control unit 110 may be configured to control overall operation of the mobile communication device 100 including control of the communication unit 120, the interface device 170, and the storage unit 180. The control unit 110 may be a programmable device, for example, but not limited to, a microprocessor (e.g., general-purpose processor, baseband modem processor, etc.) or microcontroller.

[0030] The storage unit 180 may be configured to store operating systems and/or application programs for operation of the mobile communication device 100 that are executed by the control unit 110, as well as to store application data and user data.

[0031] FIG. 1B is a diagram illustrating a network environment 105 for various embodiments. Referring to FIGS. 1A and 1B, a mobile communication device 100 may be configured to communicate with a first communication network 190 on a first subscription 192 and a second communication network 195 on a second subscription 197. One of ordinary skill in the art will appreciate that the mobile communication device may configured to communicate with more than two communication networks and may communicate on more than two subscriptions without departing from the scope of the inventive concept.

[0032] The first communication network 190 and the second communication network 195 may implement the same or different radio access technologies (RATs). For example, the first communication network 190 may be a GSM network and the first subscription 192 may be a GSM subscription. The second communication network 195 may also be a GSM network. Alternatively, the second communication network 195 may implement another RAT including, for example, but not limited to, LTE, Wideband Code Division Multiple Access (WCDMA), and Time Division-Synchronous Code Division Multiple Access (TD-SCDMA).

[0033] The first communication network 190 may include one or more base transceiver stations (BTSs) including, for example, but not limited to, a first BTS 193. The second communication network 195 may also include one or more BTSs, including, for example, but not limited to, a second BTS 198. A person having ordinary skill in the art will appreciate that the network environment 105 may include any number of communication networks, mobile communication devices, and BTSs without departing from the scope of the present inventive concept.

[0034] The mobile communication device 100 may attempt to acquire the first communication network 190 and camp on the first BTS 193. The mobile communication device 100 may also attempt to acquire the second communication network 195 and camp on the second BTS 198. A person having ordinary skill in the art will appreciate that the acquisition of the first communication network 190 performed on the first subscription 192 may be independent of the acquisition of the second communication network 195 performed on the second subscription 197. Furthermore, the mobile communication device 100 may attempt to acquire the first communication network 190 on the first subscription 192 and the second communication network 195 on the second subscription 197.

[0035] FIG. 2 is a flowchart illustrating a method 200 for reducing call failure rates according to various embodiments. Referring to FIGS. 1A-2, the control unit 110 may cause the communication unit 120 to attempt a call initiation on a VPLMN (e.g., the first communication network 190) using the first SIM 140 camped on the VPLMN (205). The attempted call may be, for example, but not limited to, an emergency call. The control unit 110 may determine whether call setup on the VPLMN was successful (210). In response to determining that the call setup was successful (210-Y), the control unit 110 may cause the mobile communication device 100 to complete the call on the VPLMN using the first SIM 140 (215).

[0036] In response to determining that the call setup on the VPLMN was not successful (210-N), the control unit 110 may determine whether the second SIM 150 is camped on an HPLMN (e.g., the second communication network 195) 220. In response to determining that the second SIM 150 is not camped on the HPLMN (220-N), the control unit 110 may still select the second SIM 150 camped on a VPLMN (225). For example, the second SIM 150 may be camped on the first communication network 190 or another VPLMN.

[0037] The control unit 110 may cause the communication unit 120 to attempt the call initiation on the VPLMN using the second SIM 150 (230). The control unit 110 may determine whether call setup on the VPLMN was successful (235). In response to determining that the call setup was successful (235-Y), the control unit 110 may cause the mobile communication device 100 to complete the call on the VPLMN using the second SIM 150 (240). In response to determining that the call setup on the VPLMN was not successful (235-N), the control unit 110 may determine whether an instruction to terminate the call attempt has been received (245). For example, the control unit 110 may determine whether an instruction to terminate the call attempt has been received from the input device 172 of the interface device 170.

[0038] In response to determining that an instruction to terminate the call attempt has been received (245-Y), the control unit 110 may cause the communication unit 120 to terminate the call attempt (280). In response to determining that an instruction to terminate the call attempt has not been received (245-N), the method 200 may continue at operation 205 and the control unit 110 may cause the communication unit 120 to again attempt to initiate the call on the VPLMN using the first SIM 140.

[0039] In response to determining that the second SIM 150 is camped on the HPLMN (220-Y), the control unit 110 may select the second SIM 150 camped on the HPLMN (255). The control unit 110 may cause the communication unit 120 to attempt the call initiation on the HPLMN using the second SIM 150 (260). The control unit 110 may determine whether call setup on the HPLMN was successful (265). In response to determining that the call setup was successful (265-Y), the control unit 110 may cause the mobile communication device 100 to complete the call on the HPLMN using the second SIM 150 (270).

[0040] In response to determining that the call setup on the HPLMN was not successful (265-N), the control unit 110 may determine whether an instruction to terminate the call attempt has been received (275). For example, the control unit 110 may determine whether an instruction to terminate the call attempt has been received from the input device 172 of the interface device 170.

[0041] In response to determining that an instruction to terminate the call attempt has been received (275-Y), the control unit 110 may cause the communication unit 120 to terminate the call attempt (280). In response to determining that an instruction to terminate the call attempt has not been received (275-N), the method may continue at operation 260, and the control unit 110 may cause the communication unit 120 to again attempt to initiate the call on the HPLMN using the second SIM 150.

[0042] FIG. 3 is flowchart illustrating a method 300 for reducing call failure rates according to various embodiments. Referring to FIGS. 1A-3, the control unit 110 may determine whether one of the first SIM (e.g., the first SIM 140) or the second SIM (e.g., the second SIM 150) is camped on an HPLMN (e.g., the second communication network 195) (305). In response to determining that one of the first SIM 140 or the second SIM 150 is not camped on an HPLMN (305-N), the control unit 110 may select one of the first SIM 140 or the second SIM 150 camped on a VPLMN (e.g., the first communication network 190 or another communication network) (340). The control unit 110 may cause the communication unit 120 to attempt a call initiation on the VPLMN using the selected SIM camped on the VPLMN (345). The attempted call may be, for example, but not limited to, an emergency call.

[0043] The control unit 110 may determine whether call setup on the VPLMN was successful (350). In response to determining that the call setup was successful

(350-Y), the control unit 110 may cause the mobile communication device 100 to complete the call on the VPLMN using the selected SIM (355). In response to determining that the call setup on the VPLMN was not successful (355-N), the control unit 110 may determine whether an instruction to terminate the call attempt has been received (360). For example, the control unit 110 may determine whether an instruction to terminate the call attempt has been received from the input device 172 of the interface device 170.

[0044] In response to determining that an instruction to terminate the call attempt has been received (360-Y), the control unit 110 may cause the communication unit 120 to terminate the call attempt (365). In response to determining that an instruction to terminate the call attempt has not been received (360-N), the method 300 may continue at operation 340, and the control unit 110 may select one of the first SIM 140 or the second SIM 150 camped on a VPLMN. The control unit 110 may select a SIM other than the SIM selected for the immediately preceding unsuccessful call attempt.

[0045] Alternatively, the control unit110 may determine at operation 305 that one of the first SIM 140 or the second SIM 150 is camped on an HPLMN (305-Y). The control unit 110 may select the SIM camped on the HPLMN (310) and cause the communication unit 120 to attempt a call initiation on the HPLMN using the selected SIM (315). The control unit 110 may determine whether call setup on the HPLMN was successful (320). In response to determining that the call setup was successful (320-Y), the control unit 110 may cause the mobile communication device 100 to complete the call on the HPLMN using the selected SIM (325).

[0046] In response to determining that the call setup was not successful on the HPLMN (320-N), the control unit 110 may determine whether an instruction to terminate the call attempt has been received (330). For example, the control unit 110 may determine whether an instruction to terminate the call attempt has been received from the input device 172 of the interface device 170.

[0047] In response to determining that an instruction to terminate the call attempt has been received (330-Y), the control unit 110 may cause the communication unit 120 to terminate the call attempt (365). In response to determining that an instruction to terminate the call attempt has not been received (330-N), the method may

continue at operation 315 and the control unit 110 may cause the communication unit 120 to again attempt to initiate the call on the HPLMN using the selected SIM.

[0048] FIG. 4 is flowchart illustrating a method 400 for reducing call failure rates according to various embodiments. Referring to FIGS. 1A-4, the control unit 110 may determine whether one of the first SIM (e.g., the first SIM 140) or the second SIM (e.g., the second SIM 150) is camped on an HPLMN (e.g., the second communication network 195) (305). In response to determining that one of the first SIM 140 or the second SIM 150 is camped on an HPLMN (405-Y), the control unit 110 may cause the mobile communication device 100 to provide a notification that the HPLMN is available (410). For example, the control unit 110 may provide a notification that the HPLMN is available via the display device 174 of the interface device 170.

[0049] In response to the notification that the HPLMN is available, a manual selection of the SIM camped on the HPLMN may be received (415). For example, the control unit 110 may determine that an instruction to select the SIM camped on the HPLMN has been received from the input device 172 of the interface device 170. The control unit 110 may cause the communication unit 120 to attempt a call initiation on the HPLMN using the selected SIM (420). The attempted call may be, for example, but not limited to, an emergency call.

[0050] The control unit 110 may determine whether call setup on the HPLMN was successful (425). In response to determining that the call setup was successful (425-Y), the control unit 110 may cause the mobile communication device 100 to complete the call on the HPLMN using the selected SIM (430). In response to determining that the call setup was not successful on the HPLMN (425-N), the control unit 110 may determine whether an instruction to terminate the call attempt has been received (435). For example, the control unit 110 may determine whether an instruction to terminate the call attempt has been received from the input device 172 of the interface device 170.

[0051] In response to determining that an instruction to terminate the call attempt has been received (435-Y), the control unit 110 may cause the communication unit 120 to terminate the call attempt (470). In response to determining that an instruction to terminate the call attempt has not been received (435-N), the method 400

may continue at operation 420 and the control unit 110 may cause the communication unit 120 to again attempt to initiate the call on the HPLMN using the selected SIM.

[0052] Alternatively, in response to the notification that the HPLMN is available at operation 410, a manual selection of the SIM camped on the VPLMN may be received (440). For example, the control unit 110 may determine that an instruction to select the SIM camped on the VPLMN has been received from the input device 172 of the interface device 170. The control unit 110 may cause the communication unit 120 to attempt a call initiation on the VPLMN using the selected SIM (445). The attempted call may be, for example, but not limited to, an emergency call.

[0053] The control unit 110 may determine whether call setup on the VPLMN was successful (450). In response to determining that the call setup was successful (450-Y), the control unit 110 may cause the mobile communication device 100 to complete the call on the VPLMN using the selected SIM (455). In response to determining that the call setup on the VPLMN was not successful (450-N), the control unit 110 may determine whether an instruction to terminate the call attempt has been received (460). For example, the control unit 110 may determine whether an instruction to terminate the call attempt has been received from the input device 172 of the interface device 170.

[0054] In response to determining that an instruction to terminate the call attempt has been received (460-Y), the control unit 110 may cause the communication unit 120 to terminate the call attempt (470). In response to determining that an instruction to terminate the call attempt has not been received (460-N), the method 400 may continue at operation 465 and the control unit 110 may select one of the first SIM 140 or the second SIM 150 camped on the VPLMN. The control unit 110 may select a SIM other than the SIM selected for the immediately preceding unsuccessful call attempt.

[0055] Alternatively, at operation 405, in response to determining that one of the first SIM 140 or the second SIM 150 is not camped on the HPLMN (405-N), the control unit 110 may select one of the first SIM 140 or the second SIM 150 camped on the VPLMN (465). The control unit 110 may cause the communication unit 120 to attempt a call initiation on the VPLMN using the selected SIM (445). The attempted call may be, for example, but not limited to, an emergency call.

[0056] The control unit 110 may determine whether call setup on the VPLMN was successful (450). In response to determining that the call setup was successful (450-Y), the control unit 110 may cause the mobile communication device 100 to complete the call on the VPLMN using the selected SIM (455). In response to determining that the call setup on the VPLMN was not successful (450-N), the control unit 110 may determine whether an instruction to terminate the call attempt has been received (460). For example, the control unit 110 may determine whether an instruction to terminate the call attempt has been received from the input device 172 of the interface device 170.

[0057] In response to determining that an instruction to terminate the call attempt has been received (460-Y), the control unit 110 may cause the communication unit 120 to terminate the call attempt (470). In response to determining that an instruction to terminate the call attempt has not been received (460-N), the method 400 may continue at operation 465 and the control unit 110 may select one of the first SIM 140 or the second SIM 150 camped on the VPLMN. The control unit 110 may select a SIM other than the SIM selected for the immediately preceding unsuccessful call attempt.

[0058] FIG. 5 is flowchart illustrating a method 500 for reducing call failure rates for emergency calls when the mobile communication device 100 display is locked according to various embodiments. Referring to FIGS. 1A-5, the control unit 110 may receive an instruction to initiate an emergency call (505). For example, the control unit 110 may determine whether an instruction to initiate an emergency call has been received from the input device 172 of the interface device 170. The control unit 110 may determine that the display device 174, for example, a display screen, of the interface device 170 is locked (510). With the display device 174 locked, the capability of the communication unit 120 to initiate all but an emergency call may be inhibited. An emergency call may be a call placed to a police emergency number, for example 911, or may be placed to another predefined telephone number stored (e.g., in the storage unit 180 or other storage) as an emergency telephone number.

[0059] The control unit 110 may determine whether one of the first SIM (e.g., the first SIM 140) or the second SIM (e.g., the second SIM 150) is camped on an HPLMN (e.g., the second communication network 195) (515). In response to determining that one of the first SIM 140 or the second SIM 150 is camped on an

HPLMN (515-Y), the control unit 110 may select the SIM camped on the HPLMN (520). The control unit 110 may cause the communication unit 120 to attempt a call initiation of the emergency call on the HPLMN using the selected SIM (525).

[0060] Alternatively, in response to determining that one of the first SIM 140 or the second SIM 150 is not camped on the HPLMN (515-N), the control unit 110 may select one of the first SIM 140 or the second SIM 150 camped a VPLMN (530). The control unit 110 may cause the communication unit 120 to attempt a call initiation of the emergency call on the VPLMN using the selected SIM (535).

[0061] The methods 200, 300, 400, and 500 described with respect to FIGS. 2, 3, 4, and 5, respectively, may be embodied on a non-transitory computer readable medium, for example, but not limited to, the storage unit 180 or other non-transitory computer readable medium known to those of skill in the art, having stored therein a program including computer executable instructions for making a processor, computer, or other programmable device execute the operations of the methods.

[0062] While the above embodiments have been described in terms of a dual-SIM mobile communication device (i.e., a first SIM and a second SIM), one of ordinary skill in the art will appreciate that the inventive concept may be extended to embodiments including more than two SIMs (i.e., multi-SIM mobile communication devices) without departing from the scope of the present inventive concept.

[0063] The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the protection. For example, the example apparatuses, methods, and systems disclosed herein can be applied to multi-SIM wireless devices subscribing to multiple communication networks and/or communication technologies. The various components illustrated in the figures may be implemented as, for example, but not limited to, software and/or firmware on a processor, ASIC/FPGA/DSP, or dedicated hardware. Also, the features and attributes of the specific example embodiments disclosed above may be combined in different ways to form additional embodiments, all of which fall within the scope of the present disclosure.

[0064] The foregoing method descriptions and the process flow diagrams are provided merely as illustrative examples and are not intended to require or imply that the operations of the various embodiments must be performed in the order presented.

As will be appreciated by one of skill in the art the order of operations in the foregoing embodiments may be performed in any order. Words such as "thereafter," "then," "next," etc., are not intended to limit the order of the operations; these words are simply used to guide the reader through the description of the methods. Further, any reference to claim elements in the singular, for example, using the articles "a," "an," or "the" is not to be construed as limiting the element to the singular.

[0065] The various illustrative logical blocks, modules, circuits, and algorithm operations described in connection with the embodiments disclosed herein may be implemented as electronic hardware, computer software, or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and operations have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the present invention.

[0066] The hardware used to implement the various illustrative logics, logical blocks, modules, and circuits described in connection with the aspects disclosed herein may be implemented or performed with a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but, in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of receiver devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration. Alternatively, some operations or methods may be performed by circuitry that is specific to a given function.

[0067] In one or more exemplary aspects, the functions described may be implemented in hardware, software, firmware, or any combination thereof. If implemented in software, the functions may be stored as one or more instructions or

code on a non-transitory computer-readable storage medium or non-transitory processor-readable storage medium. The operations of a method or algorithm disclosed herein may be embodied in processor-executable instructions that may reside on a non-transitory computer-readable or processor-readable storage medium. Non-transitory computer-readable or processor-readable storage media may be any storage media that may be accessed by a computer or a processor. By way of example but not limitation, such non-transitory computer-readable or processor-readable storage media may include RAM, ROM, EEPROM, FLASH memory, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium that may be used to store desired program code in the form of instructions or data structures and that may be accessed by a computer. Disk and disc, as used herein, includes compact disc (CD), laser disc, optical disc, digital versatile disc (DVD), floppy disk, and Blu-ray disc where disks usually reproduce data magnetically, while discs reproduce data optically with lasers. Combinations of the above are also included within the scope of non-transitory computer-readable and processor-readable media. Additionally, the operations of a method or algorithm may reside as one or any combination or set of codes and/or instructions on a non-transitory processor-readable storage medium and/or computer-readable storage medium, which may be incorporated into a computer program product.

[0068] Although the present disclosure provides certain example embodiments and applications, other embodiments that are apparent to those of ordinary skill in the art, including embodiments which do not provide all of the features and advantages set forth herein, are also within the scope of this disclosure. Accordingly, the scope of the present disclosure is intended to be defined only by reference to the appended claims.

WHAT IS CLAIMED IS:

1. A method for reducing call failure rates on a multi-subscriber identity module (SIM) mobile communication device, the method comprising:

selecting a first SIM camped on a visiting public land mobile network (VPLMN);

attempting call initiation on the first SIM;

determining whether call setup on the first SIM on the VPLMN is successful;

in response to determining that the call setup on the first SIM is unsuccessful, determining if a second SIM is camped on a home public land mobile network (HPLMN); and

in response to determining that the second SIM is camped on the HPLMN:

selecting the second SIM camped on the HPLMN; and

attempting call initiation using the second SIM.

2. The method of claim 1, further comprising:

determining whether the call setup on the HPLMN using the second SIM is successful;

in response to determining that the call setup on the HPLMN using the second SIM is unsuccessful, reattempting call initiation on the HPLMN using the second SIM.

3. The method of claim 1, further comprising:

in response to determining that the second SIM is camped on a VPLMN instead of the HPLMN:

selecting the second SIM camped on the VPLMN; and

attempting call initiation on the VPLMN using the second SIM.

4. The method of claim 3, wherein the first SIM and the second SIM are camped on a same VPLMN.

5. The method of claim 3, wherein the first SIM and the second SIM are camped on different VPLMNs.

6. A method for initiating a call on a multi-subscriber identity module (SIM) mobile communication device, the method comprising:

determining whether at least one of a plurality of SIMs is camped on a home public land mobile network (HPLMN);

in response to determining that at least one of the plurality of SIMs is camped on the HPLMN, selecting the at least one of the plurality of SIMs; and

attempting call initiation using the selected at least one of the plurality of SIMs camped on the HPLMN.

7. The method of claim 6, further comprising:

determining whether call setup is successful on the HPLMN using the selected at least one of the plurality of SIMs camped on the HPLMN; and

in response to determining that the call setup is unsuccessful, reattempting call initiation using the selected at least one of the plurality of SIMs camped on the HPLMN.

8. The method of claim 6, further comprising:

in response to determining that none of the plurality of SIMs is camped on the HPLMN:

selecting a first SIM of the plurality of SIMs camped on a visiting public land mobile network (VPLMN); and

attempting call initiation using the first SIM camped on the VPLMN.

9. The method of claim 8, further comprising:

determining whether call setup is successful using the first SIM camped on the VPLMN;

in response to determining that the call setup is unsuccessful:

selecting a second SIM of the plurality of SIMs camped on the VPLMN; and

attempting call initiation using the second SIM camped on the VPLMN.

10. The method of claim 9, further comprising:

determining whether call setup is successful using the second SIM camped on the VPLMN;

in response to determining that the call setup is unsuccessful:

reselecting the first SIM of the plurality of SIMs camped on the VPLMN; and

reattempting call initiation using the first SIM camped on the VPLMN.

11. A method for initiating a call on a multi-subscriber identity module (SIM) mobile communication device, the method comprising:

determining whether at least one of a plurality of SIMs is camped on a home public land mobile network (HPLMN);

in response to determining that at least one of the plurality of SIMs is camped on the HPLMN, providing a notification that an HPLMN is available;

in response to the notification that an HPLMN is available, receiving a selection of the at least one of the plurality of SIMs camped on the HPLMN; and

attempting call initiation using the selected at least one of the plurality of SIMs camped on the HPLMN.

12. The method of claim 11, further comprising:

determining whether call setup is successful on the HPLMN using the selected at least one of the plurality of SIMs camped on the HPLMN; and

in response to determining that the call setup is unsuccessful, reattempting call initiation using the selected at least one of the plurality of SIMs camped on the HPLMN.

13. The method of claim 11, further comprising:

in response to determining that at least one of the plurality of SIMs is camped on a visiting public land mobile network (VPLMN), providing a notification that a VPLMN is available;

in response to the notification that the VPLMN is available, receiving a selection of the at least one of the plurality of SIMs camped on the VPLMN; and

attempting call initiation using the selected at least one of the plurality of SIMs camped on the VPLMN.

14. The method of claim 11, further comprising:

in response to determining that none of the plurality of SIMs is camped on the HPLMN:

receiving a selection of a first SIM of the plurality of SIMs camped on a visiting public land mobile network (VPLMN); and

attempting call initiation using the first SIM camped on the VPLMN.

15. The method of claim 14, further comprising:

determining whether call setup is successful using the first SIM camped on the VPLMN;

in response to determining that the call setup is unsuccessful:

receiving a selection of a second SIM of the plurality of SIMs camped on the VPLMN; and

attempting call initiation using the second SIM camped on the VPLMN.

16. The method of claim 15, further comprising:

determining whether call setup is successful using the second SIM camped on the VPLMN;

in response to determining that the call setup is unsuccessful:

receiving a reselection of the first SIM; and

reattempting call initiation using the first SIM camped on the VPLMN.

17. A mobile communication device, comprising:

a communication unit configured to communicate with at least one communication network; and

a control unit configured to:

select a first SIM camped on a visiting public land mobile network (VPLMN);

cause the communication unit to attempt call initiation on the first SIM;

determine whether call setup on the first SIM on the VPLMN is successful;

in response to determining that the call setup on the first SIM is unsuccessful, determine if a second SIM is camped on a home public land mobile network (HPLMN); and

in response to determining that the second SIM is camped on the HPLMN, select the second SIM camped on the HPLMN and cause the communication unit to attempt call initiation using the second SIM.

18. The mobile communication device of claim 17, wherein the control unit is further configured to:

in response to determining that the call setup on the HPLMN using the second SIM is unsuccessful, cause the communication unit to reattempt call initiation on the HPLMN using the second SIM.

19. The mobile communication device of claim 17, wherein the control unit is further configured to:

in response to determining that the second SIM is camped on a VPLMN, select the second SIM camped on the VPLMN and cause the communication unit to call initiation on the VPLMN using the second SIM.

20. The mobile communication device of claim 19, wherein the first SIM and the second SIM are camped on a same VPLMN.

21. The mobile communication device of claim 19, wherein the first SIM and the second SIM are camped on different VPLMNs.

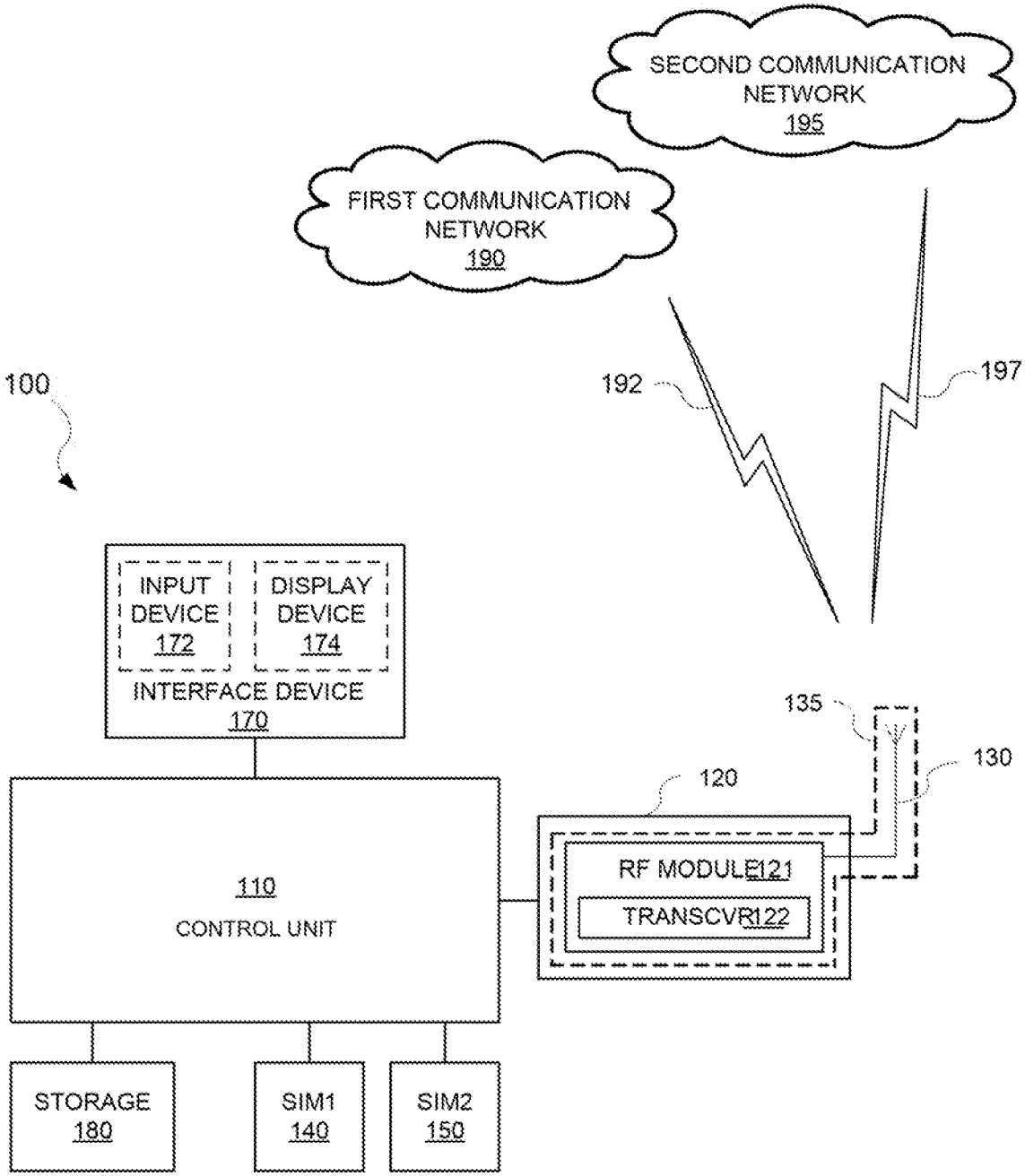
SECOND COMMUNICATION NETWORK 195
FIRST COMMUNICATION NETWORK 190
100
192
197
INPUT DEVICE 172
DISPLAY DEVICE 174
INTERFACE DEVICE 170
135
130
120
110
CONTROL UNIT
RF MODULE 121
TRANSCVR 122
STORAGE 180
SIM1 140
SIM2 150

FIG. 1A

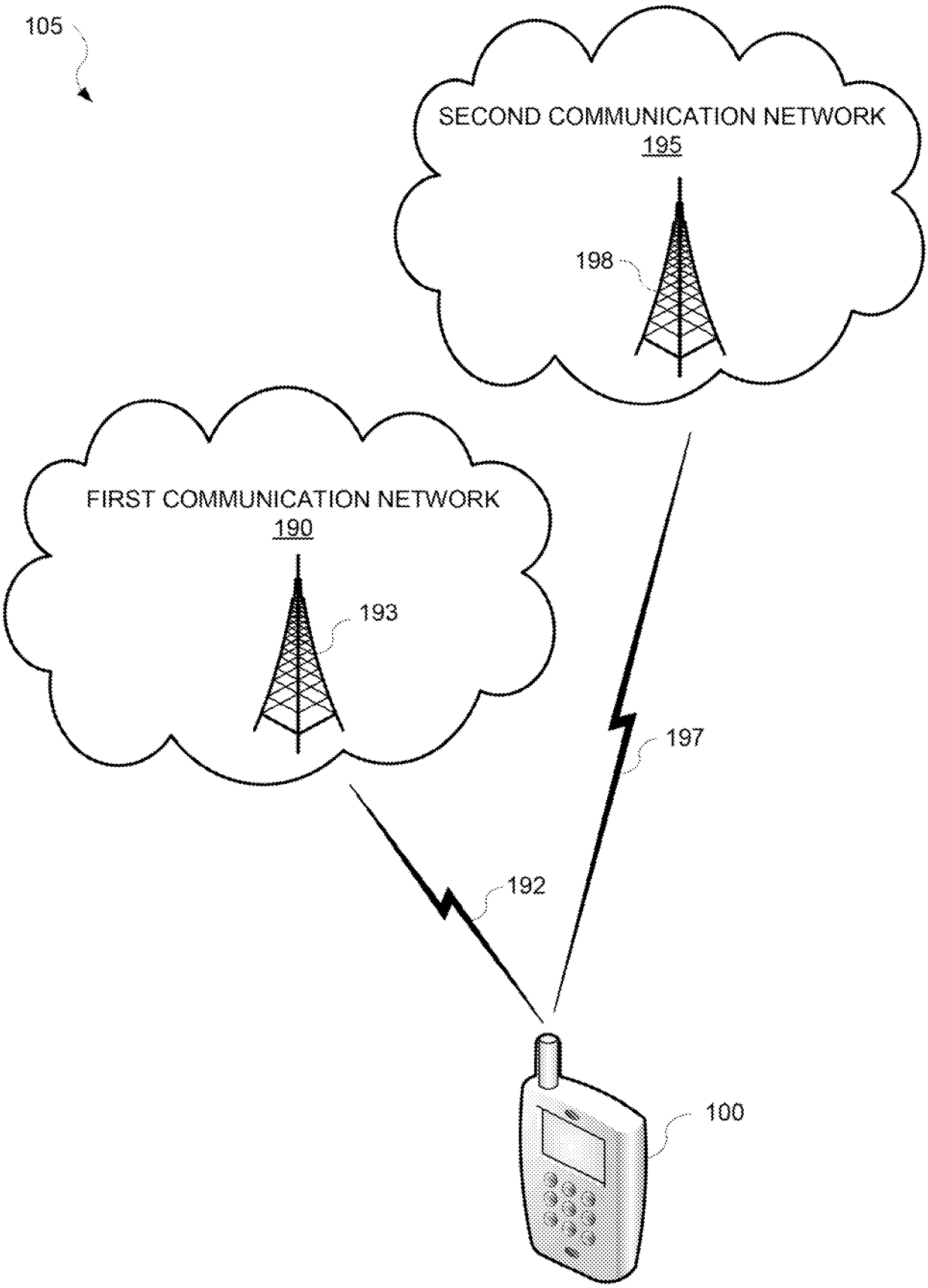
105
SECOND COMMUNICATION NETWORK
195
198
FIRST COMMUNICATION NETWORK
190
193
197
192
100

FIG. 1B

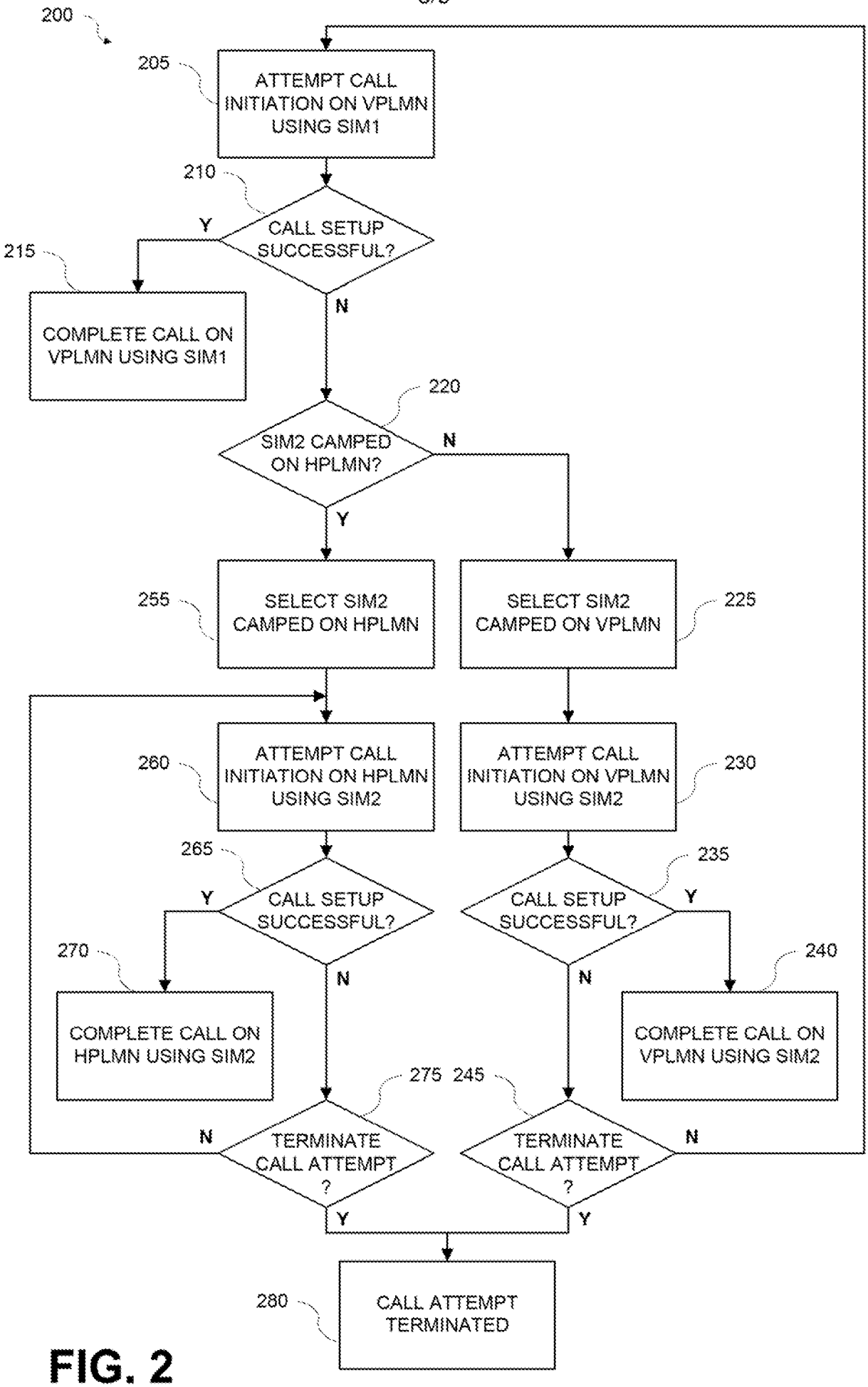
200
205
ATTEMPT CALL INITIATION ON VPLMN USING SIM1
210
CALL SETUP SUCCESSFUL?
Y
215
COMPLETE CALL ON VPLMN USING SIM1
N
220
SIM2 CAMPED ON HPLMN?
N
Y
255
SELECT SIM2 CAMPED ON HPLMN
SELECT SIM2 CAMPED ON VPLMN
225
260
ATTEMPT CALL INITIATION ON HPLMN USING SIM2
ATTEMPT CALL INITIATION ON VPLMN USING SIM2
230
265
CALL SETUP SUCCESSFUL?
Y
235
CALL SETUP SUCCESSFUL?
Y
270
COMPLETE CALL ON HPLMN USING SIM2
N
N
240
COMPLETE CALL ON VPLMN USING SIM2
275
245
TERMINATE CALL ATTEMPT ?
N
TERMINATE CALL ATTEMPT ?
N
Y
Y
280
CALL ATTEMPT TERMINATED

FIG. 2

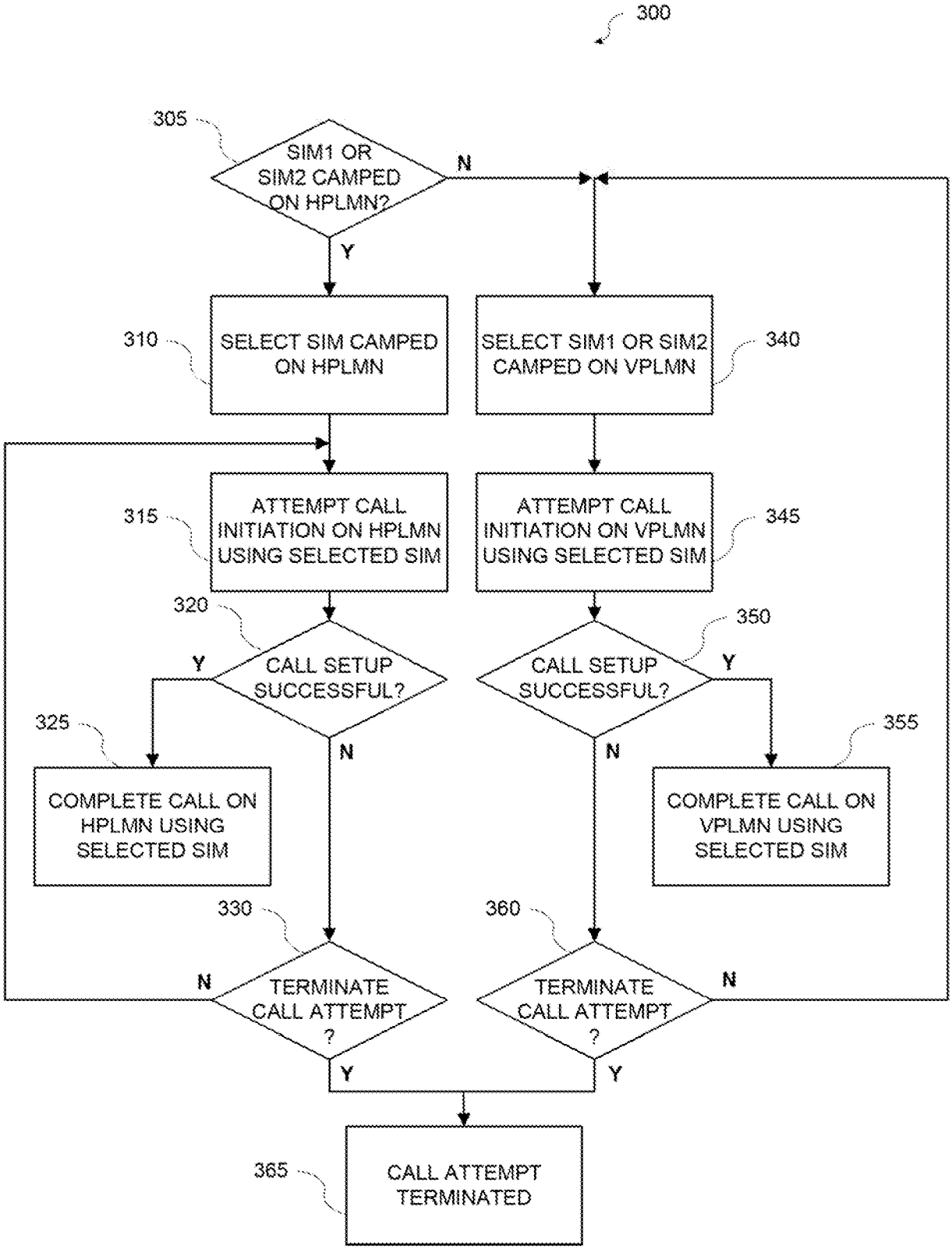
300
305
SIM1 OR SIM2 CAMPED ON HPLMN?
N
Y
310
SELECT SIM CAMPED ON HPLMN
340
SELECT SIM1 OR SIM2 CAMPED ON VPLMN
315
ATTEMPT CALL INITIATION ON HPLMN USING SELECTED SIM
345
ATTEMPT CALL INITIATION ON VPLMN USING SELECTED SIM
320
CALL SETUP SUCCESSFUL?
Y
N
350
CALL SETUP SUCCESSFUL?
Y
N
325
COMPLETE CALL ON HPLMN USING SELECTED SIM
355
COMPLETE CALL ON VPLMN USING SELECTED SIM
330
TERMINATE CALL ATTEMPT ?
N
Y
360
TERMINATE CALL ATTEMPT ?
N
Y
365
CALL ATTEMPT TERMINATED

FIG. 3

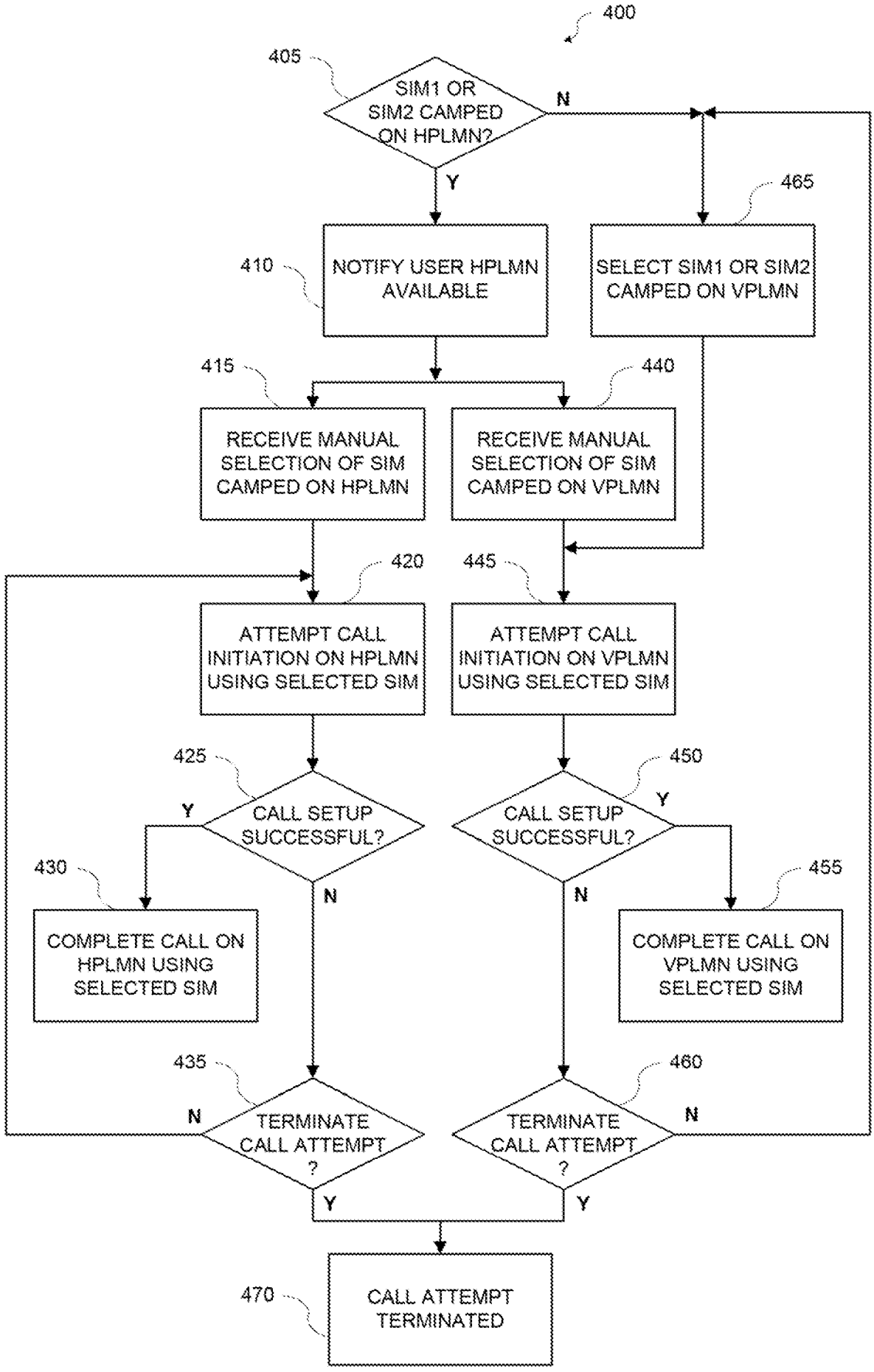
400
405
SIM1 OR SIM2 CAMPED ON HPLMN?
N
Y
465
410
NOTIFY USER HPLMN AVAILABLE
SELECT SIM1 OR SIM2 CAMPED ON VPLMN
415
440
RECEIVE MANUAL SELECTION OF SIM CAMPED ON HPLMN
RECEIVE MANUAL SELECTION OF SIM CAMPED ON VPLMN
420
445
ATTEMPT CALL INITIATION ON HPLMN USING SELECTED SIM
ATTEMPT CALL INITIATION ON VPLMN USING SELECTED SIM
425
450
Y
CALL SETUP SUCCESSFUL?
Y
CALL SETUP SUCCESSFUL?
430
455
N
N
COMPLETE CALL ON HPLMN USING SELECTED SIM
COMPLETE CALL ON VPLMN USING SELECTED SIM
435
460
N
TERMINATE CALL ATTEMPT ?
TERMINATE CALL ATTEMPT ?
N
Y
Y
470
CALL ATTEMPT TERMINATED

FIG. 4

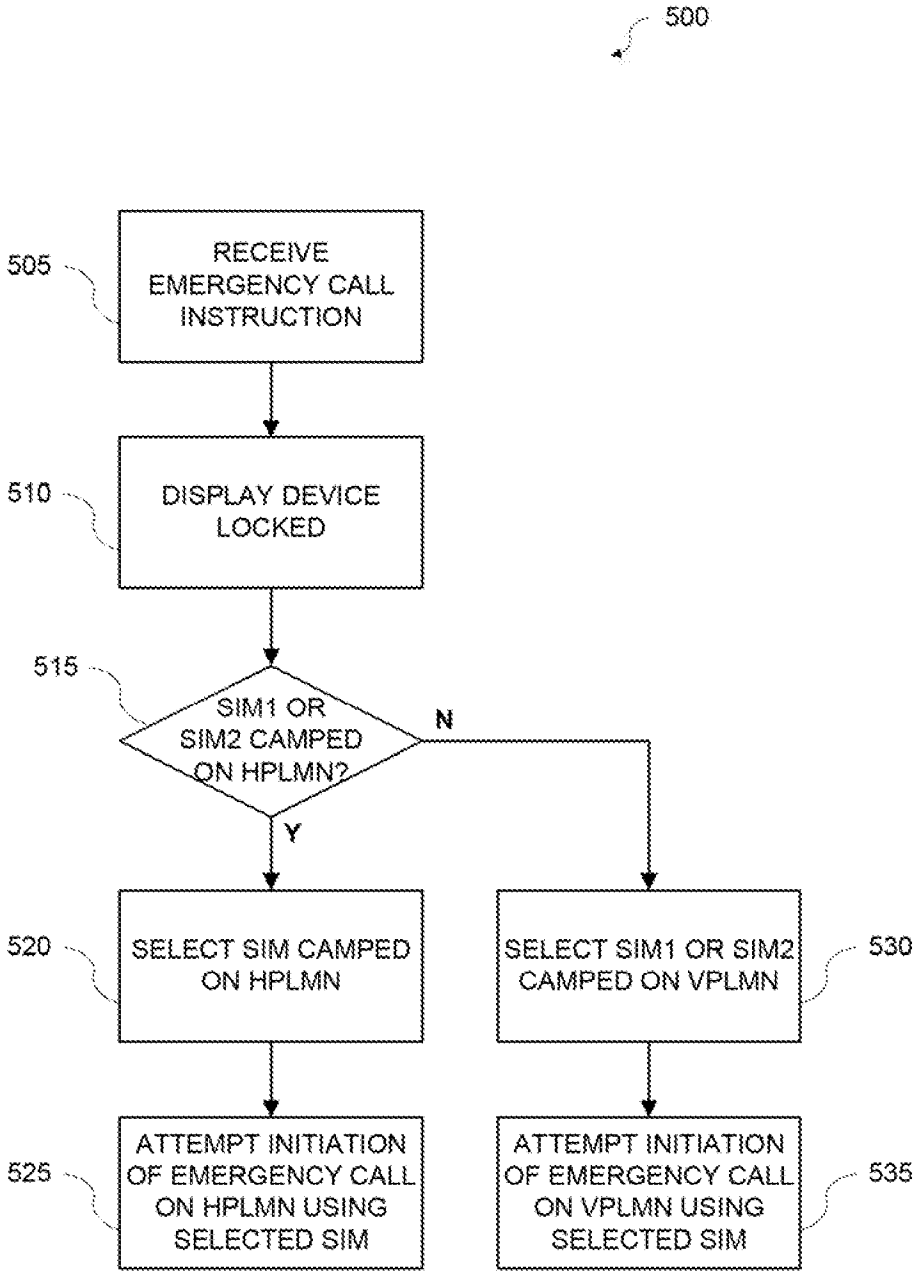
500
505
RECEIVE EMERGENCY CALL INSTRUCTION
510
DISPLAY DEVICE LOCKED
515
SIM1 OR SIM2 CAMPED ON HPLMN?
N
Y
520
SELECT SIM CAMPED ON HPLMN
530
SELECT SIM1 OR SIM2 CAMPED ON VPLMN
525
ATTEMPT INITIATION OF EMERGENCY CALL ON HPLMN USING SELECTED SIM
535
ATTEMPT INITIATION OF EMERGENCY CALL ON VPLMN USING SELECTED SIM

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/044083

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W76/02
ADD. H04W4/22 H04W8/18 H04W48/18 H04W60/00 H04W76/00

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)
H04W

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, COMPENDEX, INSPEC, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2015/065132 A1 (RAMKUMAR THIRUMALLI SURESHSAH [IN] ET AL) 5 March 2015 (2015-03-05) paragraph [0035] - paragraph [0036] paragraphs [0051], [0061] paragraph [0070] - paragraph [0071] paragraph [0076] figures 1,3A,3B	1-5, 17-21
Y	WO 2015/024596 A1 (HUAWEI TECH CO LTD [CN]; HUANG JINBO [SE]; SINGVALL JAKOB [SE]) 26 February 2015 (2015-02-26) page 1, line 9 - page 2, line 22 page 3, line 20 - line 30 figures 1-3	1-5, 17-21

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* 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
7 October 2016	19/12/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Ruscitto, Alfredo

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/044083

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2012/097002 A1 (QUALCOMM INC [US]; KRISHNAMOORTHY SATHISH [IN]; GUPTA AJIT [IN]; PATTA) 19 July 2012 (2012-07-19) paragraph [0041] - paragraph [0048] figures 1-2	1-5, 17-21
A	US 2012/142308 A1 (LEE SHIN-DUCK [KR] ET AL) 7 June 2012 (2012-06-07) paragraph [0017] paragraph [0021] paragraph [0027] - paragraph [0032] figures 1-2	1-5, 17-21
Y	VODAFONE ET AL: "Emergency registration in HPLMN", 3GPP DRAFT; C1-102900-EMERGENCY-REG-HPLMN-24229-A00, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. CT WG1, no. Xian; 20100702, 13 August 2010 (2010-08-13), XP050443696, paragraph 5.1.6.1	1-5, 17-21

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2016/044083

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015065132 A1	05-03-2015	CN 105493574 A	13-04-2016
		EP 3039912 A1	06-07-2016
		KR 20150026982 A	11-03-2015
		US 2015065132 A1	05-03-2015
		WO 2015030530 A1	05-03-2015
WO 2015024596 A1	26-02-2015	CN 104641717 A	20-05-2015
		EP 2888919 A1	01-07-2015
		US 2015056943 A1	26-02-2015
		WO 2015024596 A1	26-02-2015
WO 2012097002 A1	19-07-2012	US 2012178402 A1	12-07-2012
		WO 2012097002 A1	19-07-2012
US 2012142308 A1	07-06-2012	KR 20120062349 A	14-06-2012
		US 2012142308 A1	07-06-2012

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/044083

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-5, 17-21

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-5, 17-21

a method for reducing call failure rates on a multi-subscriber identity module, SIM, mobile communication device , the method comprising selecting a first SIM camped on a visiting public land mobile network, VPLMN, attempting call initiation on the first SIM; determining whether call setup on the first SIM on the VPLMN is successful; in response to determining that the call setup on the first SIM is unsuccessful, determining if a second SIM is camped on a home public land mobile network, HPLMN, and in response to determining that the second SIM is camped on the HPLMN selecting the second SIM camped on the HPLMN and attempting call initiation using the second SIM according to the subject matter of claim 1.

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2. claims: 6-10

a method for initiating a call on a multi-subscriber identity module, SIM, mobile communication device, the method comprising determining whether at least one of a plurality of SIMs is camped on a home public land mobile network, HPLMN, in response to determining that at least one of the plurality of SIMs is camped on the HPLMN, selecting the at least one of the plurality of SlMs, and attempting call initiation using the selected at least one of the plurality of SIMs camped on the HPLMN; in response to determining that none of the plurality of SIMs is camped on the HPLMN selecting a first SIM of the plurality of SIMs camped on a visiting public land mobile network,VPLMN, and attempting call initiation using the first SIM camped on the VPLMN according to the subject matters of claims 6 and 8.

---

3. claims: 11-16

a method for initiating a call on a multi-subscriber identity module, SIM, mobile communication device, the method comprising determining whether at least one of a plurality of SIMs is camped on a home public land mobile network, HPLMN, in response to determining that at least one of the plurality of SIMs is camped on the HPLMN, providing a notification that an HPLMN is available; in response to the notification that an HPLMN is available, receiving a selection of the at least one of the plurality of SIMs camped on the HPLMN; and attempting call initiation using the selected at least one of the plurality of SIMs camped on the HPLMN according to the subject matter of claim 11.