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(54) **DETECTION OF SPOOFED CALL INFORMATION**

(71) Applicant: **Apple Inc.**, Cupertino, CA (US)

(72) Inventors: **Shi LU**, Foster City, CA (US); **Camille CHEN**, Cupertino, CA (US); **Wenping LOU**, San Jose, CA (US); **Wen ZHAO**, San Jose, CA (US)

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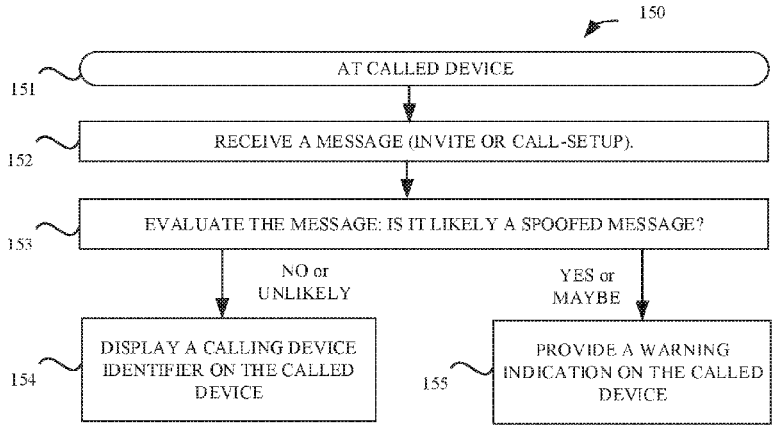
H04W 12/12	(2006.01)
G06F 17/30	(2006.01)

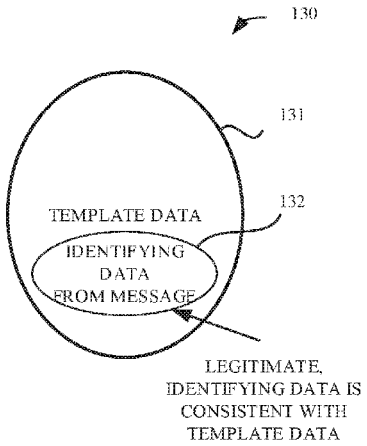
(52) **U.S. Cl.**

CPC ***H04L 63/1416*** (2013.01); ***H04L 65/1006*** (2013.01); ***H04L 65/1076*** (2013.01); ***H04L 63/1466*** (2013.01); ***H04L 41/12*** (2013.01); ***H04W 12/12*** (2013.01); ***G06F 17/30864*** (2013.01); ***H04L 65/1069*** (2013.01)

(57) **ABSTRACT**

A mobile device receives an invitation to commence a media session. The invitation may be from a legitimate caller or from a spoofing caller. The mobile device checks parameters using templates to evaluate a consistency of the invitation with respect to a database in the mobile device. The templates include session protocol, network topology, routing, and social templates. Specific template data includes standardized protocol parameters, values from a database of the mobile device and phonebook entries of the mobile device. Examples of the parameters include capabilities, preconditions, vendor equipment identifiers, a hop counter value and originating network information. The originating network information may be obtained from the database by first querying an on-line database to determine a network identifier associated with caller identification information in the invitation. Then, the obtained carrier identifier is used as an index into a database to obtain template data characteristic of the identified originating network.





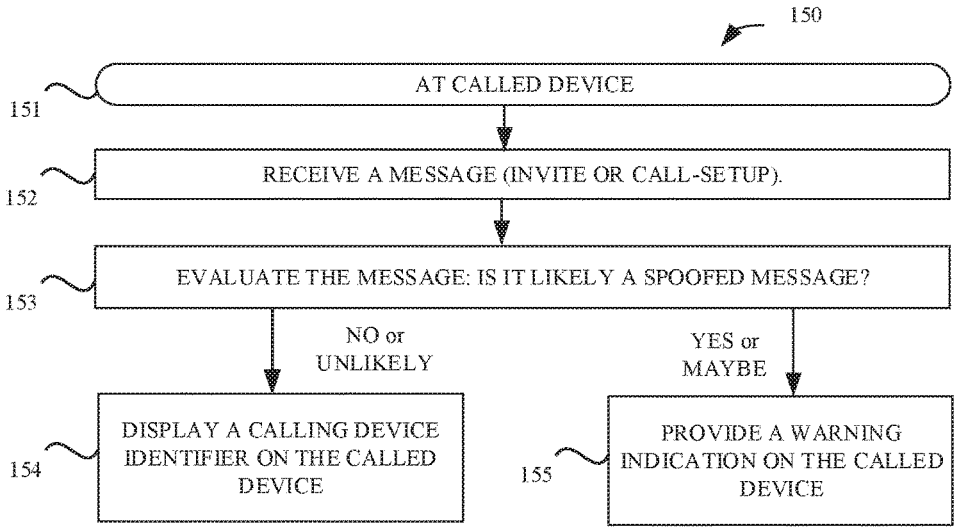


FIG. 1A

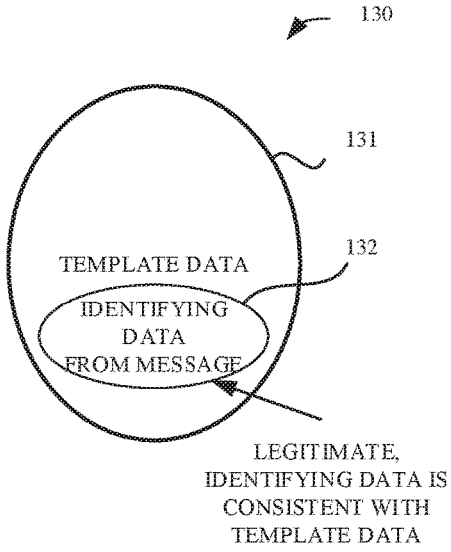


FIG. 1B

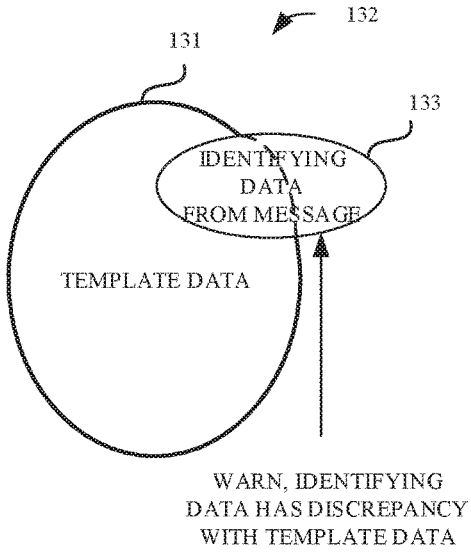


FIG. 1C

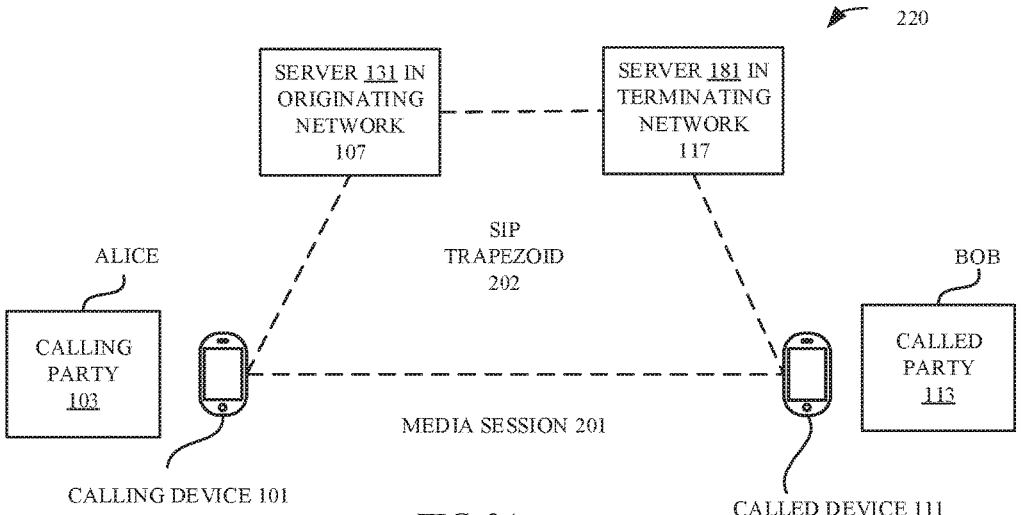


FIG. 2A

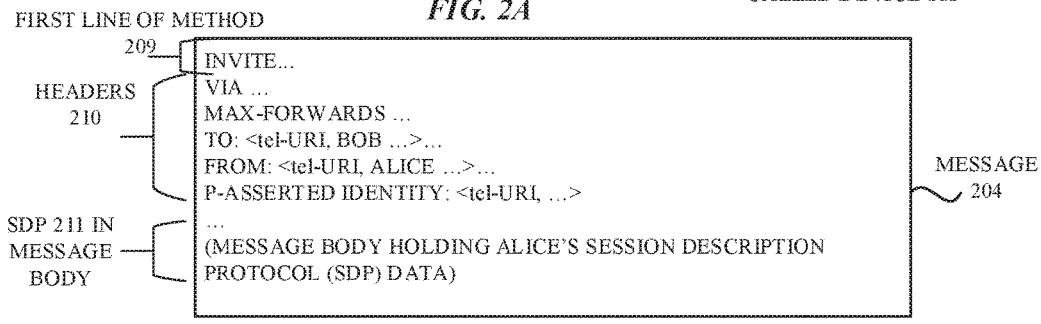


FIG. 2B

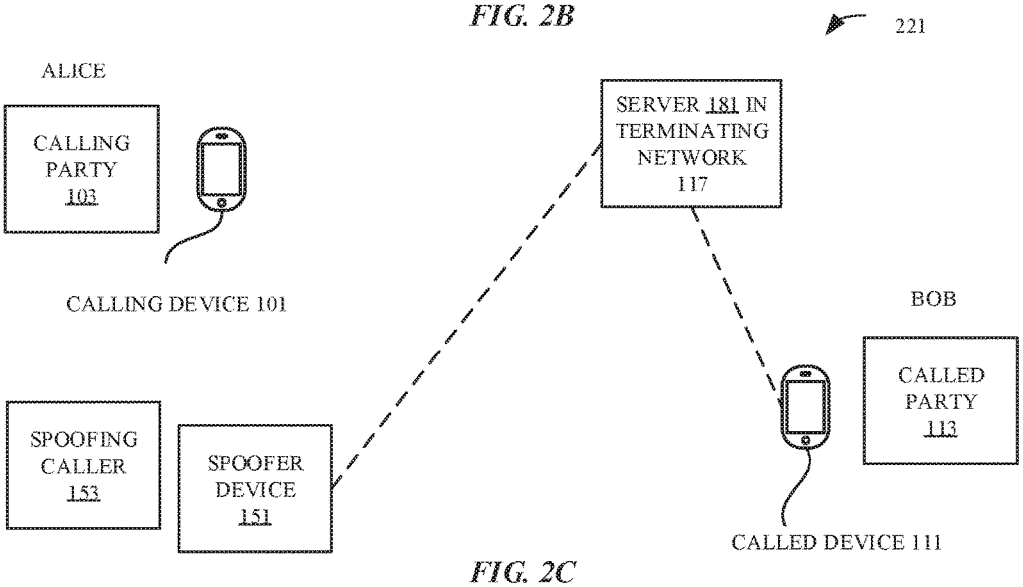


FIG. 2C

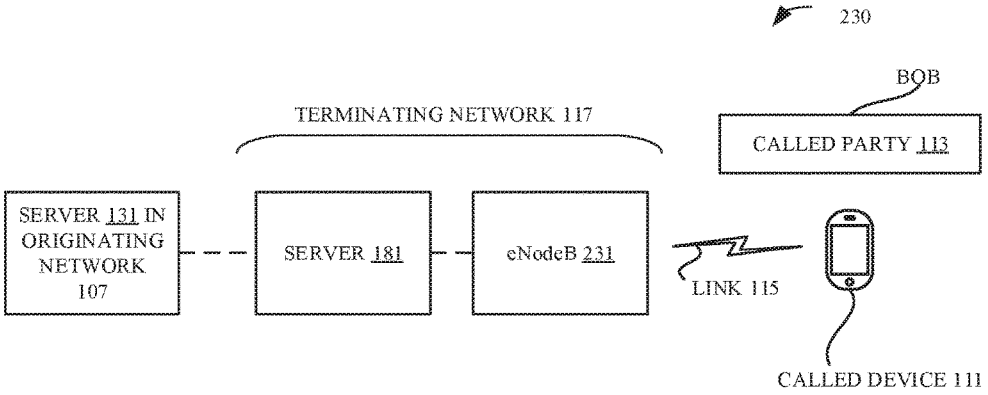


FIG. 2D

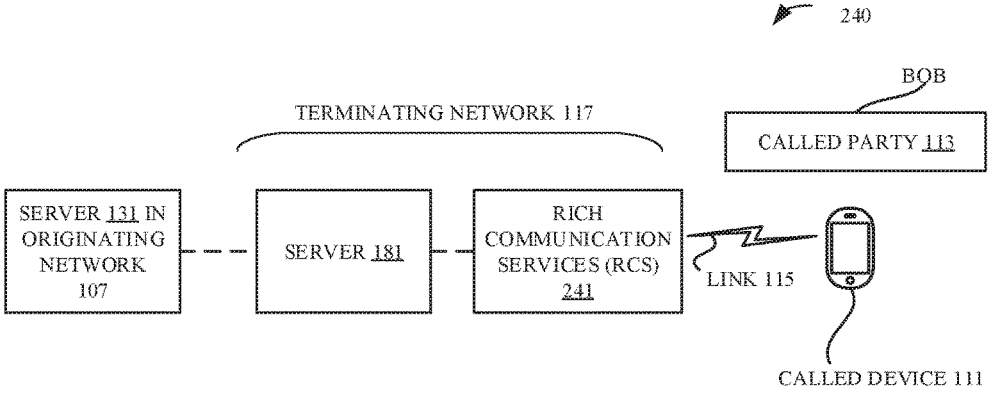


FIG. 2E

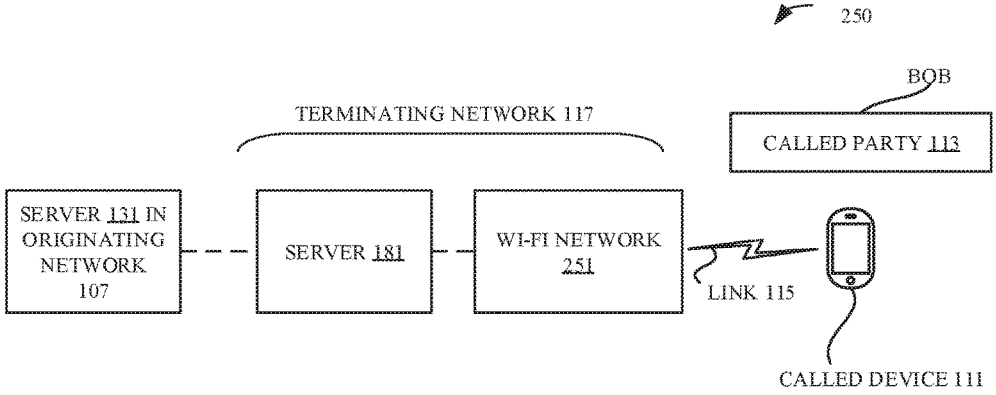


FIG. 2F

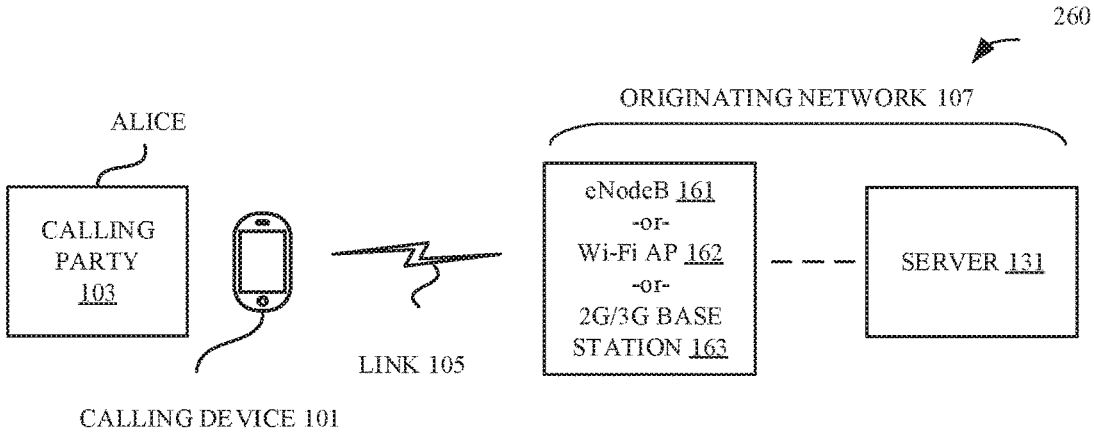


FIG. 2G

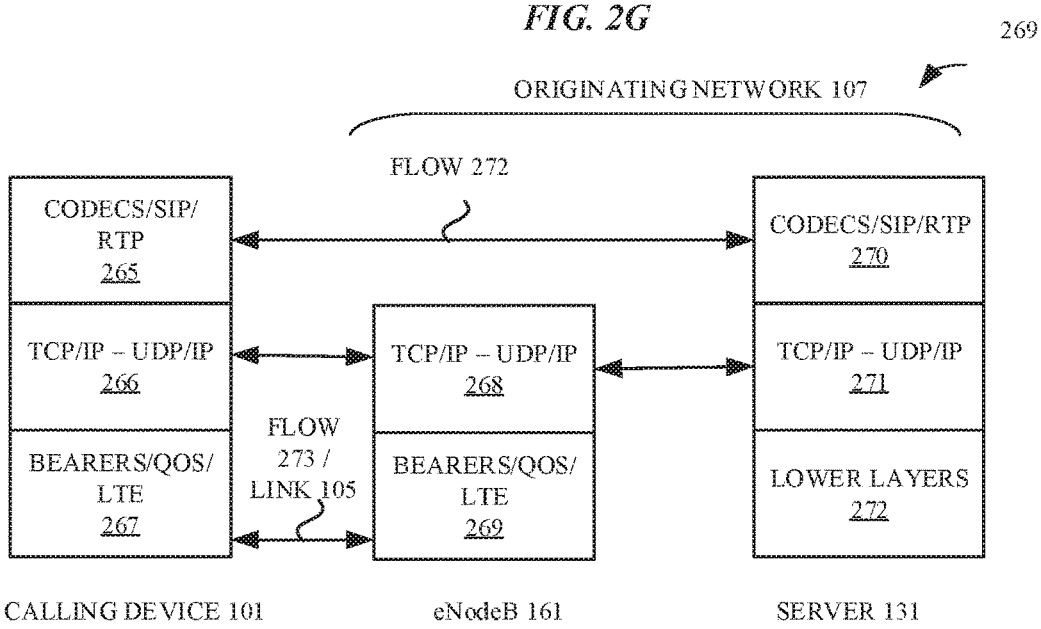


FIG. 2H

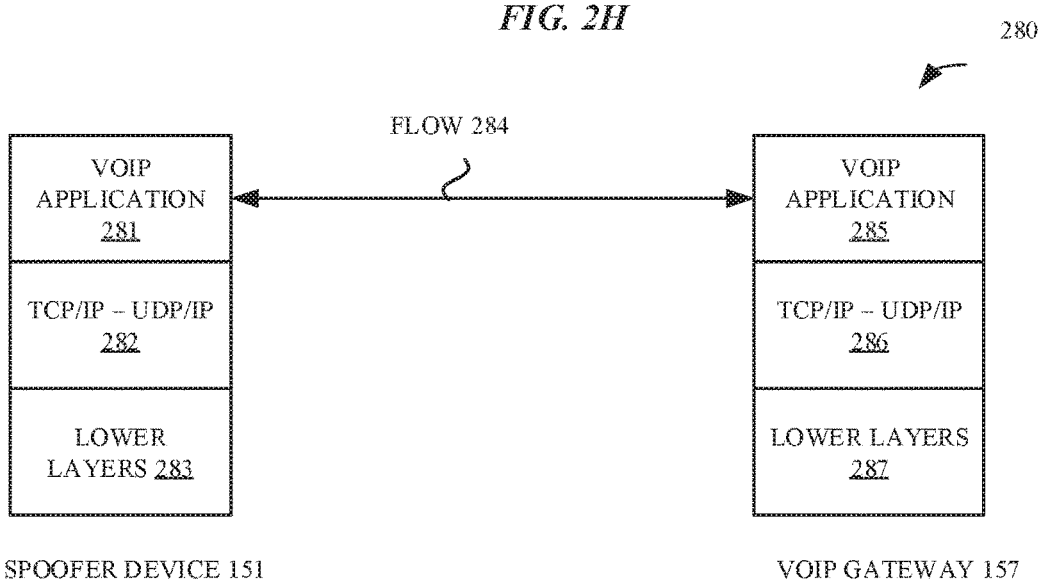


FIG. 2I

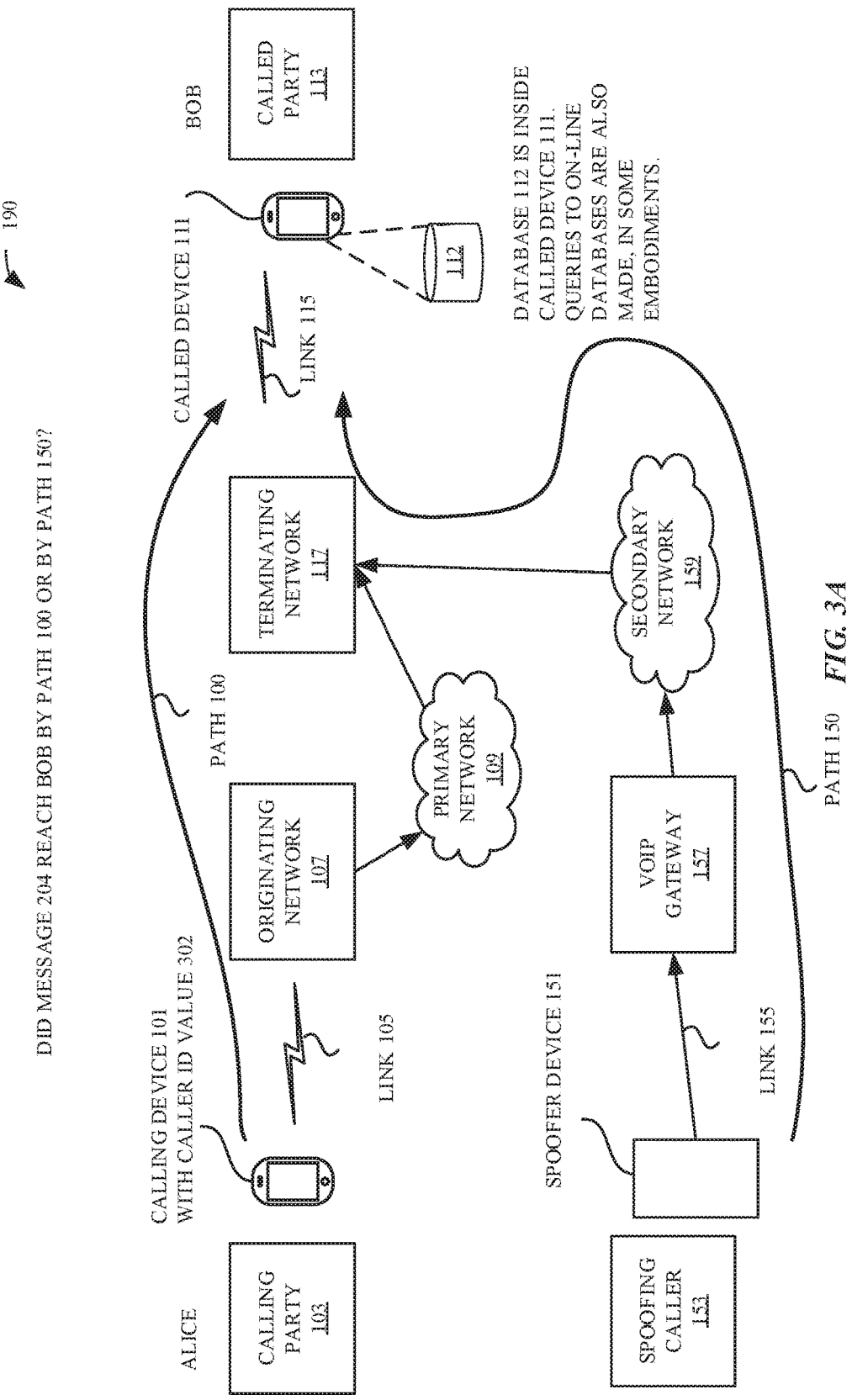

190
DID MESSAGE 204 REACH BOB BY PATH 100 OR BY PATH 150?
ALICE
CALLING PARTY 103
CALLING DEVICE 101 WITH CALLER ID VALUE 302
LINK 105
ORIGINATING NETWORK 107
PRIMARY NETWORK 109
PATH 100
TERMINATING NETWORK 117
CALLED DEVICE 111
LINK 115
BOB
CALLED PARTY 113
112
DATABASE 112 IS INSIDE CALLED DEVICE 111. QUERIES TO ON-LINE DATABASES ARE ALSO MADE, IN SOME EMBODIMENTS.
SECONDARY NETWORK 159
VOIP GATEWAY 157
SPOOFER DEVICE 151
LINK 155
SPOOFING CALLER 153
PATH 150

FIG. 3A

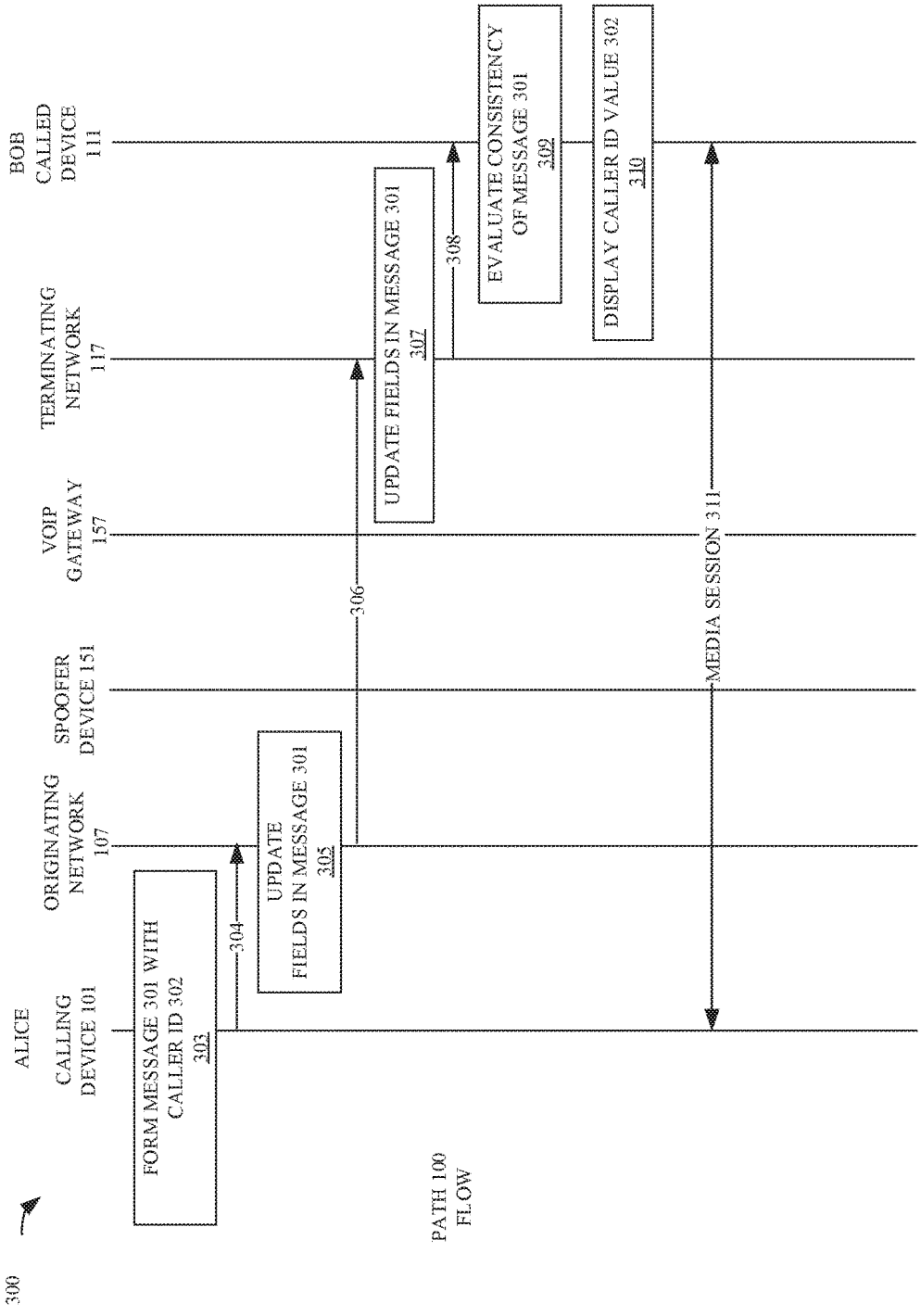

300
PATH 100 FLOW
ALICE CALLING DEVICE 101
ORIGINATING NETWORK 107
SPOOFER DEVICE 151
VOIP GATEWAY 157
TERMINATING NETWORK 117
BOB CALLED DEVICE 111
FORM MESSAGE 301 WITH CALLER ID 302 303
304
UPDATE FIELDS IN MESSAGE 301 305
306
UPDATE FIELDS IN MESSAGE 301 307
308
EVALUATE CONSISTENCY OF MESSAGE 301 309
DISPLAY CALLER ID VALUE 302 310
MEDIA SESSION 311

FIG. 3B

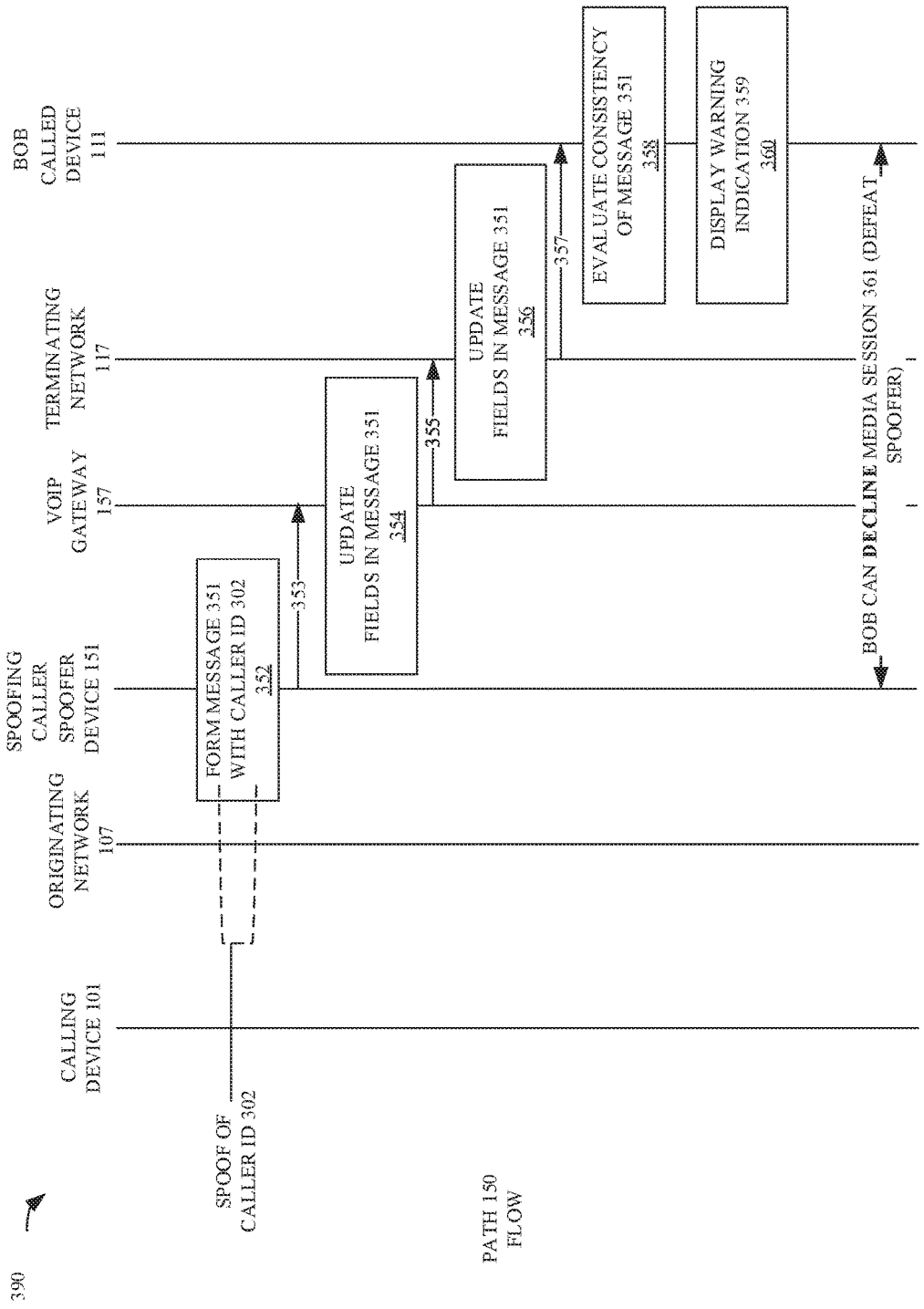

390
PATH 150 FLOW
SPOOF OF CALLER ID 302
CALLING DEVICE 101
ORIGINATING NETWORK 107
SPOOFING CALLER SPOOFER DEVICE 151
VOIP GATEWAY 157
TERMINATING NETWORK 117
BOB CALLED DEVICE 111
FORM MESSAGE 351 WITH CALLER ID 302 352
353
UPDATE FIELDS IN MESSAGE 351 354
355
UPDATE FIELDS IN MESSAGE 351 356
357
EVALUATE CONSISTENCY OF MESSAGE 351 358
DISPLAY WARNING INDICATION 359 360
BOB CAN DECLINE MEDIA SESSION 361 (DEFEAT SPOOFER)

FIG. 3C

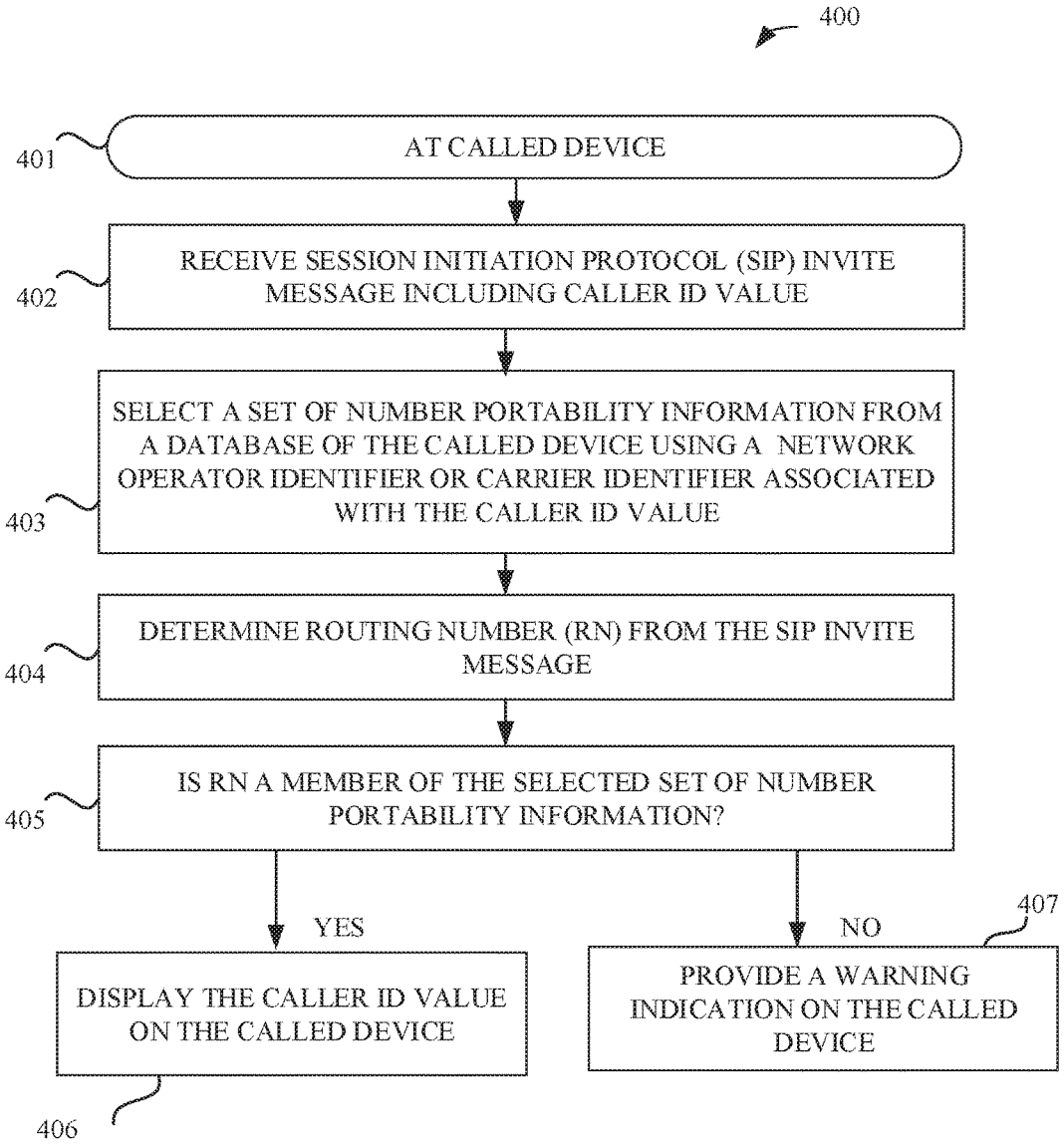

400
401
AT CALLED DEVICE
402
RECEIVE SESSION INITIATION PROTOCOL (SIP) INVITE MESSAGE INCLUDING CALLER ID VALUE
403
SELECT A SET OF NUMBER PORTABILITY INFORMATION FROM A DATABASE OF THE CALLED DEVICE USING A NETWORK OPERATOR IDENTIFIER OR CARRIER IDENTIFIER ASSOCIATED WITH THE CALLER ID VALUE
404
DETERMINE ROUTING NUMBER (RN) FROM THE SIP INVITE MESSAGE
405
IS RN A MEMBER OF THE SELECTED SET OF NUMBER PORTABILITY INFORMATION?
YES
NO
406
DISPLAY THE CALLER ID VALUE ON THE CALLED DEVICE
407
PROVIDE A WARNING INDICATION ON THE CALLED DEVICE

FIG. 4A

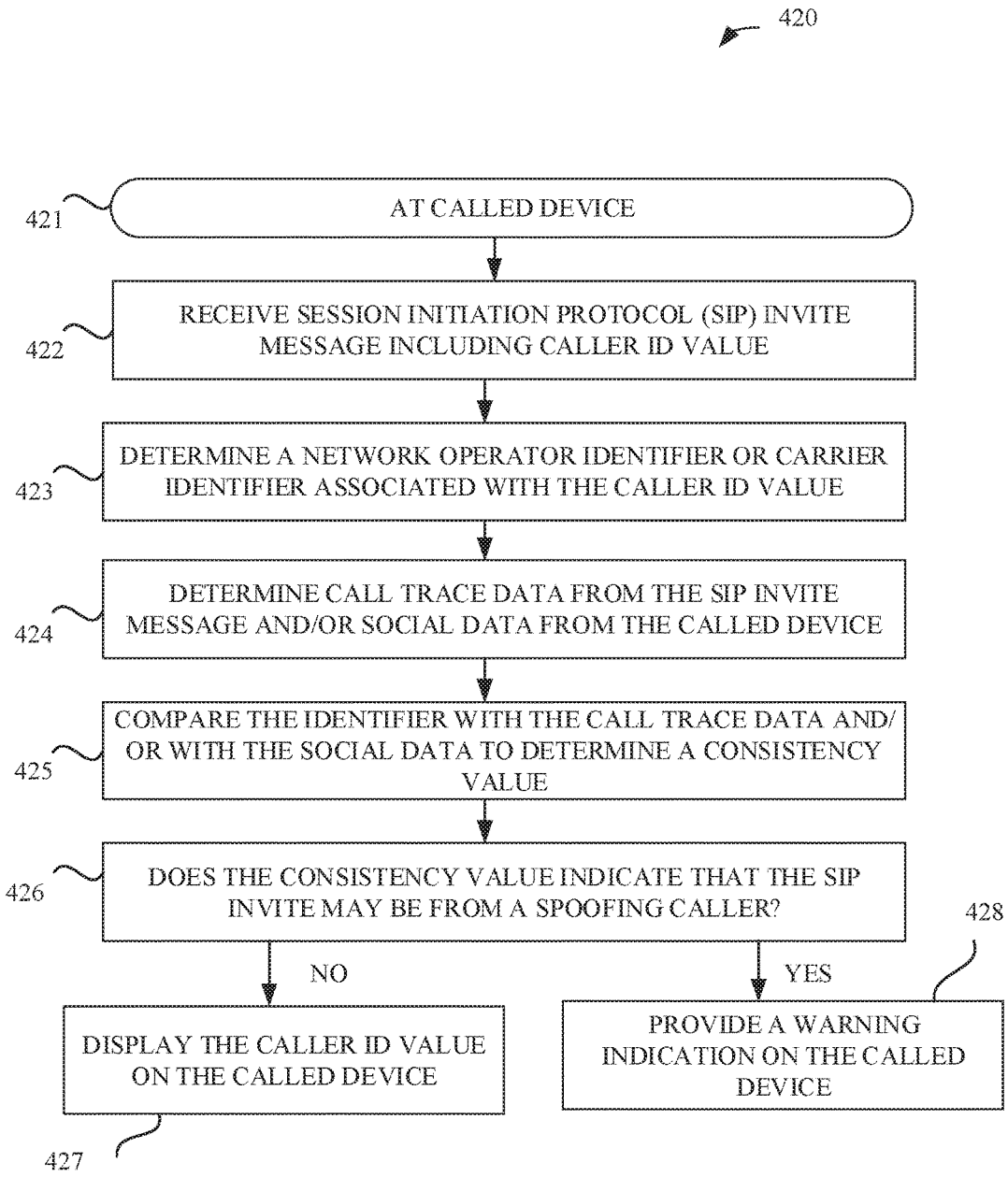

420
421
AT CALLED DEVICE
422
RECEIVE SESSION INITIATION PROTOCOL (SIP) INVITE MESSAGE INCLUDING CALLER ID VALUE
423
DETERMINE A NETWORK OPERATOR IDENTIFIER OR CARRIER IDENTIFIER ASSOCIATED WITH THE CALLER ID VALUE
424
DETERMINE CALL TRACE DATA FROM THE SIP INVITE MESSAGE AND/OR SOCIAL DATA FROM THE CALLED DEVICE
425
COMPARE THE IDENTIFIER WITH THE CALL TRACE DATA AND/OR WITH THE SOCIAL DATA TO DETERMINE A CONSISTENCY VALUE
426
DOES THE CONSISTENCY VALUE INDICATE THAT THE SIP INVITE MAY BE FROM A SPOOFING CALLER?
NO
YES
428
DISPLAY THE CALLER ID VALUE ON THE CALLED DEVICE
PROVIDE A WARNING INDICATION ON THE CALLED DEVICE
427

FIG. 4B

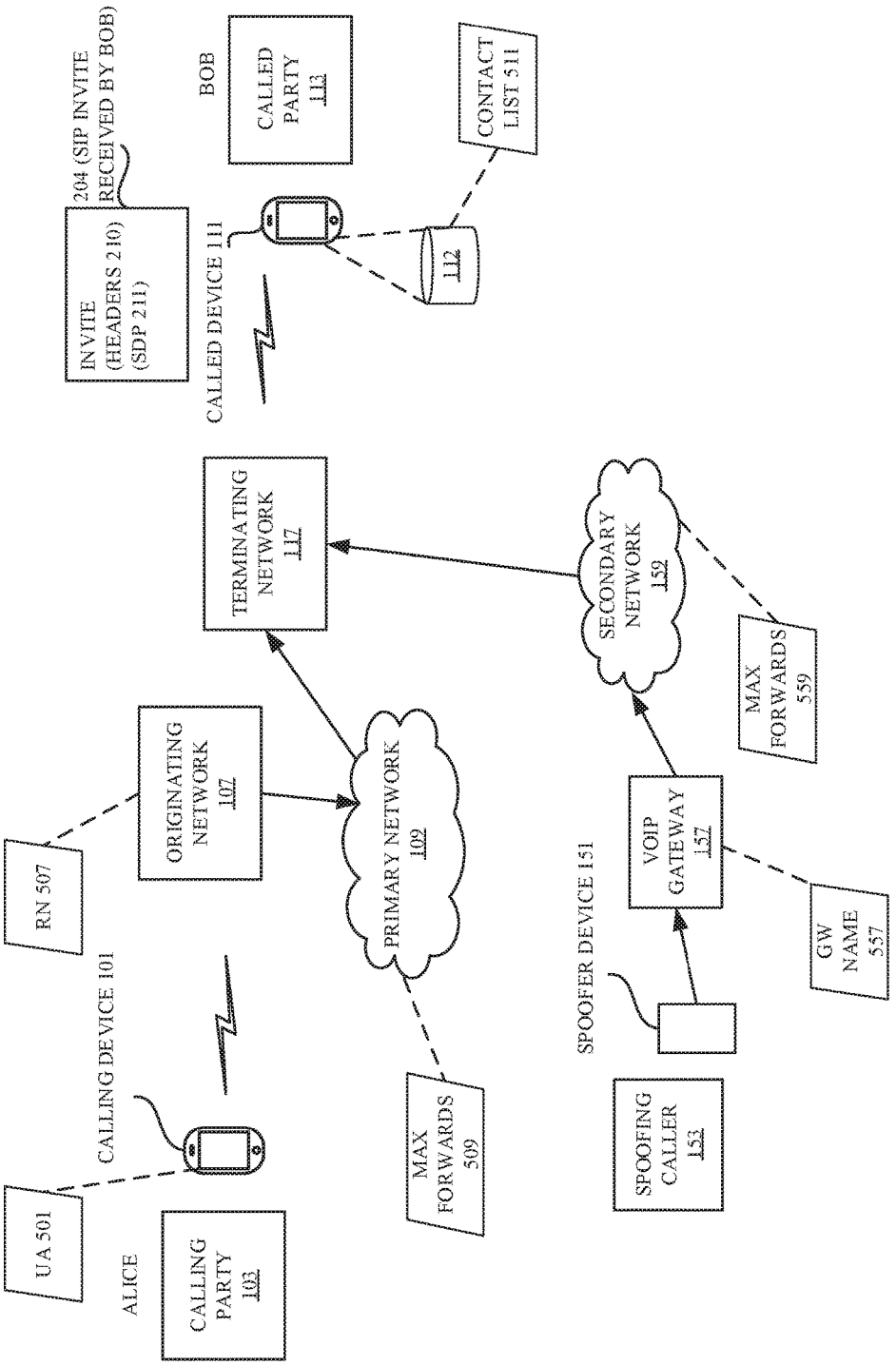

500
INVITE (HEADERS 210) (SDP 211)
204 (SIP INVITE RECEIVED BY BOB)
BOB
CALLED PARTY 113
CONTACT LIST 511
CALLED DEVICE 111
112
TERMINATING NETWORK 117
SECONDARY NETWORK 159
MAX FORWARDS 559
ORIGINATING NETWORK 107
PRIMARY NETWORK 102
RN 507
CALLING DEVICE 101
MAX FORWARDS 509
VOIP GATEWAY 157
GW NAME 557
SPOOFER DEVICE 151
SPOOFING CALLER 153
UA 501
ALICE
CALLING PARTY 103

FIG. 5

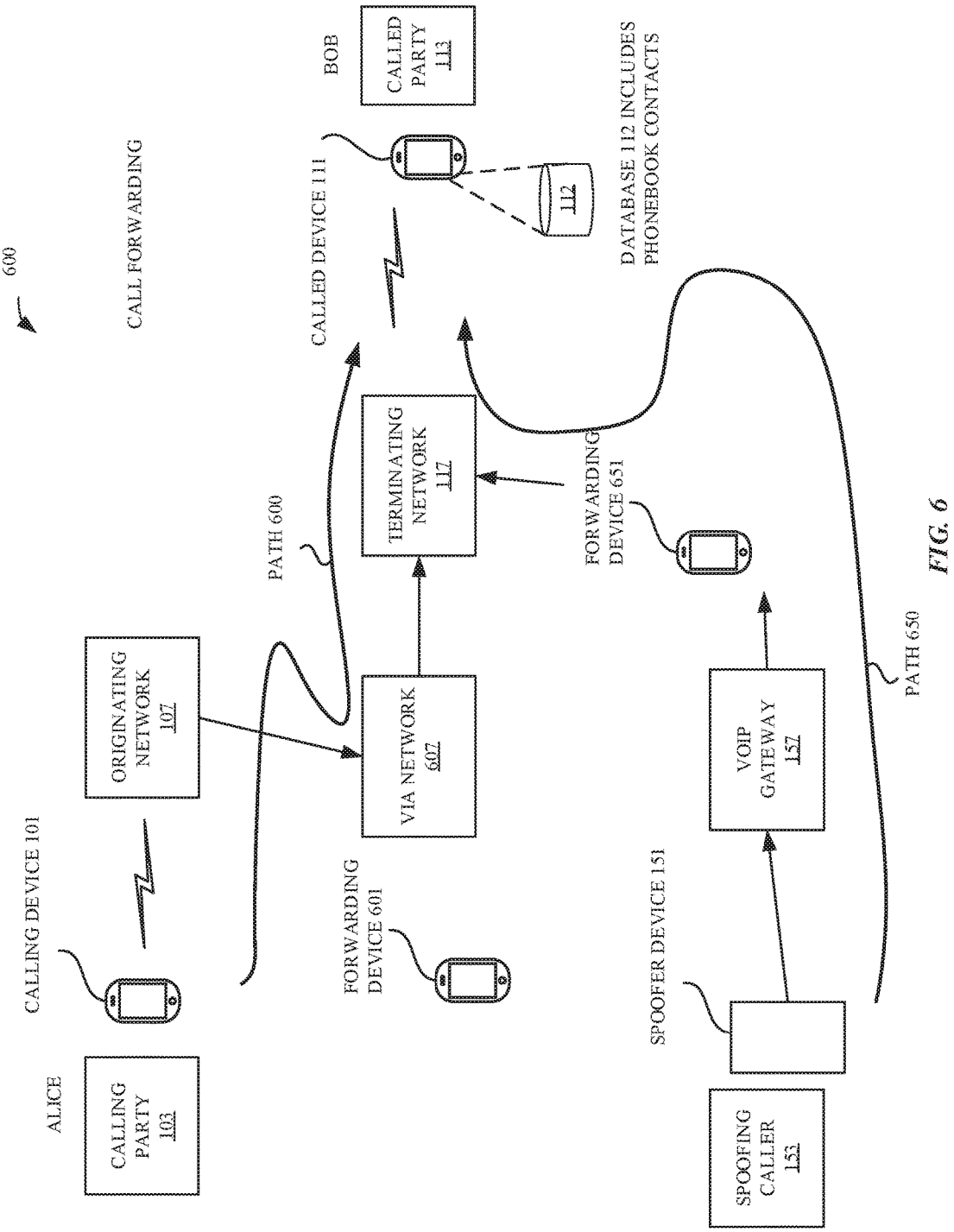

600
CALL FORWARDING
ALICE
CALLING PARTY 103
CALLING DEVICE 101
ORIGINATING NETWORK 107
VIA NETWORK 607
FORWARDING DEVICE 601
PATH 600
TERMINATING NETWORK 117
CALLED DEVICE 111
BOB
CALLED PARTY 113
112
DATABASE 112 INCLUDES PHONEBOOK CONTACTS
FORWARDING DEVICE 651
SPOOFER DEVICE 151
SPOOFING CALLER 153
VOIP GATEWAY 157
PATH 650

FIG. 6

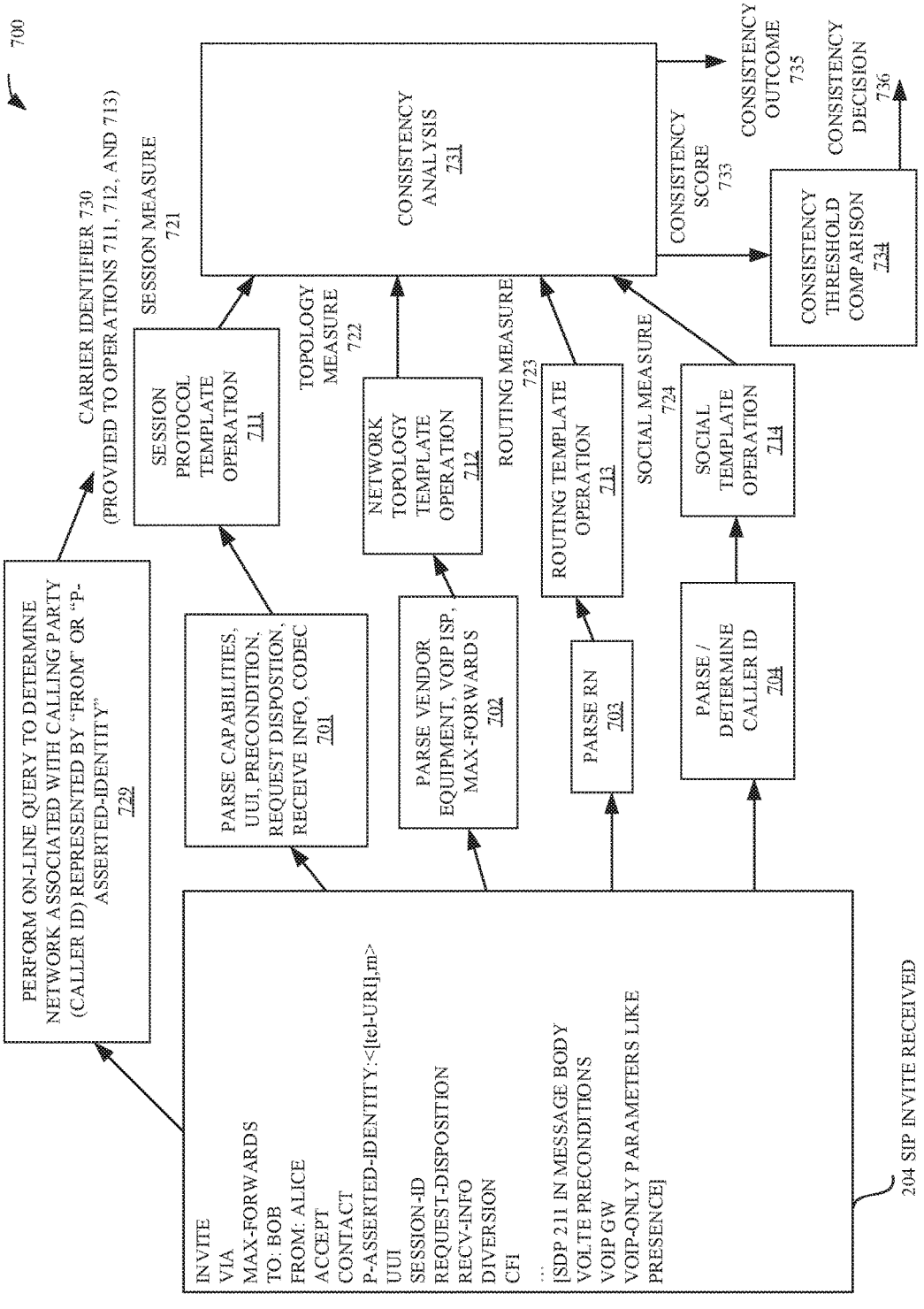

700
204 SIP INVITE RECEIVED BY BOB
INVITE
VIA
MAX-FORWARDS
TO: BOB
FROM: ALICE
ACCEPT
CONTACT
P-ASSERTED-IDENTITY:<[tel-URI],m>
UUI
SESSION-ID
REQUEST-DISPOSITION
RECV-INFO
DIVERSION
CFI
...
[SDP 211 IN MESSAGE BODY
VOLTE PRECONDITIONS
VOIP GW
VOIP-ONLY PARAMETERS LIKE
PRESENCE]
PERFORM ON-LINE QUERY TO DETERMINE NETWORK ASSOCIATED WITH CALLING PARTY (CALLER ID) REPRESENTED BY "FROM" OR "P-ASSERTED-IDENTITY" 729
CARRIER IDENTIFIER 730 (PROVIDED TO OPERATIONS 711, 712, AND 713)
PARSE CAPABILITIES, UUI, PRECONDITION, REQUEST DISPOSTION, RECEIVE INFO, CODEC 701
PARSE VENDOR EQUIPMENT, VOIP ISP, MAX-FORWARDS 702
PARSE RN 703
PARSE / DETERMINE CALLER ID 704
SESSION PROTOCOL TEMPLATE OPERATION 711
NETWORK TOPOLOGY TEMPLATE OPERATION 712
ROUTING TEMPLATE OPERATION 713
SOCIAL TEMPLATE OPERATION 714
SESSION MEASURE 721
TOPOLOGY MEASURE 722
ROUTING MEASURE 723
SOCIAL MEASURE 724
CONSISTENCY ANALYSIS 731
CONSISTENCY SCORE 733
CONSISTENCY OUTCOME 735
CONSISTENCY THRESHOLD COMPARISON 734
CONSISTENCY DECISION 736

FIG. 7

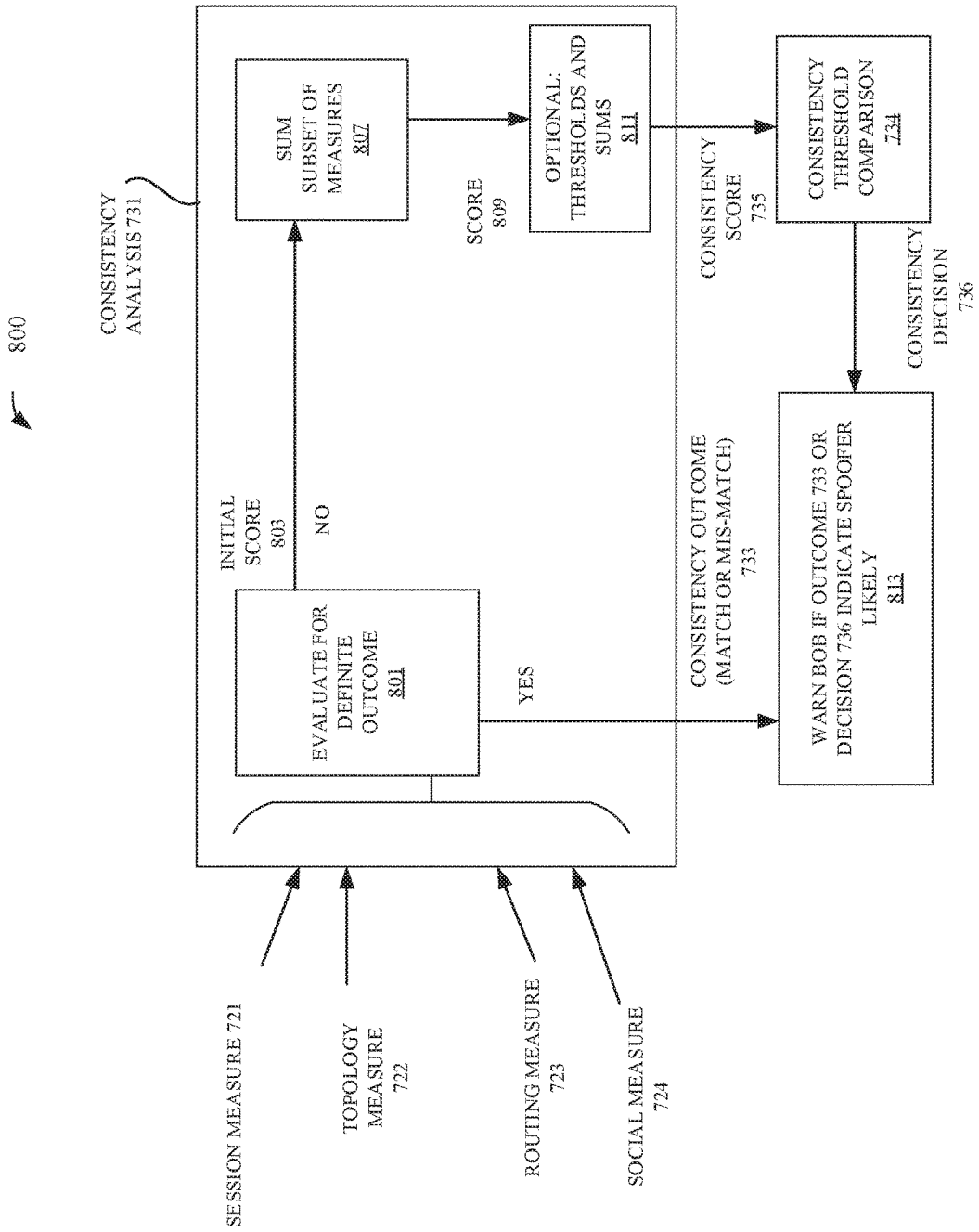

800
CONSISTENCY ANALYSIS 731
SESSION MEASURE 721
TOPOLOGY MEASURE 722
ROUTING MEASURE 723
SOCIAL MEASURE 724
EVALUATE FOR DEFINITE OUTCOME 801
INITIAL SCORE 803
NO
YES
SUM SUBSET OF MEASURES 807
SCORE 809
OPTIONAL: THRESHOLDS AND SUMS 811
CONSISTENCY OUTCOME (MATCH OR MIS-MATCH) 733
CONSISTENCY SCORE 735
CONSISTENCY THRESHOLD COMPARISON 734
CONSISTENCY DECISION 736
WARN BOB IF OUTCOME 733 OR DECISION 736 INDICATE SPOOFER LIKELY 813

FIG. 8

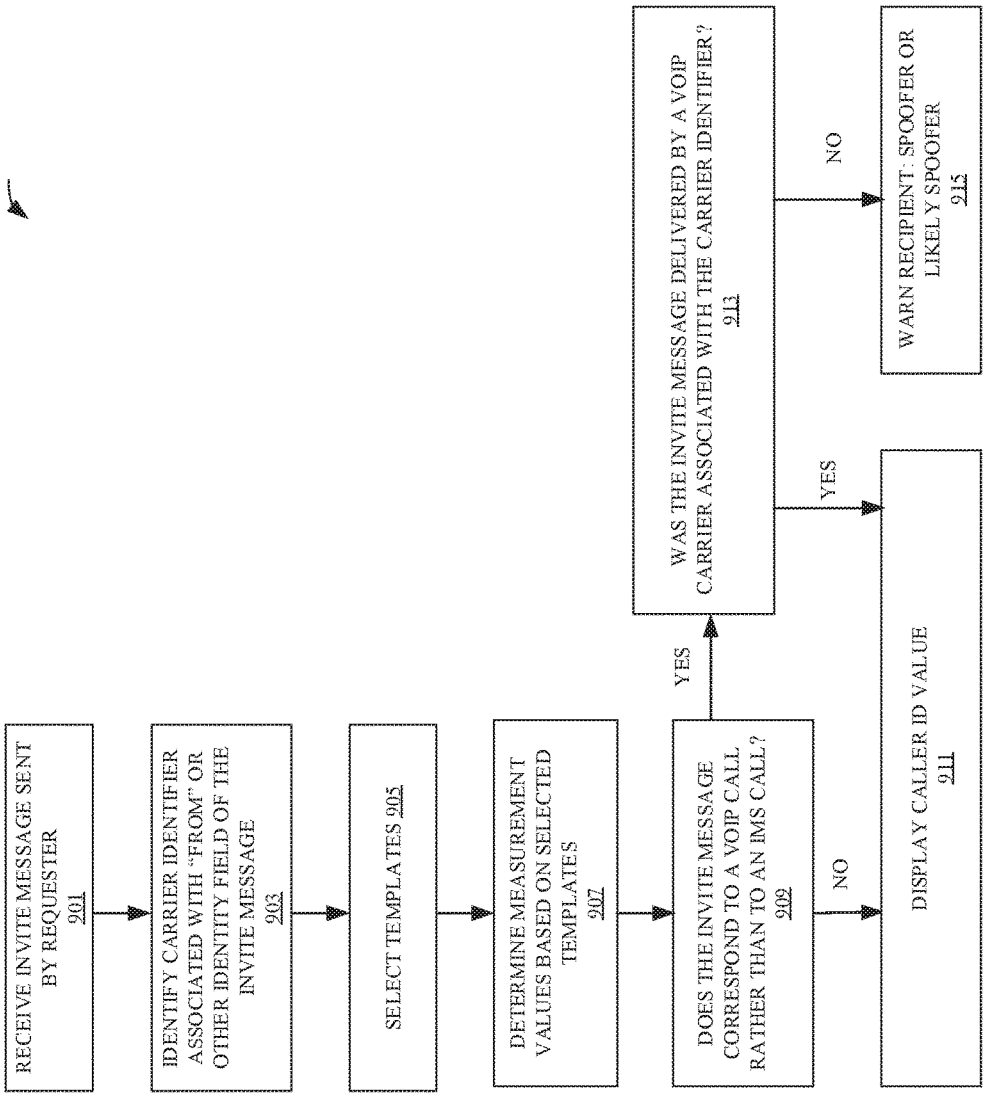

900
RECEIVE INVITE MESSAGE SENT BY REQUESTER 901
IDENTIFY CARRIER IDENTIFIER ASSOCIATED WITH "FROM" OR OTHER IDENTITY FIELD OF THE INVITE MESSAGE 903
SELECT TEMPLATES 905
DETERMINE MEASUREMENT VALUES BASED ON SELECTED TEMPLATES 907
DOES THE INVITE MESSAGE CORRESPOND TO A VOIP CALL RATHER THAN TO AN IMS CALL? 909
YES
NO
WAS THE INVITE MESSAGE DELIVERED BY A VOIP CARRIER ASSOCIATED WITH THE CARRIER IDENTIFIER? 913
YES
NO
DISPLAY CALLER ID VALUE 911
WARN RECIPIENT: SPOOFER OR LIKELY SPOOFER 915

FIG. 9

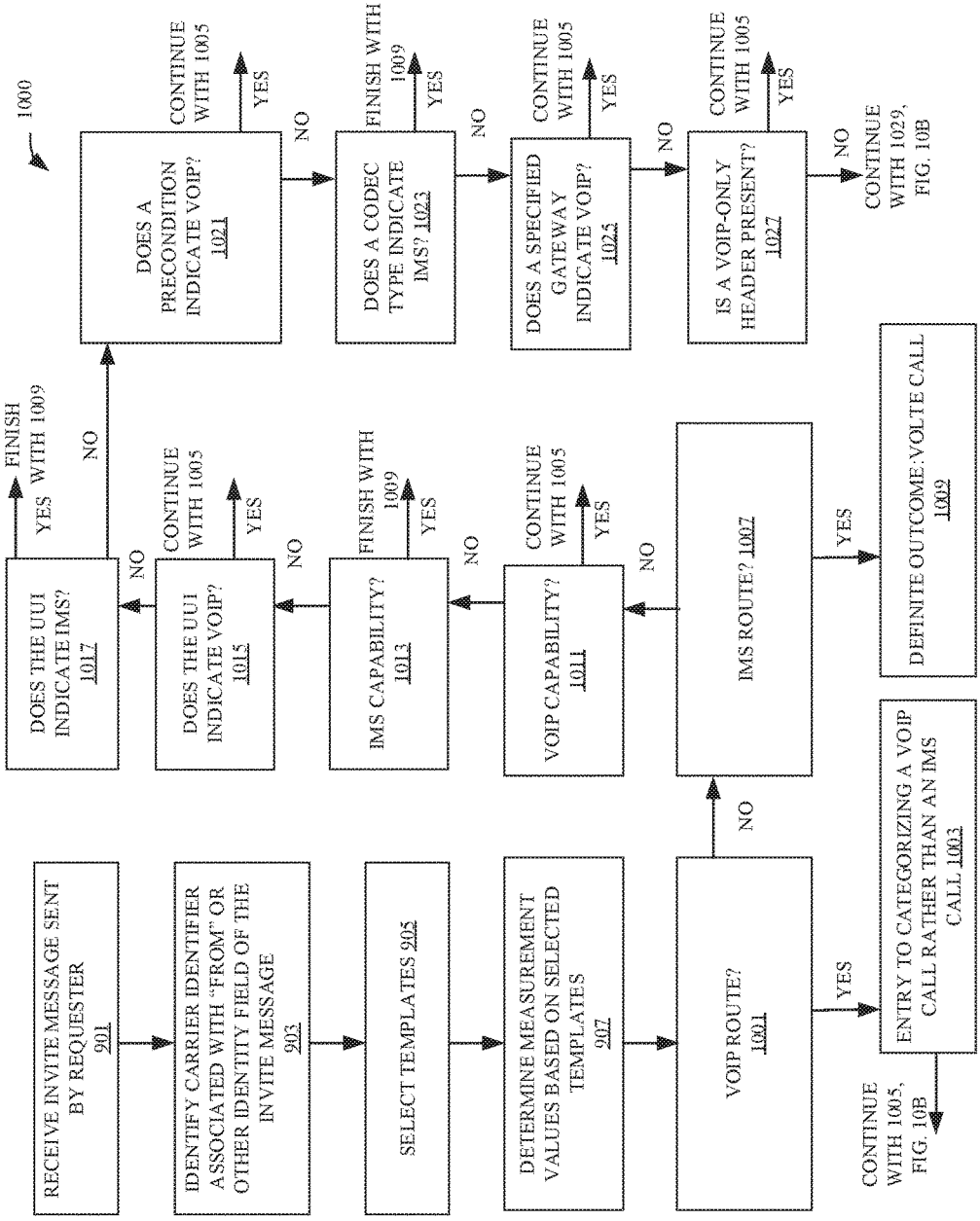

1000
RECEIVE INVITE MESSAGE SENT BY REQUESTER 901
IDENTIFY CARRIER IDENTIFIER ASSOCIATED WITH "FROM" OR OTHER IDENTITY FIELD OF THE INVITE MESSAGE 903
SELECT TEMPLATES 905
DETERMINE MEASUREMENT VALUES BASED ON SELECTED TEMPLATES 907
VOIP ROUTE? 1001
YES
NO
ENTRY TO CATEGORIZING A VOIP CALL RATHER THAN AN IMS CALL 1003
CONTINUE WITH 1005, FIG. 10B
IMS ROUTE? 1007
YES
DEFINITE OUTCOME: VOLTE CALL 1009
VOIP CAPABILITY? 1011
YES
CONTINUE WITH 1005
NO
IMS CAPABILITY? 1013
YES
FINISH WITH 1009
NO
DOES THE UUI INDICATE VOIP? 1015
YES
CONTINUE WITH 1005
NO
DOES THE UUI INDICATE IMS? 1017
YES
FINISH WITH 1009
NO
DOES A PRECONDITION INDICATE VOIP? 1021
YES
CONTINUE WITH 1005
NO
DOES A CODEC TYPE INDICATE IMS? 1023
YES
FINISH WITH 1009
NO
DOES A SPECIFIED GATEWAY INDICATE VOIP? 1025
YES
CONTINUE WITH 1005
NO
IS A VOIP-ONLY HEADER PRESENT? 1027
YES
CONTINUE WITH 1005
NO
CONTINUE WITH 1029, FIG. 10B

FIG. 10A

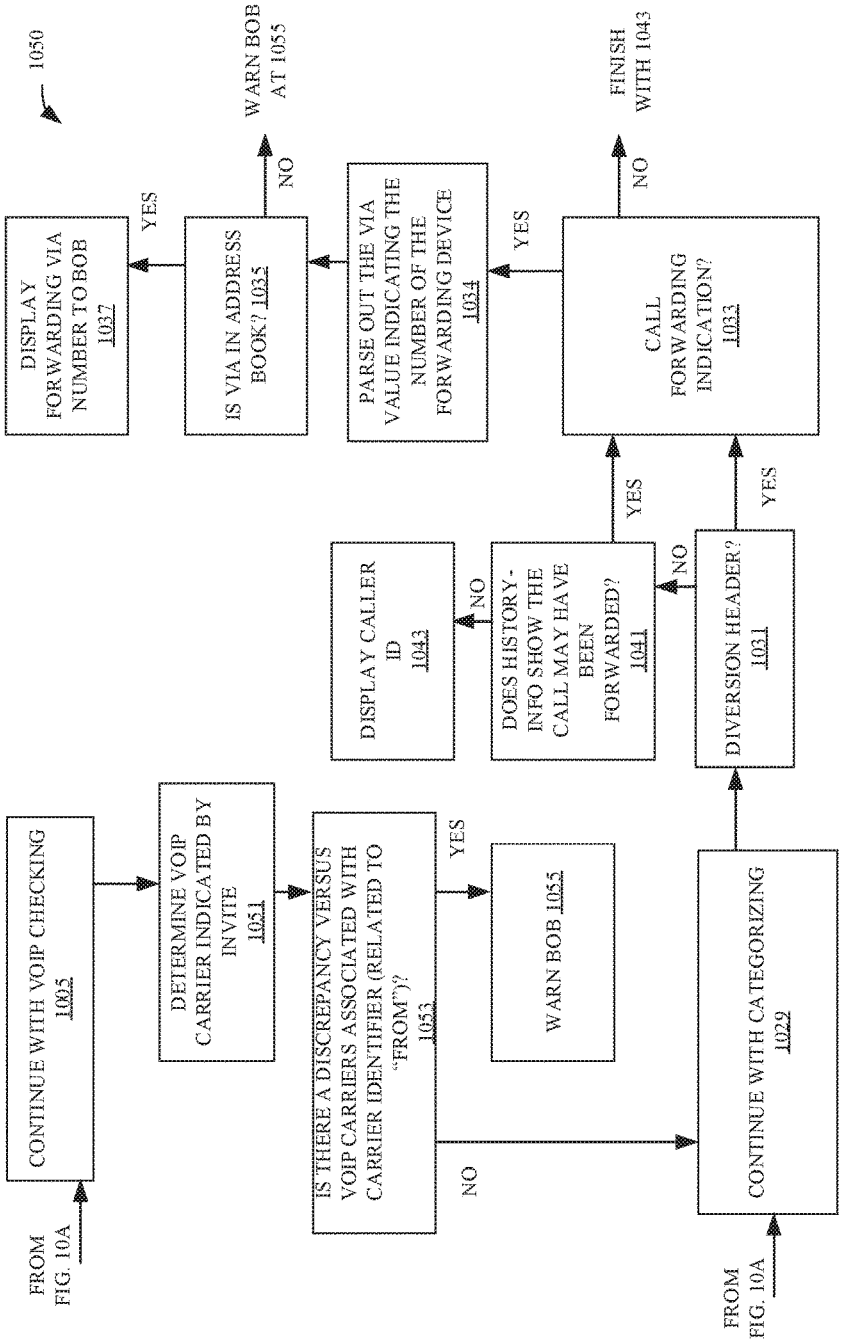

1050
FROM FIG. 10A
CONTINUE WITH VOIP CHECKING 1005
DETERMINE VOIP CARRIER INDICATED BY INVITE 1051
IS THERE A DISCREPANCY VERSUS VOIP CARRIERS ASSOCIATED WITH CARRIER IDENTIFIER (RELATED TO "FROM")? 1053
YES
NO
WARN BOB 1055
FROM FIG. 10A
CONTINUE WITH CATEGORIZING 1029
DIVERSION HEADER? 1031
YES
NO
DOES HISTORY-INFO SHOW THE CALL MAY HAVE BEEN FORWARDED? 1041
YES
NO
DISPLAY CALLER ID 1043
CALL FORWARDING INDICATION? 1033
YES
NO
FINISH WITH 1043
PARSE OUT THE VIA VALUE INDICATING THE NUMBER OF THE FORWARDING DEVICE 1034
IS VIA IN ADDRESS BOOK? 1035
YES
NO
WARN BOB AT 1055
DISPLAY FORWARDING VIA NUMBER TO BOB 1037

FIG. 10B

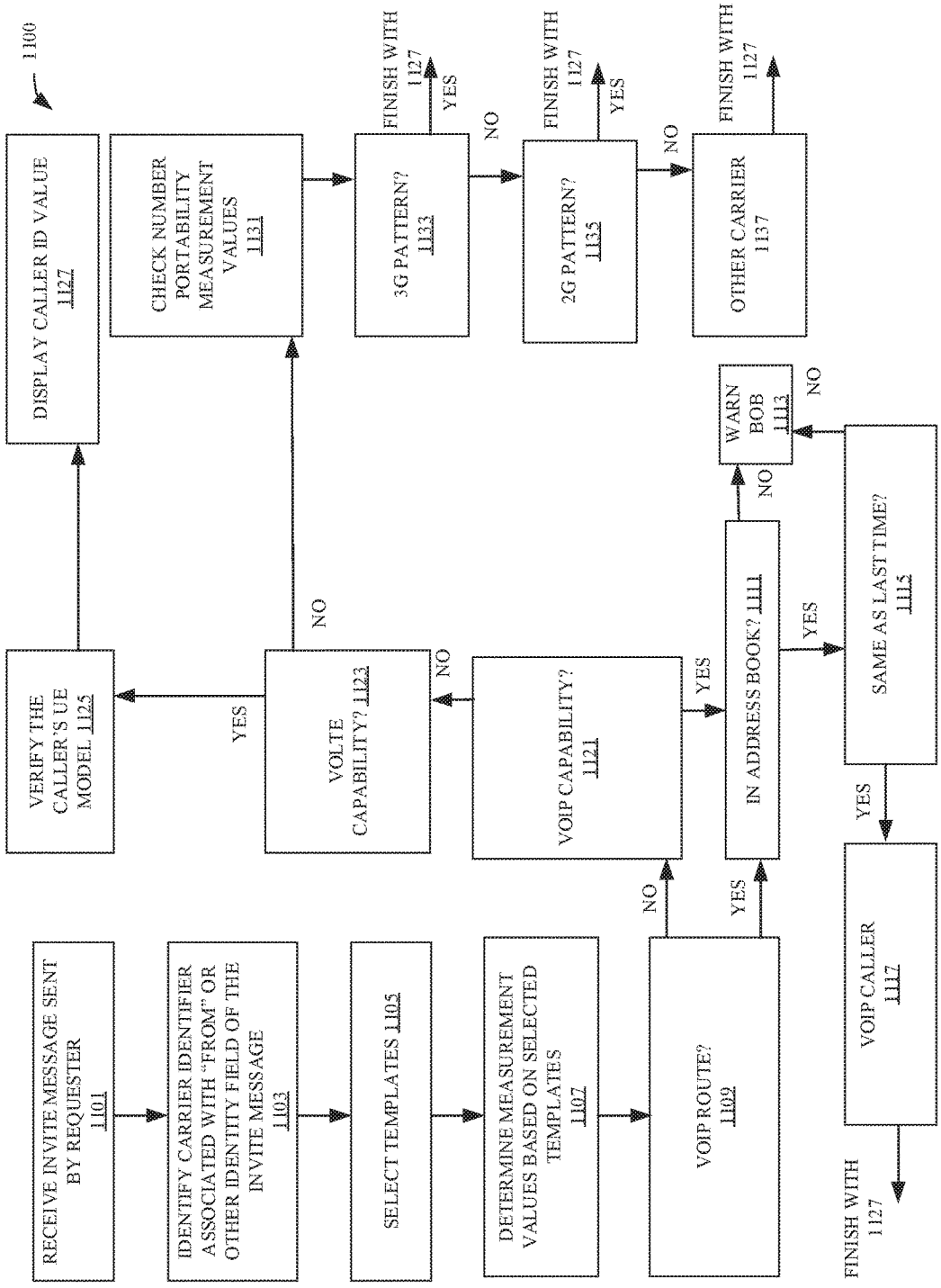

1100
RECEIVE INVITE MESSAGE SENT BY REQUESTER 1101
IDENTIFY CARRIER IDENTIFIER ASSOCIATED WITH "FROM" OR OTHER IDENTITY FIELD OF THE INVITE MESSAGE 1103
SELECT TEMPLATES 1105
DETERMINE MEASUREMENT VALUES BASED ON SELECTED TEMPLATES 1107
VOIP ROUTE? 1109
NO
YES
VOIP CAPABILITY? 1121
YES
NO
IN ADDRESS BOOK? 1111
YES
NO
SAME AS LAST TIME? 1115
YES
NO
VOIP CALLER 1117
FINISH WITH 1127
WARN BOB 1113
VOLTE CAPABILITY? 1123
YES
NO
VERIFY THE CALLER'S UE MODEL 1125
DISPLAY CALLER ID VALUE 1127
CHECK NUMBER PORTABILITY MEASUREMENT VALUES 1131
3G PATTERN? 1133
YES
FINISH WITH 1127
NO
2G PATTERN? 1135
YES
FINISH WITH 1127
NO
OTHER CARRIER 1137
FINISH WITH 1127

FIG. 11

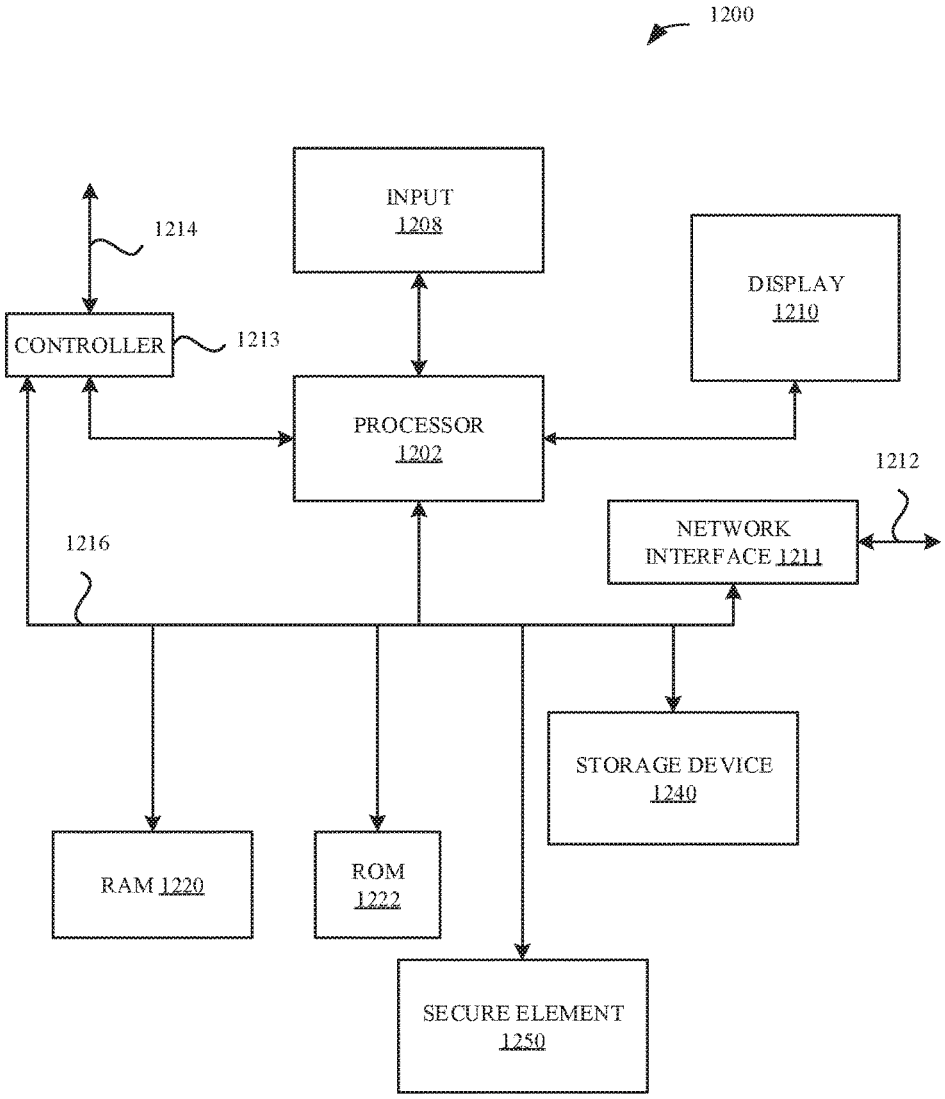

1200
INPUT
1208
1214
DISPLAY
1210
CONTROLLER
1213
PROCESSOR
1202
1212
NETWORK
INTERFACE 1211
1216
STORAGE DEVICE
1240
RAM 1220
ROM
1222
SECURE ELEMENT
1250

FIG. 12

DETECTION OF SPOOFED CALL INFORMATION

FIELD

[0001] Representative embodiments set forth herein disclose various systems and techniques for detection of spoofed call information.

BACKGROUND

[0002] An application layer control protocol can be used for establishing a media session. The application layer control protocol can be the session initiation protocol (SIP) defined by internet engineering task force (IETF) request for comments (RFC) 3261. SIP describes a number of message types called methods. One method is a SIP INVITE. A SIP INVITE includes a first line, subsequent lines including headers, and may include a message body. Some of the headers are defined in RFC 3261 and some headers, sometimes referred to as extension headers, are defined in other RFCs. The message body can include session description protocol (SDP) data.

[0003] In some cases, a calling party wishes to have a media session with a second party. The calling party and the second party may be referred to as participants. A SIP INVITE is sent by a requester (the calling party) to a receiving party (the second party) as a first step of a dialog. The SIP INVITE is routed by servers between the requester and the receiving party. The servers can overwrite or add headers to the SIP INVITE. Sometimes the servers are referred to as proxy servers or as proxies. After the media session parameters are agreed upon, the calling party and the receiving party may conduct a media session, possibly without routing media data through the proxy servers. For a mobile network participant, a voice session may be based on a standard known as voice over LTE (VoLTE).

[0004] The overall diagram of the session establishment and the media session may suggest a geometric figure called a trapezoid and so the overall message diagram is referred to as a SIP trapezoid. A party with bad intentions, a spoofing caller, may juxtapose a flow onto the SIP trapezoid in order to deceive the called party and conduct an activity injurious to the called party.

[0005] Some of the parameters of the media session are negotiated using headers and some are negotiated based on the SDP in the message body. Further description of headers, SDP, and parameter formats and handling can be found in the following documents.

[0006] RFC 2806 tel URL is relevant for the specification of a terminal in a telephone network.

[0007] RFC 5626 describes client-initiated connections including the behavior of user agents and proxy servers.

[0008] RFC 5621 describes message body handling, including for example, a content-type that has the value application/sdp.

[0009] RFC 3625 describes SIP-specific event notifications such as Presence.

[0010] RFC 2327 defines the session description protocol (SDP).

[0011] RFC 6086 defines a SIP Info method and package framework, including Receive Info.

[0012] RFC 3841 defines caller preferences for SIP, including Reject-Contact and Request Disposition.

[0013] RFC 3325 defines Private Extensions to the Session Initiation Protocol (SIP) for Asserted Identity within Trusted Networks, including P-Asserted-Identity.

[0014] RFC 4694 describes number portability parameters, including routing number (rn), for the "tel" URI.

[0015] RFC 7433 describes user-to-user information (UUI).

[0016] RFC 5806 describes the diversion indication in SIP, related to call forwarding.

[0017] RFC 4244 describes an extension to SIP for request history information. This is related to the History-Info header.

[0018] RFC 3856 describes a presence event package.

[0019] GSMA IR.51, "IMS over Wi-Fi," Version 1.0, Feb. 5, 2015 (hereinafter "GSMA IMS over Wi-Fi").

[0020] GSMA IR. 92 IMS Profile for Voice and SMS, version 10, May 19, 2016 (hereinafter "GSMA IMS Profile").

[0021] 3GPP TS 24.229 IP Multimedia Call Control Protocol based on SIP and SDP, version v5.25.0, September 2011 (hereinafter "3GPP 24.229").

[0022] GSMA FCM.01 VoLTE Service Description and Implementation Guidelines, version 1.1, Mar. 26, 2014 (hereinafter "GSMA VoLTE Description").

[0023] The documents found at these URLs also may provide background of interest: https://tools.ietf.org/id/draft-haluska-dispatch-isup-oli-01.txt; https://www.nationalnanpa.com/number_resource_info/ani_ii_assignments.html; and http://localcallingguide.com/lca_prefix.php?exch=024320.

SUMMARY

[0024] A device that receives a message, a "called device," evaluates the message to determine consistency. The message may include an identifier of a calling device associated with a calling person or persons, a "calling party." Unfortunately, the message may be spoofed, for example, the message may be a counterfeit message or a fake message. An example of a spoofed message is one in which a person with bad intentions, a "spoofing caller," or a machine under the control of the spoofing caller, pushes forward a financial scam by inserting a caller ID value in the message that the called party will trust. For example, the caller ID value may be associated with law enforcement, an electric company or with a family relative of the called party. The spoofing caller may attempt to induce the called party to take some financial action detrimental to the called party based on this trust of the observed caller ID value. In some countries, this kind of financial scam is widespread and a problem for everyday users of mobile devices.

[0025] In some embodiments, an algorithm provided here verifies network-filled SIP fields of a SIP INVITE message as it is routed from an apparent source ("Alice") to its intended recipient ("Bob"). A spoofing caller (a fake Alice) does not fill or is unable to control those fields before the SIP INVITE reaches Bob. That is, the spoofing caller fills some fields, but various header fields of a SIP INVITE are either populated, inserted, or over-written by a network server that processes the message on the way to Bob (see FIG. **2**A). In effect, the spoofing caller is unable to fake the network activity. These fields constitute a signature of the route the message took. The called device, in some embodiments, looks for a network signature confirming originating of the message from Alice. In some embodiments, this involves

identifying the originating network corresponding to the Caller ID value received in the message at Bob's called device.

[0026] In some embodiments, a mobile device is configured to detect that a message inviting a call initiation is a spoofed message. Data received in the message may be referred to herein as "call record" information or data or as "call trace" information or data. A database of candidate call record information is included in the mobile device and/or is accessible to the called device from a server via the Internet ("online"). For instances when the called device accesses an on-line database, the mobile device submits a query for real-time processing. The candidate call record information includes templates based on various characteristics of call initiation messages. The candidate call record information can be addressed (or read or indexed-into) based on a network operator identity, calling device information, and/or VOIP information. A network operator may also be referred to herein as a carrier. The mobile device, in some embodiments includes contact information associated with a phonebook application.

[0027] When a message is received, the mobile device parses a call record included in the message. A caller ID value may be included in the call record. The mobile device, using the database, can determine a network operator identifier associated with the caller ID value. Based on the network operator identifier, the mobile device can fetch a template from the database and compare the template with the call record. The comparison may result in a positive indication that the invitation message is legitimate (not from a spoofer), that the message invitation is not associated with the caller ID value (that is, the invitation message is a fake, it is spoofed), or the comparison may indicate that further checks on the call record should be done.

[0028] The invitation message may be a SIP INVITE and the network operator may host both an LTE network and an internet multimedia subsystem (IMS) network of servers. The network operator may be an MNO. The SIP INVITE may include a routing number (RN). If the RN is a value associated in the database with the network operator corresponding to the caller ID, then the SIP INVITE is deemed legitimate.

Network Operator Tests

[0029] The SIP INVITE may include a max-forwards value. If the max-forwards value is not within a particular range indicated in the database for the network operator, this is a strong indication that the SIP INVITE is spoofed.

[0030] The SIP INVITE may include a speech codec indication. If the speech codec indication matches with a speech codec used for IMS and not for VOIP, then this is a strong indication that the SIP INVITE is legitimate.

[0031] The SIP INVITE may include a network equipment identifier associated with a particular kind of equipment that the message passed through in the originating network enroute to the called party. If network equipment identifier matches an entry in the database indexed by the network operator identifier, this is a strong indication that the SIP INVITE is legitimate.

[0032] The SIP INVITE may include protocol information uniquely associated with the 3GPP VoLTE standards. VoLTE protocol information is a strong indication that the SIP INVITE is legitimate.

[0033] The SIP INVITE may include an IMS server identifier, where the IMS server is in the originating network of the network operator. If the IMS server identifier matches an entry in the database indexed by the network operator identifier, this is a conclusive indication that the SIP INVITE is legitimate.

[0034] The SIP INVITE may include a VOIP server identifier. If VOIP server identifier does not match an entry in the database indexed by the network operator identifier, this is a strong indication that the SIP INVITE is spoofed.

UA Test

[0035] The mobile device can retrieve device template data from the database. The mobile device can also read a user agent (UA) field from the SIP INVITE message. If the UA field corresponds to a smart phone manufacturer, this is a strong indication that the SIP INVITE message is legitimate. If an unknown or non-smartphone User Agent field is seen, this is a strong indication of a VOIP caller such as a Skype client.

VOIP Parameters

[0036] The SIP INVITE may include VOIP parameters not used in VoLTE. This would indicate that further checks should be done to determine whether the SIP INVITE originated with the network operator through, for example, a Wi-Fi connection rather than through a 4G (LTE) connection.

[0037] VOIP parameters that the mobile device can check include VOIP capability parameters, a VOIP gateway address, a VOIP header field value, and/or a VOIP parameter to be negotiated during call establishment.

Check of Call Forwarding

[0038] Some spoofed SIP INVITE messages originate at a spoofer device but pass through a forwarding device, where the forwarding device is attached to a legitimate network that then sends the SIP INVITE on to the terminating network serving the called device. In some instances a spoofing caller fakes a call forwarding signaling message in order to deceive a terminating or ingress network. The terminating network wishes to block a faked Caller ID. However, it is difficult for the terminating network to verify the Caller ID value if the INVITE message is in a call forwarding format.

[0039] In either case, after determining that the SIP INVITE has been forwarded (or at least appears to have been forwarded), the mobile device can read the VIA number of a VIA header field from the call record. VIA is a header field defined in RFC 3261. The mobile device can then check the VIA number of the SIP INVITE against the address book of the user. If the VIA number is not in the address book, this suggests that the called party is unaware of the device through which the SIP INVITE was forwarded, that the SIP INVITE may have originated with a spoofing caller and thus that the called party is to be warned.

[0040] In some instances, the legitimate network used by the forwarding device may send a CS (circuit-switched) voice call setup message. Whether the network sends a SIP INVITE or a CS voice call setup message, the mobile device can check the VIA number of the received message against the address book of the user. As above, if the VIA number is not in the address book, this suggests that the called party

is unaware of the device through which the SIP INVITE was forwarded, and the called party is to be warned.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041] The included drawings are for illustrative purposes and serve only to provide examples of possible structures and arrangements for the disclosed systems and techniques for intelligently and efficiently managing calls and other communications between multiple associated user devices. These drawings in no way limit any changes in form and detail that may be made to the embodiments by one skilled in the art without departing from the spirit and scope of the embodiments. The embodiments will be readily understood by the following detailed description in conjunction with the accompanying drawings, wherein like reference numerals designate like structural elements.

[0042] FIG. **1**A provides exemplary logic for categorizing a message, according to some embodiments. FIG. **1**B provides an exemplary Venn diagram for a message with no discrepancies, according to some embodiments. FIG. **1**C provides an exemplary Venn diagram for a message with a discrepancy, according to some embodiments.

[0043] FIG. **2**A illustrates an exemplary SIP trapezoid, according to some embodiments. FIG. **2**B illustrates an exemplary SIP INVITE message from a legitimate caller, Alice, to a called party, Bob, according to some embodiments. FIG. **2**C illustrates an exemplary spoofing caller connecting to a server in the SIP trapezoid.

[0044] FIG. **2**D illustrates an exemplary terminating network including a 3GPP LTE eNodeB, according to some embodiments. FIG. **2**E illustrates an exemplary terminating network including access to the called device versus rich communication services (RCS), according to some embodiments. FIG. **2**F illustrates an exemplary terminating network including a Wi-Fi network, according to some embodiments.

[0045] FIG. **2**G illustrates exemplary access of the calling device to the originating network, according to some embodiments. FIG. **2**H illustrates exemplary stack layers when the calling device accesses the originating network via an eNodeB, according to some embodiments.

[0046] FIG. **2**I illustrates a stack layer for a spoofer device connecting to a VOIP gateway.

[0047] FIG. **3**A illustrates further details of the SIP trapezoid with spoofing caller present, according to some embodiments. FIG. **3**B illustrates an exemplary message flow from Alice to Bob and the establishment of a media session, according to some embodiments. FIG. **3**C illustrates the spoofing caller sending a SIP INVITE to Bob and Bob being provided with a warning indication, according to some embodiments.

[0048] FIG. **4**A illustrates exemplary logic for determining consistency of a received message in comparison with a database, according to a routing number embodiment. FIG. **4**B illustrates exemplary logic for determining consistency of a received message in comparison with a database and/or social data, according to some embodiments.

[0049] FIG. **5** illustrates exemplary data originating in or added to a SIP INVITE as it traverses the SIP trapezoid before it reaches Bob, according to some embodiments.

[0050] FIG. **6** illustrates an exemplary pathway that a spoofing caller may use to route a message to Bob using a forwarding device.

[0051] FIG. **7** illustrates exemplary templates and measures provided to an exemplary consistency analysis module to determine whether a warning indication should be provided to Bob, according to some embodiments.

[0052] FIG. **8** illustrates exemplary operations performed by the consistency analysis module to evaluate whether a warning indication should be provided to Bob, according to some embodiments.

[0053] FIG. **9** illustrates exemplary logic to evaluate whether a warning indication should be provided to Bob, according to some embodiments.

[0054] FIGS. **10**A and **10**B illustrate exemplary logic to evaluate whether a warning indication should be provided to Bob, according to some embodiments.

[0055] FIG. **11** illustrates exemplary logic to evaluate whether a warning indication should be provided to Bob, according to some embodiments.

[0056] FIG. **12** illustrates an exemplary computing apparatus that can be used to implement the various components and techniques described herein, according to some embodiments.

DETAILED DESCRIPTION

[0057] Representative applications of apparatuses, systems, and methods according to the presently described embodiments are provided in this section. These examples are being provided solely to add context and aid in the understanding of the described embodiments. It will thus be apparent to one skilled in the art that the presently described embodiments can be practiced without some or all of these specific details. In other instances, well known process steps have not been described in detail in order to avoid unnecessarily obscuring the presently described embodiments. Other applications are possible, such that the following examples should not be taken as limiting.

Call Warning

[0058] FIG. **1**A illustrates exemplary logic **150** for evaluating whether a warning indication should be provided to a recipient of a message. **151** indicates that the logic begins at a called device. At **152** the called device receives a message. At **153**, the called device evaluates the message to determine the likelihood that the message is spoofed, for example, the likelihood that the self-identifying information in the message from the calling party is false. Likelihood as described herein includes, but is not limited to, categorizing by: i) a voting algorithm such as a majority vote, or a two-thirds vote, ii) calculation of a risk by a sum of weighted costs, iii) a true/false value based on not matching any row from a table of known legitimate parameter values, and/or iv) a true/false value based on matching any row from a table of known spoofer parameter values. If the result of the evaluation is that the message is not spoofed or that it is unlikely that the message is spoofed, the logic flows to **154** and a calling device identifier based on the message is presented to a called party. If the result of the evaluation is that the message is spoofed or the likelihood that the message is spoofed is substantial, then a warning is provided to the called party. In some embodiments, a media session is chosen at the called party's discretion after the warning. That is, in some embodiments, the logic **150** permits the called party to continue with a media session despite the warning.

[0059] FIG. **1**B illustrates an exemplary Venn diagram **130** showing template data **131** from one or more databases in a

called device. Identifying data **132** is parsed by the called device from a received message. In FIG. **1**B, the identifying data **132** is consistent with the template data **131** (this is the flow to **154** in FIG. **1**A) and no warning indication will be generated.

[0060] FIG. **1**C illustrates an exemplary Venn diagram **132** showing the template data **131** of FIG. **1**B. Identifying data **133** is parsed by the called device from a received message. In FIG. **1**C, the identifying data **133** is has a discrepancy with the template data **131** (this is the flow to **155** in FIG. **1**A) and a warning indication will be generated.

Session Initiation Protocol, Invitation to Establish Media Session

[0061] FIG. **2**A illustrates an exemplary SIP trapezoid **202** in a system **220**. Further description of the SIP trapezoid can be found in RFC 3261. A calling party **103**, sometimes called "Alice" herein, has a calling device **101** and sends a SIP INVITE message **204** to a called party **113**, sometimes called "Bob" herein. Alice may, for example, represent a family relative of Bob's, a well-known electrical utility, a well-known law enforcement department, or possibly a party unknown to Bob. The message **204** is routed through a server **131** in an originating network **107** serving Alice. In some embodiments, the originating network is a public mobile network (PMN) including 3GPP LTE equipment and Internet Multimedia Subsystem (IMS) equipment. The 3GPP LTE equipment can include a base station such as an eNodeB that receives the message **204** in a wireless transmission from the calling device **101**. The message **204** flows from the server **131** to a server **181** in a terminating network **117** serving Bob and reaches the called device **111**. The terminating network may also include IMS equipment and 3GPP LTE equipment, and the called device **111** may receive the message in a wireless transmission from an eNodeB of the terminating network. When Bob responds appropriately to the message **204**, a media session **201** can be established. In some embodiments, the media session **201** is based on a voice over LTE standard, VoLTE.

[0062] FIG. **2**B illustrates some portions of the exemplary message **204**. Three particular portions are shown: i) the first line **209** including the method name, ii) headers **210**, and iii) SDP **211** in the message body. Further details on the structure of a SIP INVITE are provided in RFC 3261 and other RFCs mentioned above. An identifier provided to a called party is called Caller ID. The Caller ID value can be based on the FROM field or the P-Asserted Identity field of the headers **210**. For example, the Caller ID value may be based on a 10 digit phone number in a tel-URI format provided in the FROM field or the P-Asserted Identity field. A MAX-FORWARDS header field is also shown. MAX-FORWARDS is a hop countdown value, or time-to-live value, used by system designers to stop a packet from circulating indefinitely in networks. The MAX-FORWARDS value may default to a value such as **70** when sent by calling device **101**. Each server in-route decrements the value. If the value reaches 0, the packet can be discarded. Thus MAX-FORWARDS provides information on how many hops a message has been through before reaching the called device **111**.

[0063] FIG. **2**C illustrates a spoofing caller **153** using a spoofer device **151** to send a message to Bob in a system **221**. The spoofing caller **153** sends the message to an address identifying Bob and the message is thus routed to the server **181** in the terminating network **117** serving Bob. The server **181** delivers the message to the called device **111**. The message again has the format **204**. Without further inquiry, called device **111** will parse Caller ID data from the message and display Alice's name and/or phone number to Bob. The spoofing caller **153** is hoping that Bob accepts the call and establishes a media session.

[0064] FIG. **2**D illustrates an exemplary system **230** for a scenario in which the terminating network **117** reaches the called device **111** using a link **115** from a 3GPP LTE eNodeB **231**. The SIP INVITE message **204** is received by the server **181**, which, in some embodiments, is a P-CSCF (proxy call session control function). Server **181** is part of an IMS network. IMS functions, in some embodiments, include authentication, registration, routing and fee-charging. How these functions are divided between the servers **131** in the originating network and **181** in the terminating network is beyond the scope of this description. Further description of P-CSCF operation can be found in the GSMA VoLTE Description and the GSMA IMS Profile. A description of the VoLTE network architecture can be found in the GSMA VoLTE Description.

[0065] FIG. **2**E illustrates an exemplary system **240** for a scenario in which the terminating network **117** reaches the called device **111** using rich communication services (RCS). RCS uses services from 3GPP and open mobile alliance (OMA).

[0066] FIG. **2**F illustrates an exemplary system **250** for a scenario in which the terminating network **117** reaches the called device **111** using a Wi-Fi network **251**. The Wi-Fi network **251** can support Wi-Fi Calling. Features for support of IMS-based telephony are provided in GSMA IMS over Wi-Fi.

[0067] The called device **111** is exemplary of a mobile phone device, a portable computer like a tablet, a laptop computer, a desktop computer, or another type of communication device.

[0068] FIG. **2**G illustrates a scenario **260** in which access to the calling device **101** of Alice is provided by a 3GPP LTE eNodeB **161**, a Wi-Fi access point (AP) **162**, or a base station (2G or 3G) **163**. Alice may call Bob using IMS-based 3GPP LTE VoLTE or Alice may call Bob using a VOIP voice carrier through, for example, Wi-Fi AP **162**. In either case, Alice's call will be routed through the originating network **107**.

[0069] FIG. **2**H provides exemplary stack layers for the instance of FIG. **2**G in which access to the calling device **101** is provided by the eNodeB **161**. The calling device **101** includes, from the bottom up, layers **267**, **266** and **265**. The eNodeB includes layers **269** and **268**. The Server **131**, which may a P-CSCF, includes layers **272**, **271**, and **270**. In terms of protocol flows, layer **265** of the calling device **101** communicates over flow **272** to layer **270** of the server **131**. In an exemplary embodiment, server **131** is an IMS server and implements IMS capabilities and services for telephony, and supports real-time media negotiation, transport and codecs. Further details of the layers can be found in the GSMA IMS Profile. Layers **267** and **269** communicate flow **273** over link **105**. Required Quality of Service (QoS) can be addressed with pre-conditions. Further description of SIP pre-conditions can be found the GSMA IMS Profile and in 3GPP 24.229. Server **131** is within originating network **107**.

[0070] FIG. **2**I illustrates some possible layer information about the spoofer device **151** and the VOIP Gateway **157** (also see FIG. **3**A). The spoofer device **151** may be running

a VOIP voice carrier application **281**. Examples are Skype and Vonage. These applications are typically proprietary and use closed-source software. These applications typically run over a transport layer of TCP or UDP. VOIP gateway **157** connects to a secondary network **159** (see FIG. **3**A) and may use internet service provider (ISP) infrastructure network equipment specifically dedicated to the VOIP voice carrier service. For example, Skype, as a service provider, may operate one or more switches or servers with unique names and/or addresses that are not part of any originating network **107** but may be identified as VOIP gateway **157** or as a node within the secondary network **159**. When VOIP application **281** is running, it may establish SDP values in a SIP INVITE message that are unique to the VOIP voice carrier application and distinct from the IMS features and functions supported, for example, at layer **270** of the server **131**. These differences are used in embodiments provided herein to assist in distinguishing a legitimate call from Alice on calling device **101** from a spoofed call from spoofer device **151**.

Network: Alice to Bob and Spoofing Caller to Bob

[0071] FIG. **3**A illustrates a system **190** including further details of network components involved in the SIP trapezoid signaling introduced in FIGS. **2**A, **2**B, and **2**C. The path from Alice to Bob is denoted generically as path **190** in FIG. **3**A. Alice sends a SIP INVITE message **204** to Bob over an LTE link **105** to an eNodeB in originating network **107**. Originating network **107** internally routes the message from a 4G network (3GPP LTE) to an IMS network including the server **131**. The server **131** may identify itself in one of the header fields using a number portability value known as a routing number (rn) which corresponds to the server **131**. The server **131** decrements MAX-FORWARDS and routes the message toward Bob by sending it to primary network **109** which will then send the message to the terminating network **117** including the server **181**. The server **181**, part of an IMS network, decrements MAX-FORWARDS and routes the message to an eNodeB which then transmits the message to Bob over a link **115**. The called device **111** (Bob's device) receives the message and this completes the path **100**. In some embodiments, not shown in FIG. **3**A, Alice calls Bob through the Wi-Fi AP **162** and the call is ultimately routed through a VOIP voice carrier gateway. Since the Caller ID value legitimately informs Bob that Alice is the caller, this is not a spoofed call. Thus, some embodiments provided herein describe a VOIP call for which the Caller ID is displayed to Bob without a warning.

[0072] FIG. **3**A also illustrates a generic path **150** from the spoofing caller **153** to Bob. The spoofing caller **153** (which may be a computer program, sometimes referred to as generating robocalls) uses a spoofer device **151** and sends a message including a SIP INVITE over a link **155** to a Voice over Internet Protocol (VOIP) gateway (GW) **157**. The VOIP GW **157** sends the message towards the terminating network **117** serving Bob using a secondary network **159**. MAX-FORWARDS is decremented by the forwarding servers in the path **150**, including server **181** in the terminating network **117**. As for Alice's message, the server **181**, part of an IMS network, routes the message to an eNodeB which then transmits the message to Bob over the link **115**. Bob's device receives the message and this completes the path **150**. Without further inquiry, Bob's device would display information about Alice on the display screen of the called device **111** and Bob may incorrectly suppose the message originated from Alice rather than from an unknown person or computer. Provided herein are methods and devices to use a database **112** of the called device **111** to detect when the message likely did not come from Alice. On-line databases may also be used.

Kinds of Data (Nature) to Compare with Database (Templates)

[0073] Table 1 illustrates information that the called device **111** uses to evaluate whether it is likely that a received message is from a spoofing caller. The first column indicates the nature of the data being used to check the received message. The second column indicates how the SIP INVITE is expected to relate to a database entry of the third column. Entries of the third column are also referred to as template data or as templates. The fourth column provides an example of the data parsed from the SIP INVITE to compare with the database entry or template.

TABLE 1

Exemplary Data Used to Estimate Whether a Received Message is from a Spoofing Caller

Nature	How the SIP INVITE Should Relate to the Database Entry	Database Entry (Templates)	Example (see FIG. 5)
Routing: Alice's Proxy Server	Originating Network (Alice's)	Routing	RN 507, gateway address in SDP 211 (GW Name 557)
Protocol: Device	Alice's device	Capabilities, UUI	3gpp-service.ims.icsi.mmtel (INVITE capabilities in Headers 210); Device Manufacturer Name (UUI in Headers 210)
Protocol: This specific call	Alice's requested service; or VoIP-only service	Precondition (QoS)	Parameter in SDP 211.
Protocol: Media Transport	IMS for Alice, VOIP for Spoofing Caller, VOIP for Alice if Alice originates call without VoLTE (IMS)	Request Disposition, Receive Info, Codec	VoIP parameters, VoLTE parameters in Headers 210 or in SDP 211.
Network Topology: Network Equipment	Alice's Originating Network or Secondary Network used by Spoofing Caller's GW	Vendor Equipment (build by observation)	Infrastructure Vendor Name (check Headers 210 and SDP 211)

TABLE 1-continued

Exemplary Data Used to Estimate Whether a Received Message is from a Spoofing Caller

Nature	How the SIP INVITE Should Relate to the Database Entry	Database Entry (Templates)	Example (see FIG. 5)
Network Topology: Network Identifier	VoIP carriers when Alice calls from VoIP phone	VOIP ISP (build by observation)	VOIP Service Provider Name. Query online database to determine VOIP service provider associated with "From" number or "P-Asserted-Identity" of Headers 210.
Network Topology: Network-Induced Effect	Number of servers traversed from Alice to Bob or from Spoofing Caller to Bob	Max-Forwards (build by observation)	The value of Max-Forwards 509 or the value of Max-Forwards 559 will appear in Headers 210.
Social	Who Bob Calls	Bob's Address Book	Contact List 511

Legitimate Flow, Evaluation by Bob

[0074] FIG. **3**B illustrates an exemplary message flow corresponding to the path **100** of FIG. **3**A. Alice's device forms a message **301**, an instance of the message **204** including FROM and/or P-Asserted-Identity fields (also see Table 1) from which a Caller ID value **302** indicating the caller name Alice or the phone number of Alice's device can be derived.

[0075] The message **301**, as created at the calling device **101**, can include session protocol data related to the media session that Alice would like to establish. In addition, the headers **210** of the message, as created at the calling device **101**, may include LTE VoLTE parameters related to capabilities. The message **301** can also include user-to-user information (UUI) headers describing the calling device **101**. The message body of the message **301**, in the form of SDP **211**, can include session protocol data such as VoLTE parameters related to QoS such as preconditions. Vendor equipment identification may occur in SDP **211**. Exemplary session protocol data are indicated under the nature annotation "Protocol" in the first column of Table 1.

[0076] After formation in the calling device **101**, the message **301** is sent, as indicated by the arrow **304**, to the originating network **107** in which the server **131** updates one or more fields of the message. The server **131** may add number portability information such as an rn value to a header value of the message **301**. Generally, rn can be considered to be routing information as indicated under the nature annotation "Routing" in the first column of Table 1.

[0077] The server **131** may also add other fields such as VIA header entries which reveal network topology information. Infrastructure vendor equipment types may be also placed in header data by the server **131**. The server **131** will decrement MAX-FORWARDS. Vendor equipment types and MAX-FORWARDS are indicated under the annotation "Network Topology" in the first column of Table 1.

[0078] As shown in FIG. **3**B, the message **301** is then sent (arrow **306**) toward the terminating network **117**. The message may traverse other networks such as Primary Network **309** (FIG. **3**A), where MAX-FORWARDS will be decremented by each forwarding server. Terminating network **117** includes server **181**, which will also decrement MAX-FORWARDS when forwarding the message **301**. The terminating network **117** will route the message internally, for example through an IMS network including the server **181** to a 4G network (3GPP LTE) including an eNodeB, and the eNodeB will deliver the message **301** to Bob at called device **111**.

[0079] The called device **111** will then evaluate the consistency of the message **301** with respect to one or more of the items in Table 1. For example, the called device **111**, in some embodiments, fetches one or more templates indicating aspects that should be present in the message **301**. This evaluation can include a network lookup using an online query based on the identity represented in the FROM or P-Asserted-Identity headers of the message **301**. The result of the look-up is an obtained carrier identifier. The called device, in some embodiments, evaluates one or more network topology attributes of the message **301** based on the obtained carrier identifier. Acceptable values of the network topology information can be obtained from the database **112**. Entries of the database **112** are established based on published standards, industry-knowledge of equipment types and network topologies and carrier-specific information related to called device **111**. In some embodiments, the database **112** is refreshed on an ongoing basis.

[0080] The called device **111** in some embodiments, evaluates the MAX-FORWARDS value in the received version of the message **301**. If the MAX-FORWARDS value is in an acceptable range, then this particular test does not indicate a warning is needed.

[0081] In the situation of FIG. **3**B, the calling device is truly Alice's device and the Caller ID value **302** is provided on the display screen of called device **111**. Bob accepts the call, and after additional signaling (not shown), media session **311** is established.

Flow Originating from Spoofing Caller, More on Evaluation by Bob

[0082] FIG. **3**C illustrates the message flow of path **150** in which the spoofing caller has used spoofer device **151** in the activity **352** to create a message **351** in which identity information falsely indicating Alice has been placed, shown as Caller ID **302**. Spoofer device **151** sends (arrow **353**) the message **351** to a VOIP GW **157**. The VOIP GW **157** updates some fields in the message **351**. One of these updates may indicate the VOIP GW **157** network address or VOIP internet service provider (ISP) name in the format of a SIP address. Message **351** is then sent toward the terminating network **117** possibly through the Secondary Network **159** (FIG. **3**A). Called device **111** of Bob then performs activity **358** and evaluates the consistency of the received message

351. One or more rows of Table 1 may be checked using the database **112** to determine a consistency outcome or a consistency score. After determining a consistency score, the called device, in some embodiments, obtains a consistency decision based on a threshold. The consistency score, in some embodiments, includes comparing the Caller ID information **302** with Bob's address book.

[0083] In some embodiments, the called device **111** determines the identity of the originating network **107** (obtained carrier identity) based on the Caller ID value **302** (which may be derived from the FROM or P-Asserted-Identity fields). The called device **111** then can check an rn value in the P-Asserted-Identity field to see if it is in a set of rn values expected for the obtained carrier identity. If there is a match, a consistency outcome has a value of True, and no warning is given (this would be for FIG. **3**B). If there is a mismatch (conflict), that is none of the possible rn values for the obtained carrier identity are found in the P-Asserted-Identity header, then the consistency outcome has a value of False, and a warning is given. In some embodiments, a consistency score is based on two or more attributes from Table 1. For example, a consistency score, in some embodiments, is based on Max-Forwards, P-Asserted-Identity, and the UUI value. The number of these headers having a value inside of a normal range or matching an entry of expected set is summed to create the consistency score. The consistency score is then compared with a consistency threshold. If the score meets or exceeds the threshold, then a consistency decision indicates that the message is probably not from a spoofing caller. Otherwise, a warning is provided to Bob.

[0084] In FIG. **3**C, for example, the activity **358** indicates by a consistency outcome or consistency decision that Bob should be warned. A warning indication **359** is provided to Bob at **360**. Bob can then decline the media session **361** as indicated.

Routing Number Logic

[0085] FIG. **4**A illustrates exemplary logic **400** associated with the activity of the called device in FIGS. **3**A, **3**B, and **3**C, according to some embodiments. **401** indicates that the logic is at a called device. At **402**, the called device receives a SIP INVITE including a caller ID value (based on one or more header fields of the SIP INVITE). At **403**, the called device obtains a network, operator or carrier identifier based on the Caller ID value. Throughout this application the Caller ID value may be based on associated underlying data from one or more headers of the SIP INVITE. Continuing at **403**, the called device selects a set of number portability information from a database of the called device based on the obtained carrier identifier. At **404**, the called device determines a routing number, rn, from the SIP INVITE. At **405**, the called device determines whether the determined rn value is a member of the set of number portability information. If yes, the logic flows to **406** and the called device displays the caller ID value on the called device. If no, the logic flows to **407** and a warning indication is provided. If a warning is provided, the Caller ID value obtained from the SIP INVITE is in doubt, or in other words, suspect. In some embodiments, the suspect caller ID value is also displayed in conjunction with the warning.

Logic Involving Social Data

[0086] FIG. **4**B illustrates exemplary logic **420** including a social data aspect. **421** indicates that the logic takes place at a called device. At **422**, the called device receives a SIP INVITE including a Caller ID value. At **423**, the called device determines a network operator or carrier identifier associated with the Caller ID value. At **424**, the called device determines call trace data (also called record information) from the SIP INVITE and/or social data, based on the Caller ID, from the called device. At **425**, the called device compares the call trace data and/or social data with the network operator data (carrier identifier) to determine a consistency value. At **426** the consistency value is analyzed to determine whether it indicates that the SIP INVITE may be from a spoofing caller.

Illustrating Origins of Some Call Trace Data

[0087] FIG. **5** associates selected call trace data of the fifth column ("Example") in Table 1 with entities of FIG. **3**A that originate or update the call trace data. At the time that a SIP INVITE is received by the called device **113**, there is substantial uncertainty as to whether the SIP INVITE originated with Alice (more abstractly "calling party **103**") or with the spoofing caller **153**.

[0088] As an example of a parameter which occurs with a range of values, headers **210** of the message **204** includes a Max-Forwards value. The called device **111** is initially uncertain; the Max-Forwards value of the headers **210** may have been affected by Primary Network **109** (the desired situation). In other words, the observed value may be the result of message **204** having passed through Primary Network **109** (this hypothesis refers to the observed value as Max-Forwards **509**). A default initial value provided by the IETF for Max-Forwards is 70 (e.g., at calling device **101**). Field tests indicate that a message **204** arriving from Alice may have an observed Max-Forwards value of 57 for a VoLTE call from Alice, values of 47, 62, or 43 for a 2G (e.g., GSM) call from Alice, or a value of 62 for a 3G (e.g., WCDMA) call from Alice. As the logic of FIGS. **1**A, **4**A, and **4**B shows, the called device will evaluate the received message **204** to estimate the likelihood (or decide or categorize) that the message **204** actually originated with a spoofing caller and passed through some other network (Secondary Network **159**) in FIG. **5**. In the spoofing caller hypothesis, the observed value of Max-Forwards in the Headers **210** is called Max-Forwards **559**. Field tests indicate that a call from a spoofing caller may have a Max-Forwards value anywhere in a range from 22 to 108. That is, when message **204** originates with a spoofing caller, the message may pass through many hops and also the MAX-FORWARDS value at the origin (spoofer device **151**) may be higher than 70.

[0089] Originating network **107** may insert number portability information into fields of the P-Asserted-Identity header of Headers **210**. This number portability information can include rn (routing number, a 10 digit number that corresponds to the name of a switch or server) and oli (oli refers to original line information). Example values of oli are: i) 00 (POTS), ii) 02 (ANI failure), and iii) 62 (wireless/cellular PCS (type 2). FIG. **5** illustrates this insertion as RN **507**. Called device **111** can parse out the rn value from the Headers **210** and see if it corresponds to an originating network, where the originating network is associated with the Caller ID number. Because the insertion of RN **507** by originating network **107** cannot be faked by the spoofing caller **153**, a positive association of the observed RN value

with the Caller ID indicates almost certainly that the message **204** originated from Alice.

[0090] The calling device may include user agent (UA) information in a user-user-information (UUI) field of the Headers **210** of the SIP message. This UA information can indicate a smartphone manufacturer and operating system version of the calling device **101**. Since the spoofer device **151** is often a computer and not a smartphone, the UA information may be present in most messages from Alice (UA **501**) but absent from messages from spoofer device **151**. In the case of a spoofing caller, the UA information may contain information about the spoofer device **151** (for example, personal computer type) or information about the SIP stack being used by the spoofer device **151**. This information helps indicate that message Bob received is from a VOIP caller, and possibly that VOIP caller may be a spoofing caller.

[0091] Alice may make a VOIP call with calling device **101** through a VOIP gateway (GW). This could be for example, using Wi-Fi (IEEE 802.11), not shown in FIG. **5**. A message establishing a VOIP call may include a VOIP GW name in the SDP **211**. If the VOIP GW name is not associated with the carrier identifier for calling device **101**, then this is an indication that the call may not be from Alice. For example, GW Name **557** of FIG. **5** may be a recognized gateway name which is not associated with the carrier identifier of Alice. The occurrence of such a name is a strong indication that Bob should be warned that message **204** may not be from Alice. That is, Bob should be warned that the call may be spoofed.

[0092] An example of social data is a contact list **511** shown as within the database **112**. The Caller ID value, in some embodiments, is compared with the contact list **511** to determine whether Bob is aware of the phone number (Caller ID value) or has received a call from this number in the past.

Call Forwarding Scenario

[0093] Bob may receive message **204** after message **204** has been forwarded by a forwarding device. FIG. **6** illustrates a path **600** in which a SIP INVITE from Alice has been forwarded from a forwarding device **601** on to network (here called Via Network **607**) and then on to the terminating network **117** and finally to called device **111**. FIG. **6** also illustrates a path **650** in which the spoofer device **151** has sent a message to Bob via a forwarding device **651**. The network serving forwarding device **651** is not shown (for example, generally another network like **607** is serving forwarding device **651**). For example, Alice, Bob, and the spoofing caller **153** may be in a first country, for example, China with a country code of '86', and the forwarding device **601** and the forwarding device **651** be in a second country, for instance, the United States with a country code of '1'. In some instances, there is no forwarding device **651** but the spoofer device **151** formats the message **204** such that a forwarding event appears to have occurred.

[0094] In some instances, network topology data associated with originating network **107** is obscured or deleted by the Via Network **607**. In some instances, data about Calling Device **101** is limited or non-existent after the forwarding by the forwarding device **601**. Because there are fewer templates from Table 1 to draw on in the call-forwarding scenario, additional checks or measurements are made, in some embodiments, to determine whether Bob should be warned when message **204** has been routed through a forwarding device. One of these checks is to see if the Caller ID of the forwarding device is in Bob's phonebook contacts (also referred to as address book). It is unlikely that spoofing caller **153** is aware of the parties that Bob would expect to be forwarding calls to Bob. Thus, phone number information of forwarding device **651** is unlikely to be in Bob's phonebook contacts or address book. If message **204** has been forwarded and the Caller ID of the forwarding device is not in Bob's phonebook, then called device **111** will provide Bob with a warning indication about the received SIP INVITE **204** before permitting Bob to establish a media session based on the received SIP INVITE **204**.

Templates, Measures, and Consistency Analysis

[0095] FIG. **7** illustrates exemplary data and operations **700** for parsing the SIP INVITE **204**, applying templates, and providing measures to a consistency analysis operation **731**. The goal is to determine whether a warning indication should be provided to Bob. The templates are representative of the templates of Table 1 and are found in database **112**. Operations **701**, **702**, **703** and **704** parse information from the message **204** and provide it to operations **711**, **712**, **713**, and **714** which use templates to compare with the information and output measures to provide to the consistency analysis **731**. An operation may also be referred to herein as an activity. The measures, in some embodiments, are Boolean values such as True or False. In some embodiments, the measures also include a non-asserted value when the operation is unable to ascertain a True or False value. The measures, in some embodiments, are arithmetic values such as, for a given template, integers that count or indicate the number of matches with the template or a count of the number of mismatches with the template (mismatches may be counted using, for example, votes with each vote having a value of −1). In some embodiments some measures are Boolean and some are arithmetic. Some embodiments do not determine all measures.

[0096] Operation **729** determines a Caller ID value and performs an on-line query to determine a network associated with the calling party and obtains a carrier identifier **730**.

[0097] Operation **701** parses one or more portions of information to be compared with a session protocol template at operation **711**. The one or more portions correspond to capabilities expressed within a header field, a UUI header field, preconditions expressed in SDP, request disposition header field, receive info header field and codec SPD information. The session protocol template is applied at **711** and may be based on the carrier identifier **730**. The result of **711** is a session measure **721** that is provided to consistency analysis **731**.

[0098] Operation **702** parses out vendor equipment identifiers, VOIP ISP identifiers, and Max-Forward values. These are compared with a network topology template at operation **712** and the resulting topology measure is provided to the consistency analysis **731**.

[0099] Operation **703** parses out RN and compares it with a routing template at operation **713** to provide a routing measure **723**. In some embodiments, **703** and **713** correspond to operations **403**, **404** and **405** of FIG. **4**A with **723** being a Boolean variable having a value of True if the parsed rn value from the message **204** matches a candidate rn value associated with the carrier identifier **730**.

[0100] Operation **704** determines a Caller ID value based on information in the SIP INVITE **204**. For example, the Caller ID value may be a telephone number or caller name parsed from the "FROM" or "P-Asserted-Identity" headers. Operation **714** applies a social template such Bob's phonebook and provides a social measure **724** to the consistency analysis **731**.

[0101] The consistency analysis **731** acts on one or more of the measures **721**, **722**, **723**, and **724** to provide a consistency score **733** and/or a consistency outcome **735**. The consistency outcome **735**, in some embodiments, is a Boolean variable or possibly a value from the set {True, False, Non-asserted}. The consistency score **733**, in some embodiments, is an integer that represents a score describing how the message **204** compares with values that would be expected for the various headers, SDP, and/or social data if message **204** was truly sent by Alice. Consistency threshold comparison **734**, in some embodiments, represents an operation in the consistency score **733** is compared with a threshold. If the consistency score **733** meets or exceeds the threshold, a consistency decision **736** takes the Boolean value True and no warning indication is provided to Bob. In some embodiments, the consistency score **733** is provided to Bob. Consistency outcome **735** is already a True or False value. If either consistency outcome **735** or consistency decision **736** is False, a warning indication is provided to Bob, in some embodiments. In some embodiments, consistency outcome **735** or **736** may not both be determined.

[0102] FIG. **8** provides further details of consistency analysis **731**, according to some embodiments. Operation **801** determines whether a definite outcome has been determined by any of the operations **711**, **712**, **713**, or **714**. A definite outcome of False from any measure will lead to a warning indication at **813**, in some embodiments. A definite outcome of True from any measure will lead to no warning at **813**, in some embodiments. If there is no definite outcome, the initial score **803** representing a set of integers (non-Boolean measures) are provided to **807** and a sum of a subset of the measures is obtained to produce the score **809**. Score **809** may be the output consistency score **735** or score **809** may lead to a thresholding test at **811** and if the result is indeterminate, further measures may be combined to produce the consistency score **735**. In either case, the consistency score **735** is finally presented for a comparison at **734** as described with respect to FIG. **7** to produce a consistency decision **736**, in some embodiments. If **733** or **736** indicate that the message **204** is from a spoofing caller or likely, in the sense of consistency analysis **731**, from a spoofing caller, then a warning indication is provided to Bob after operation **813**.

Logic, IMS versus VOIP

[0103] FIG. **9** provides exemplary logic **900** for processing a SIP INVITE message such as message **204** described earlier and with respect to Table 1. At **901**, a called device receives a SIP INVITE message sent by a requester. At **903**, a carrier identifier is obtained based on a "FROM" header or other identifier in the message. At **905**, templates are determined. At **907**, the selected templates are used to obtain measurement values. At **909**, if, based on the measurement values, the INVITE message is found to correspond to a VOIP call, the logic flows to **913**. Otherwise the INVITE corresponds to an IMS call and the logic flows to **911** and a Caller ID value is displayed on a display screen of the called device. At **913**, if the INVITE message is found to have been routed by a VOIP carrier associated with the carrier identifier, then the logic also flows to **913**. Otherwise, the logic flows to **913** and a warning indication is provided on the display screen of the called device. In some embodiments, a Caller ID based on the received message is also displayed at **915**.

Logic, Applying Several Templates

[0104] FIGS. **10**A and **10**B provide exemplary logic **1000** and **1050** using templates from a database and header fields and/or SDP of a received message, in particular, a received SIP INVITE such as message **204** described earlier and templates described with respect to Table 1. For brevity the received SIP INVITE will be referred to as "the message" for FIGS. **10**A-**10**B. Operations **901**-**907** are as in FIG. **9**. At **1001**, the check "VOIP Route?" determines whether information from the message matches with a known VOIP server name. If a match is found, the logic flows to **1003**. From **1003**, the logic flows to **1005** of FIG. **10**B. If no, the logic flows to **1007**. The check "IMS Route?" determines whether a known IMS server is identified in, for example, the VIA headers of the message. If yes, the logic completes with a definite outcome at **1009** and no warning indication. If no, the logic flows to **1011** to determine whether VOIP-specific parameters are included in message headers or the SDP of the message. If yes, the logic flows to **1005**, otherwise to **1013**.

[0105] At **1013**, the check "IMS Capability?" is resolved by examining header fields of the message. If IMS-specific parameters are found in one or more header fields then the logic flows to **1009** and no warning indication is provided. Otherwise, the logic flows to **1015** and a check concerning UUI and VOIP. If a UUI header indicates VOIP, then the logic flows to **1005** on FIG. **10**B. Otherwise, the logic flows to **1017** and a check on UUI and IMS. If a UUI header indicates IMS, then the logic flows to **1009** and no warning indication is provided. Otherwise, the logic flows to **1021**.

[0106] At **1021**, an SDP check touches on VOIP preconditions. If the SDP indicates preconditions for a VOIP call, the logic flows to **1005** of FIG. **10**B. Otherwise, the logic continues to **1023**. At **1023**, an SDP check evaluates codec types in the offer of the offer-submit model. If an IMS-specific codec is identified, then the logic flows to **1009** and no warning indication is provided. Otherwise, the logic flows to **1025**. At **1025** an SDP check searches for a VOIP-specific gateway. If one is identified in the SDP of the message, then the logic flows to **1005** of FIG. **10**B. Otherwise, the logic flows to **1027** and a check for a VOIP-only header in the message. If a VOIP-only header is present, the logic flows to **1005** of FIG. **10**B. Otherwise, the logic flows to **1029** of FIG. **10**B. This completes the description of FIG. **10**A.

[0107] At **1005** on FIG. **10**B, the logic flows to **1051**. At **1051**, the logic determines the VOIP voice carrier (also called VOIP carrier herein) indicated by the message. At **1053**, one or more VOIP carriers associated with the carrier identifier (the latter recovered by an on-line query based on a Caller ID value parsed from "FROM" or "P-Asserted-Identity") are compared with the VOIP carrier indicated by the message. If there is a discrepancy (no match), then the logic flows to **1055** and a warning indication is provided to Bob. If there is no discrepancy, the logic flows to **1029** and on to **1031**.

[0108] At **1031**, queries related to call-forwarding begin. At **1031**, the message is checked for a diversion header. If there is no diversion header, the logic flows to **1041**, otherwise to **1033**. At **1041**, a check is made to determine whether a history-info header indicates that the call may have been forwarded. If the result is yes, the logic flows to **1033**, while if the result is no, the logic determines there are no discrepancies, flows to **1043** and displays a Caller ID value to Bob.

[0109] At **1033**, a check is made for a call forwarding indication in the diversion header. If the result is no, logic completes with **1043**. If yes, the logic flows to **1034**. At **1034**, a telephone number of the forwarding device is determined by parsing from a VIA header of the message. At **1035**, a check is made to determine if the forwarding device is in Bob's address book. If no, the logic flows to **1055** and a warning indication. If the forwarding number is found, the logic flows to **1037** and the forwarding number or party name is provided on the display screen to Bob.

Logic Including Number Portability Values

[0110] FIG. **11** provides exemplary logic **1100** for processing a SIP INVITE message such as message **204** described earlier and with respect to Table 1. At **1101**, a called device receives a SIP INVITE message sent by a requester. At **1103**, a carrier identifier is obtained based on a "FROM" header or other identifier in the message. At **1105**, templates are selected. At **1109** the headers and SDP of the message are checked to see if a known VOIP gateway is identified. If no, the logic flows to **1121**, while if yes, the logic flows to **1111**. At **1111**, the address book in the called device is searched for a Caller ID value obtained from the message (using "FROM" or "P-Asserted-Identity"). If no match is found, the logic flows to **1113** and a warning indication is provided. If a match is found, the logic flows to **1115**. At **1115**, a check is made to see whether the carrier identifier of the present call matches a stored carrier identifier associated with this Caller ID value from a call history stored in the called device. If the carrier identifier is the same identifier as the last time a call was received with this Caller ID value, the logic flows to **1117**, otherwise to **1113** (warn Bob).

[0111] At **1121**, the message is checked for VOIP capability indications in one or more header fields. If there is VOIP capability, then the logic flows to **1111**, discussed above. If there is no VOIP capability information, then the logic flows to **1123** and a check is made in the message headers for VoLTE capability information. If VoLTE capability information is found, then the logic flows to **1125** to verify the caller's UE model and on to **1127** to display a Caller ID value. In some embodiments, operation **1127** also includes displaying a name of the carrier associated with the Caller ID value.

[0112] At **1131**, a check is made of number portability measurement values from, for example, a P-Asserted-Identity header of the message. If a 3G pattern is found (**1133**) or a 2G pattern is found, then the logic finishes at **1127** and displays a Caller ID value. Otherwise, the logic flows to **1137** and the Caller ID value is displayed.

[0113] Wireless devices, and mobile devices in particular, can incorporate multiple different radio access technologies (RATs) to provide connections through different wireless networks that offer different services and/or capabilities. A wireless device can include hardware and software to support a wireless personal area network ("WPAN") according to a WPAN communication protocol, such as those standardized by the Bluetooth® special interest group ("SIG") and/or those developed by Apple referred to as an Apple Wireless Direct Link (AWDL). The wireless device can discover compatible peripheral wireless devices and can establish connections to these peripheral wireless devices located in order to provide specific communication services through a WPAN. In some situations, the wireless device can act as a communications hub that provides access to a wireless local area network ("WLAN") and/or to a wireless wide area network ("WWAN") to a wide variety of services that can be supported by various applications executing on the wireless device. Thus, communication capability for an accessory wireless device, e.g., without and/or not configured for WWAN communication, can be extended using a local WPAN (or WLAN) connection to a companion wireless device that provides a WWAN connection. Alternatively, the accessory wireless device can also include wireless circuitry for a WLAN connection and can originate and/or terminate connections via a WLAN connection. Whether to use a direct connection or a relayed connection can depend on performance characteristics of one or more links of an active communication session between the accessory wireless device and a remote device. Fewer links (or hops) can provide for lower latency, and thus a direct connection can be preferred; however, unlike a legacy circuit-switched connection that provides a dedicated link, the direct connection via a WLAN can share bandwidth with other wireless devices on the same WLAN and/or with the backhaul connection from the access point that manages the WLAN. When performance on the local WLAN connection link and/or on the backhaul connection degrades, a relayed connection via a companion wireless device can be preferred. By monitoring performance of an active communication session and availability and capabilities of associated wireless devices (such as proximity to a companion wireless device), an accessory wireless device can request transfer of an active communication session between a direction connection and a relayed connection or vice versa.

[0114] In accordance with various embodiments described herein, the terms "wireless communication device," "wireless device," "mobile device," "mobile station," "wireless station", "wireless access point", "station", "access point" and "user equipment" (UE) may be used herein to describe one or more common consumer electronic devices that may be capable of performing procedures associated with various embodiments of the disclosure. In accordance with various implementations, any one of these consumer electronic devices may relate to: a cellular phone or a smart phone, a tablet computer, a laptop computer, a notebook computer, a personal computer, a netbook computer, a media player device, an electronic book device, a MiFi® device, a wearable computing device, as well as any other type of electronic computing device having wireless communication capability that can include communication via one or more wireless communication protocols such as used for communication on: a wireless wide area network (WWAN), a wireless metro area network (WMAN) a wireless local area network (WLAN), a wireless personal area network (WPAN), a near field communication (NFC), a cellular wireless network, a fourth generation (4G) LTE, LTE Advanced (LTE-A), and/or 5G or other present or future developed advanced cellular wireless networks.

[0115] The wireless device, in some embodiments, can also operate as part of a wireless communication system, which can include a set of client devices, which can also be referred to as stations, client wireless devices, or client wireless devices, interconnected to an access point (AP), e.g., as part of a WLAN, and/or to each other, e.g., as part of a WPAN and/or an "ad hoc" wireless network, such as a Wi-Fi direct connection. In some embodiments, the client device can be any wireless device that is capable of communicating via a WLAN technology, e.g., in accordance with a wireless local area network communication protocol. In some embodiments, the WLAN technology can include a Wi-Fi (or more generically a WLAN) wireless communication subsystem or radio, the Wi-Fi radio can implement an Institute of Electrical and Electronics Engineers (IEEE) 802.11 technology, such as one or more of: IEEE 802.11a; IEEE 802.11b; IEEE 802.11g; IEEE 802.11-2007; IEEE 802.11n; IEEE 802.11-2012; IEEE 802.11ac; or other present or future developed IEEE 802.11 technologies.

[0116] Additionally, it should be understood that the wireless devices described herein may be configured as multi-mode wireless communication devices that are also capable of communicating via different third generation (3G) and/or second generation (2G) RATs. In these scenarios, a multi-mode wireless device or UE can be configured to prefer attachment to LTE networks offering faster data rate throughput, as compared to other 3G legacy networks offering lower data rate throughputs. For instance, in some implementations, a multi-mode wireless device or UE may be configured to fall back to a 3G legacy network, e.g., an Evolved High Speed Packet Access (HSPA+) network or a Code Division Multiple Access (CDMA) 2000 Evolution-Data Only (EV-DO) network, when LTE and LTE-A networks are otherwise unavailable.

Representative Exemplary Apparatus

[0117] FIG. **12** illustrates in block diagram format an exemplary computing device **1200** that can be used to implement the various components and techniques described herein, according to some embodiments. In particular, the detailed view of the exemplary computing device **1200** illustrates various components that can be included in the called device **111**. As shown in FIG. **12**, the computing device **1200** can include a processor **1202** that represents a microprocessor or controller for controlling the overall operation of computing device **1200**. The computing device **1200** can also include a user input device **1208** that allows a user of the computing device **1200** to interact with the computing device **1200**. For example, the user input device **1208** can take a variety of forms, such as a button, keypad, dial, touch screen, audio input interface, visual/image capture input interface, input in the form of sensor data, etc. Still further, the computing device **1200** can include a display **1210** (screen display) that can be controlled by the processor **1202** to display information to the user (for example, information relating to incoming, outgoing, or active communication session). A data bus **1216** can facilitate data transfer between at least a storage device **1240**, the processor **1202**, and a controller **1213**. The controller **1213** can be used to interface with and control different equipment through an equipment control bus **1214**. The computing device **1200** can also include a network/bus interface **1211** that couples to a data link **1212**. In the case of a wireless connection, the network/bus interface **1211** can include wireless circuitry, such as a wireless transceiver and/or baseband processor.

[0118] The computing device **1200** also includes a storage device **1240**, which can comprise a single storage or a plurality of storages (e.g., hard drives), and includes a storage management module that manages one or more partitions within the storage device **1240**. In some embodiments, storage device **1240** can include flash memory, semiconductor (solid state) memory or the like. The computing device **1200** can also include a Random Access Memory ("RAM") **1220** and a Read-Only Memory ("ROM") **1222**. The ROM **1222** can store programs, utilities or processes to be executed in a non-volatile manner. The RAM **1220** can provide volatile data storage, and stores instructions related to the operation of the computing device **1200**. The computing device **1200** also includes a secure element (SE) **1250**. The SE **1250** provides SIM and/or eSIM authentication and encryption operations.

[0119] The various aspects, embodiments, implementations or features of the described embodiments can be used separately or in any combination. Various aspects of the described embodiments can be implemented by software, hardware or a combination of hardware and software. The described embodiments can also be embodied as computer readable code on a computer readable medium. The computer readable medium is any data storage device that can store data which can thereafter be read by a computer system. Examples of the computer readable medium include read-only memory, random-access memory, CD-ROMs, DVDs, magnetic tape, hard storage drives, solid state drives, and optical data storage devices. The computer readable medium can also be distributed over network-coupled computer systems so that the computer readable code is stored and executed in a distributed fashion.

[0120] The foregoing description, for purposes of explanation, used specific nomenclature to provide a thorough understanding of the described embodiments. However, it will be apparent to one skilled in the art that the specific details are not required in order to practice the described embodiments. Thus, the foregoing descriptions of specific embodiments are presented for purposes of illustration and description. They are not intended to be exhaustive or to limit the described embodiments to the precise forms disclosed. It will be apparent to one of ordinary skill in the art that many modifications and variations are possible in view of the above teachings.

What is claimed is:

1. A method comprising:

at a mobile device:

receiving, from a calling device, a message including an identifier;

determining a portion of identifying data parsed from the message, wherein the portion of identifying data includes one or more of: i) session protocol data, ii) network topology data, and/or iii) routing data;

retrieving, from a database and based on the identifying data, template data;

performing a comparison of the template data with the portion of identifying data; and

displaying, on a user interface of the mobile device and based on the comparison, a warning indication about the message.

2. The method of claim **1**, wherein the mobile device includes the database in its entirety.

3. The method of claim 1, further comprising:
displaying on the user interface a Caller ID value, wherein the Caller ID value is based on the identifier.

4. The method of claim 1, wherein the session protocol data includes one or more of: i) capabilities data, ii) user-to-user data, iii) precondition data, iv) request disposition data, v) in-call notification data, or vi) codec data.

5. The method of claim 1, wherein the network topology data includes one or more of: i) a vendor equipment identifier, ii) an internet service provider (ISP) identifier, or iii) a network hop down-count value.

6. The method of claim 1, wherein the routing data includes a routing number (rn).

7. The method of claim 1, wherein the performing further comprises:
producing a consistency score; and
comparing the consistency score to a consistency threshold to produce a decision on an adequate degree of matching.

8. The method of claim 7, wherein the consistency score represents a number of matches between the template data and the portion of identifying data.

9. A mobile device comprising:
a user interface;
a memory; and
one or more processors, wherein the memory comprises instructions that when executed by a processor of the one or more processors cause the mobile device to perform operations comprising:
receiving, from a calling device, a message including an identifier,
determining a portion of identifying data parsed from the message, wherein the portion of identifying data includes one or more of: i) session protocol data, ii) network topology data, and/or iii) routing data,
retrieving, from a database and based on the identifying data, template data,
performing a comparison of the template data with the portion of identifying data, and
displaying, on a user interface of the mobile device and based on the comparison, a warning indication about the message.

10. The mobile device of claim 9, wherein the memory includes the database in its entirety.

11. The mobile device of claim 9, wherein the retrieving comprises retrieving at least a portion of the template data from an online server.

12. The mobile device of claim 9, further comprising:
displaying on the user interface a Caller ID value, wherein the Caller ID value is based on the identifier.

13. The mobile device of claim 9, wherein the routing data includes a routing number (rn).

14. The mobile device of claim 9, wherein the network topology data includes one or more of: i) a vendor equipment identifier, ii) an internet service provider (ISP) identifier, or iii) a network hop down-count value.

15. A method comprising:
at a mobile device:
receiving, from a calling device, a message including an identifier;
determining a portion of identifying data parsed from the message;
retrieving, from a database and based on the identifying data, template data;
performing a first comparison of the template data with the portion of identifying data;
determining, based on the first comparison, that the message may have been routed through a forwarding device;
parsing routing data from the message;
performing a second comparison of social data retrieved from a memory of the mobile device with the routing data; and
displaying, on a user interface of the mobile device and based on the second comparison, a warning indication about the message.

16. The method of claim 15, wherein the message is a session initiation protocol (SIP) INVITE and the routing data is associated with a VIA header field of the message.

17. The method of claim 15, wherein the portion of identifying data includes one or more of: i) session protocol data, ii) network topology data, and/or iii) second routing data.

18. The method of claim 15, wherein the message is a circuit-switched (CS) call setup message.

19. The method of claim 15, wherein the warning indication informs a user of the mobile device the message may be associated with a spoofing caller.

20. The method of claim 19, wherein the displaying further comprises displaying a Caller ID value based on the identifier.

21. A mobile device comprising:
a user interface;
a memory; and
one or more processors, wherein the memory comprises instructions that when executed by a processor of the one or more processors cause the mobile device to perform operations comprising:
receiving, from a calling device, a message including an identifier,
determining a portion of identifying data parsed from the message,
retrieving, from a database and based on the identifying data, template data,
performing a first comparison of the template data with the portion of identifying data,
determining, based on the first comparison, that the message may have been routed through a forwarding device,
parsing routing data from the message,
performing a second comparison of social data retrieved from a memory of the mobile device with the routing data, and
displaying, on a user interface of the mobile device and based on the second comparison, a warning indication about the message.

22. The mobile device of claim 21, wherein the message is a session initiation protocol (SIP) INVITE and the routing data is associated with a VIA header field of the message.

23. The mobile device of claim 21, wherein the displaying further comprises displaying a Caller ID value based on the identifier.

24. The mobile device of claim 21, wherein the portion of identifying data includes one or more of: i) session protocol data, ii) network topology data, and/or iii) second routing data.

25. The mobile device of claim 24, wherein the performing a first comparison further comprises:

producing an indeterminate outcome; and

determining, based on the indeterminate outcome, that the routing data should be parsed from the message.

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