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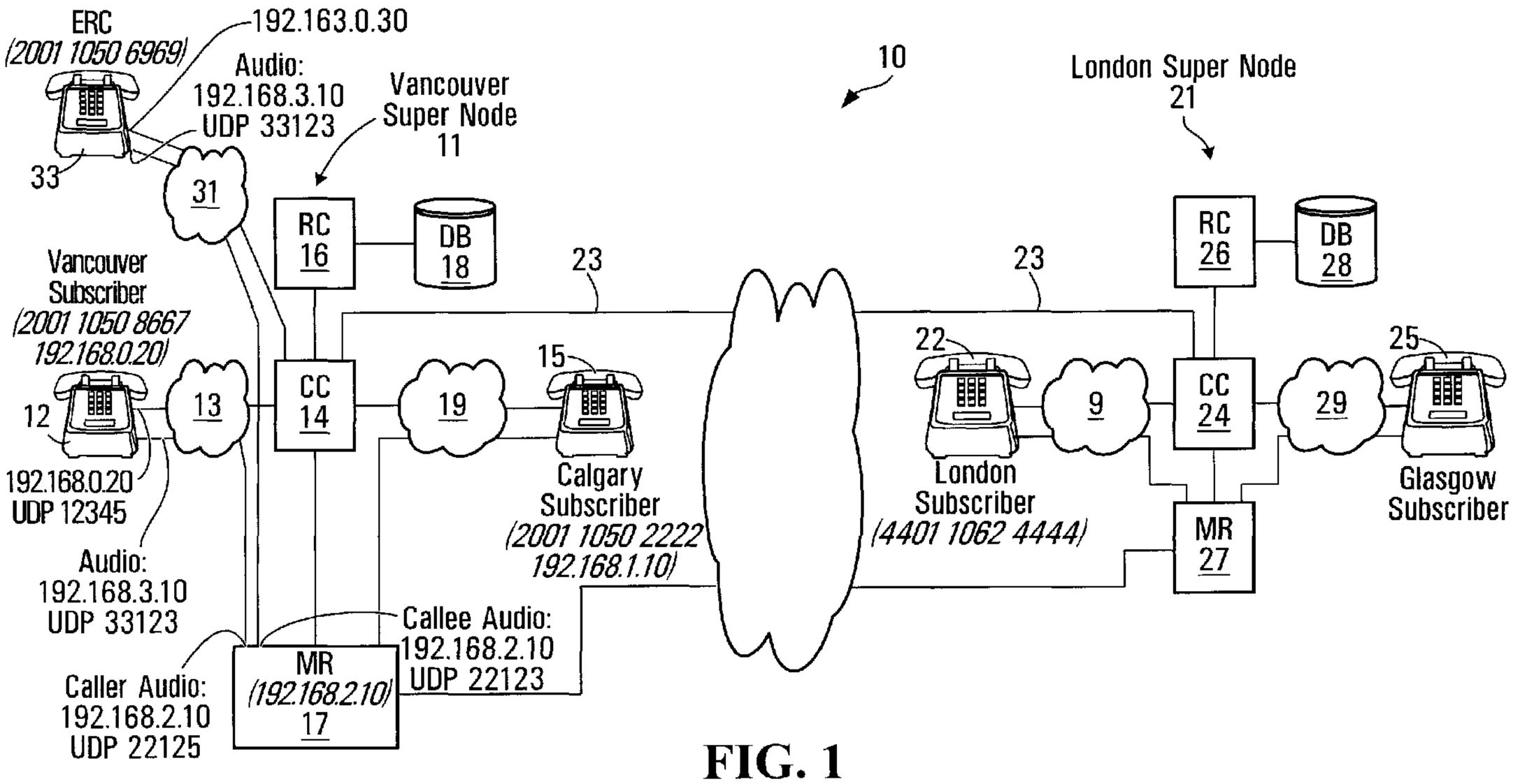

FIG. 1

(57) Abrégé/Abstract:
In accordance with one aspect of the invention there is provided a process for handling emergency calls from a caller in a voice over IP system. The process involves receiving a routing request message including a caller identifier and a callee identifier. The process also involves setting an emergency call flag active in response to the callee identifier matching an emergency call identifier pre-associated with the caller. The process further involves producing an emergency response center identifier in response to the emergency call identifier. The process also involves determining whether the caller identifier is associated with a pre-associated direct inward dialing (DID) identifier. The process further involves producing a direct inward dialing (DID) identifier for the caller by associating a temporary DID identifier with the caller identifier when the emergency call flag is active and it is determined that the caller has no pre-associated DID. The process also involves producing a routing message including the emergency response center identifier and the temporary DID identifier for receipt by a routing controller operable to cause a route to be established between the caller and the emergency response center.

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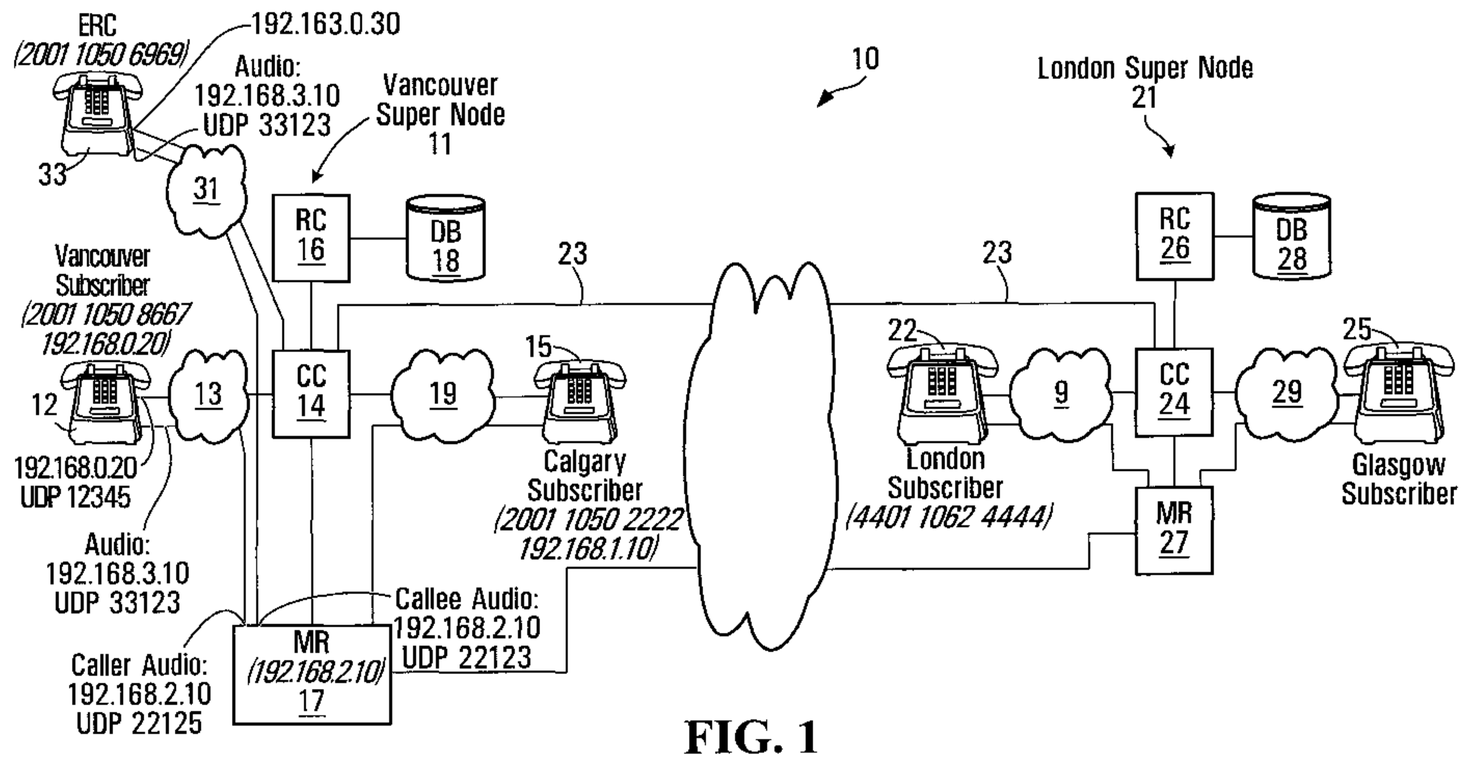

FIG. 1

(57) **Abstract:** In accordance with one aspect of the invention there is provided a process for handling emergency calls from a caller in a voice over IP system. The process involves receiving a routing request message including a caller identifier and a callee identifier. The process also involves setting an emergency call flag active in response to the callee identifier matching an emergency call identifier pre-associated with the caller. The process further involves producing an emergency response center identifier in response to the emergency call identifier. The process also involves determining whether the caller identifier is associated with a pre-associated direct inward dialing (DID) identifier. The process further involves producing a direct inward dialing (DID) identifier for the caller by associating a temporary DID identifier with the caller identifier when the emergency call flag is active and it is determined that the caller has no pre-associated DID. The process also involves producing a routing message including the emergency response center identifier and the temporary DID identifier for receipt by a routing controller operable to cause a route to be established between the caller and the emergency response center.

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EMERGENCY ASSISTANCE CALLING FOR VOICE OVER IP COMMUNICATIONS SYSTEMS

BACKGROUND OF THE INVENTION

Field of Invention

This invention relates to emergency assistance calling, voice over internet protocol communications and methods and apparatus for emergency assistance calling for voice over IP data communications.

An essential feature of traditional telephone systems (PSTN) is the ability of its subscribers to dial a universal emergency number (911 in North America) to access a host of emergency services such as fire, police and ambulance. Because of the hierarchical nature of telephone networks and numbering schemes, a call coming from a specific telephone number on the PSTN network is automatically routed to a nearest Emergency Response Center (ERC) based on the area code and exchange code contained in the specific telephone number. Normally, the specific telephone number will be compliant with the E.**164** standard set by the International Telecommunication Union. When the call comes into the ERC, call information presended the ERC operator includes the phone number, and where available, the address associated with this phone number.

Since the late **1990**s, an enhanced emergency service (E**911**) was mandated for PSTN and cellular carriers in North America and elsewhere. In particular, with this enhanced service the information automatically provided to the ERC includes the physical location of the person calling, even where the caller is using a cellular telephone. Moreover, a callback functionality is integrated into E**911**-compliant systems allowing an ERC operator to call back the person who placed the emergency call even if the original phone call was disconnected or if the calling line became busy.

In the realm of VoIP networks, implementation of **911** and E**911** services often presents significant problems.

Even to provide basic **911** services, VoIP systems present a number of problems because they do not employ hierarchical numbering schemes, and the phone numbers assigned to VoIP system subscribers, while still in the E.**164** format, do not actually reflect the subscribers physical location via area code and exchange codes. As a result, a VoIP provider is not able to automatically route an emergency call to an ERC nearest to the subscriber. Because VoIP subscriber phone numbers are assigned from a bulk of phone numbers that VoIP providers purchase from wireline PSTN carriers, a VoIP **911** emergency services call coming into the ERC is not associated with a subscriber address that can be accessed by the ERC operator.

In addition, because VoIP systems are not based on the Signaling System **7** (SS**7**) protocol, they do not natively support special short phone numbers such as **911**. In particular, they do not natively support variable length phone number dialing, or dynamic translation of dialed universal phone numbers into actual destination phone numbers based on user attributes such as location or service type.

VoIP systems are also typically not able to comply with E**911** service requirements, for the same reasons they are not able to comply with regular **911** services.

In accordance with one aspect of the invention, there is provided a process for handling emergency calls from a caller in a voice over IP system. The method involves receiving a routing request message including a caller identifier and a callee identifier. The method also involves setting an emergency call flag active in response to the callee identifier matching an emergency call identifier pre-associated with the caller. The method further involves producing an emergency response center identifier in response to the emergency call

identifier. The method also involves determining whether the caller identifier is associated with a pre-associated direct inward dialing (DID) identifier. The method further involves producing a direct inward dialing (DID) identifier for the caller by associating a temporary DID identifier with the caller identifier when the emergency call flag is active and it is determined that the caller has no pre-associated DID identifier. The method also involves producing a routing message including the emergency response center identifier and the temporary DID identifier for receipt by a routing controller operable to cause a route to be established between the caller and the emergency response center.

Setting the emergency call flag active may involve retrieving a dialing profile associated with the caller and setting the emergency call flag active when the contents of an emergency call identifier field of the dialing profile match the callee identifier.

Determining whether the caller identifier is associated with a pre-associated DID identifier may involve searching a database for a DID record associating a DID identifier with the caller and determining that the caller identifier is associated with a pre-associated DID identifier when the record associating a DID identifier with the caller is found.

Associating a pre-assigned DID identifier with the caller identifier may involve copying the pre-associated DID identifier from the DID record to a DID identifier buffer.

Producing the routing message may involve causing the contents of the DID identifier buffer to define the DID identifier in the routing message.

Determining whether the caller identifier is associated with a pre-associated DID identifier may involve searching a database for a DID record associating a DID identifier with the caller and determining that the caller identifier is not

associated with a pre-associated DID identifier when a record associating a DID identifier with the caller is not found.

Associating a temporary DID identifier with the caller identifier may involve associating with the caller identifier a DID identifier from a pool of pre-determined DID identifiers.

Associating the DID identifier from the pool may involve associating a temporary DID record with the caller, the temporary DID record having a DID identifier field populated with the DID identifier from the pool.

Associating the DID identifier from the pool may involve copying the DID identifier from the temporary DID record to a DID identifier buffer.

The method may involve canceling the temporary DID record after a pre-defined period of time.

Producing the emergency response center identifier may involve obtaining an emergency response center identifier from an emergency response center field of the dialing profile associated with the caller.

Obtaining may involve copying an emergency response center identifier from the dialing profile associated with the caller to a routing message buffer such that the emergency response center identifier is included in the routing message.

Producing the routing message may involve causing the routing message to specify a maximum call time for the emergency call, the maximum call time exceeding a duration of an average non-emergency telephone call.

In accordance with another aspect of the invention, there is provided an apparatus for handling emergency calls from a caller in a voice over IP

system. The apparatus includes provisions for receiving a routing request message including a caller identifier and a callee identifier. The apparatus also includes setting provisions for setting an emergency call flag active in response to the callee identifier matching an emergency call identifier pre-associated with the caller. The apparatus further includes provisions for producing an emergency response center identifier in response to the emergency call identifier. The apparatus also includes provisions for determining whether the caller identifier is associated with a pre-associated direct inward dialing (DID) identifier. The apparatus further includes provisions for producing a direct inward dialing (DID) identifier for the caller including provisions for associating a temporary DID identifier with the caller identifier in response to the emergency call flag being active and the caller identifier not being pre-associated with direct inward dialing identifier. The provisions for producing a direct inward dialing (DID) identifier for the caller further include provisions for associating a pre-assigned DID identifier with the caller identifier when the caller identifier has no pre-associated direct inward dialing identifier. The apparatus also includes provisions for producing a routing message including the emergency response center identifier and the temporary DID identifier for receipt by a routing controller operable to cause a route to be established between the caller and the emergency response center.

The apparatus may further include provisions for accessing a database of dialing profiles associated with respective subscribers to the system, each of the dialing profiles including an emergency call identifier field and an emergency call center field and the setting provisions may comprise provisions for retrieving a dialing profile associated with the caller and for setting the emergency call flag active when the contents of the emergency call identifier field of the dialing profile match the callee identifier.

The apparatus may further include database accessing provisions for accessing a database including direct inward dialing (DID) records associated

with at least some subscribers to the system, each of the direct inward dialing records comprising a system username and a direct inward dialing number, and wherein the determining provisions comprise searching provisions for searching a database for a DID record associating a DID identifier with the caller. The determining provisions may be operably configured to determine that the caller identifier is associated with a pre-associated DID identifier when a record associating a DID identifier with the caller is found.

The apparatus may further include a DID identifier buffer and the provisions for associating a pre-assigned DID identifier with the caller identifier may comprise provisions for copying the pre-associated DID identifier from the DID record to the DID identifier buffer.

The provisions for producing the routing message may include provisions for causing the contents of the DID identifier buffer to define the DID identifier in the routing message.

The apparatus may further include database accessing provisions for accessing a database including direct inward dialing records associated with at least some subscribers to the system, each of the direct inward dialing records comprising a system username and a direct inward dialing number and the determining provisions may comprise searching provisions for searching a database for a DID record associating a DID identifier with the caller and wherein the determining provisions may be operably configured to determine that the caller identifier is not associated with a pre-associated DID identifier when a record associating a DID identifier with the caller is not found.

The apparatus may further include provisions for accessing a pool of pre-determined DID identifiers and the provisions for associating a temporary DID identifier with the caller identifier may comprise provisions for associating a

DID identifier from the pool of pre-determined DID identifiers with the caller identifier.

The provisions for associating the DID identifier from the pool may include provisions for associating a temporary DID record with the caller, the temporary DID record having a DID identifier field populated with the DID identifier from the pool.

The provisions for associating the DID identifier may include provisions for copying the DID identifier from the temporary DID record to a DID identifier buffer.

The apparatus may further include provisions for canceling the temporary DID record after a period of time.

The provisions for producing the emergency response center identifier may include provisions for obtaining an emergency response center identifier from an emergency response center field of the dialing profile associated with the caller.

The apparatus may include a routing message buffer and the provisions for obtaining may include provisions for copying the contents of the emergency response center field of the dialing profile associated with the caller to the routing message buffer such that the contents of the emergency response center field are included in the routing message.

The provisions for producing the routing message may include provisions for causing the routing message to include a maximum call time for the emergency call, the maximum call time exceeding a duration of an average non-emergency telephone call.

In accordance with another aspect of the invention, there is provided an apparatus for handling emergency calls from a caller in a voice over IP system. The apparatus includes an processor circuit operably configured to receive a routing request message including a caller identifier and a callee identifier. The processor circuit is also operably configured to set an emergency call flag active in response to the callee identifier matching an emergency call identifier pre-associated with the caller. The processor circuit is further operably configured to produce an emergency response center identifier in response to the emergency call identifier and to determine whether the caller identifier is associated with a pre-associated direct inward dialing (DID) identifier. The processor circuit is also operably configured to produce a direct inward dialing (DID) identifier for the caller by associating a temporary DID identifier with the caller identifier when the emergency call flag is active and it is determined that the caller identifier has no pre-associated DID identifier. The processor circuit is further operably configured to produce a routing message including the emergency response center identifier and the temporary DID identifier for receipt by a routing controller operable to cause a route to be established between the caller and the emergency response center.

The processor circuit may be operably configured to retrieve a dialing profile associated with the caller and to set the emergency call flag active when the contents of an emergency call identifier field of the dialing profile match the callee identifier.

The processor circuit may be operably configured to search a database for a DID record associating a DID identifier with the caller and to determine that the caller identifier is associated with a pre-associated DID identifier when the record associating a DID identifier with the caller is found.

The processor circuit may be operably configured to copy the pre-associated DID identifier from the DID record to a DID identifier buffer.

The processor circuit may be operably configured to cause the contents of the DID identifier buffer to define the DID identifier in the routing message.

The processor circuit may be operably configured to search a database for a DID record associating a DID identifier with the caller and to determine that the caller identifier is not associated with a pre-associated DID identifier when a record associating a DID identifier with the caller is not found.

The processor circuit may be operably configured to associate with the caller identifier a DID identifier from a pool of pre-determined DID identifiers.

The processor circuit may be operably configured to associate a temporary DID record with the caller, the temporary DID record having a DID identifier field populated with the DID identifier from the pool.

The processor circuit may be operably configured to copy the DID identifier from the temporary DID record to a DID buffer.

The processor circuit may be operably configured to cancel the temporary DID record after a period of time.

The processor circuit may be operably configured to obtain an emergency response center identifier from an emergency response center field of the dialing profile associated with the caller.

The apparatus may further a routing message buffer and the processor circuit may be operably configured to copy an emergency response center identifier from the dialing profile associated with the caller to the routing message buffer such that the emergency response center identifier is included in the routing message.

The processor circuit may be operably configured to cause the routing message to include a maximum call time for the emergency call, the maximum call time exceeding a duration of an average non-emergency telephone call.

In accordance with another aspect of the invention, there is provided a computer readable medium encoded with codes for directing a processor circuit to handle emergency calls from callers in a voice over IP system. The codes direct the processor circuit to receive a routing request message including a caller identifier and a callee identifier. The codes also direct the processor circuit to set an emergency call flag active in response to the callee identifier matching an emergency call identifier pre-associated with the caller. The codes further direct the processor circuit to produce an emergency response center identifier in response to the emergency call identifier. The codes also direct the processor circuit to determine whether the caller identifier is associated with a pre-associated direct inward dialing (DID) identifier. The codes further direct the processor circuit to produce a direct inward dialing (DID) identifier for the caller by associating a temporary DID identifier with the caller identifier when the emergency call flag is active and it is determined that the caller identifier has no pre-associated DID identifier. The codes also direct the processor circuit to produce a routing message including the emergency response center identifier and the temporary DID identifier for receipt by a routing controller operable to cause a route to be established between the caller and the emergency response center.

BRIEF DESCRIPTION OF THE DRAWINGS

In drawings which illustrate embodiments of the invention,

Figure **1** is a block diagram of a system according to a first embodiment of the invention;

Figure **2** is a block diagram of a caller VoIP telephone according to the first embodiment of the invention;

Figure **3** is a schematic representation of a SIP Invite message transmitted between the caller telephone and a call controller (CC) shown in Figure **1**;

Figure **4** is a block diagram of the call controller shown in Figure **1**;

Figure **5** is a flowchart of a process executed by the call controller shown in Figure **1**;

Figure **6** is a schematic representation of a routing controller (RC) Request message produced by the call controller shown in Figure **1**;

Figure **7** is a block diagram of a routing controller (RC) processor circuit of the routing controller shown in Figure **1**;

Figures **8**A-**8**D are flowcharts of a RC Request message handler executed by the RC processor circuit shown in Figure **7**;

Figure **9** is a tabular representation of a dialling profile stored in a database accessible by the RC shown in Figure **1**;

Figure **10** is a tabular representation of a dialling profile for a Vancouver caller using the caller telephone shown in Figure **1**;

Figure **10**A is a tabular representation of a dialling profile for the Emergency Response Center subscriber shown in Figure **1**;

Figure **11** is a tabular representation of a dialing profile for the Calgary subscriber shown in Figure **1**;

Figure **12** is a tabular representation of a dialing profile for the London subscriber shown in Figure **1**;

Figure **13** is a tabular representation of a DID bank table record stored in the database shown in Figure **1**;

Figure **13A** is a tabular representation of an exemplary DID bank table record for the Vancouver subscriber;

Figure **13B** is a tabular representation of an exemplary DID bank table record for the Calgary subscriber;

Figure **14** is a tabular representation of an exemplary DID bank table record for the London subscriber;

Figure **15** is a tabular representation of a routing message buffer for holding a routing message to be transmitted from the RC to the call controller shown in Figure **1**;

Figure **16** is a tabular representation of a routing message for routing a call to the Emergency Response Center;

Figure **16A** is a tabular representation of a routing message for routing a call to the London subscriber;

Figure **17** is a tabular representation of a prefix to supernode table record stored in the database shown in Figure **1**;

Figure **18** is a tabular representation of a prefix to supernode table record that would be used for the London subscriber;

Figure **19** is a tabular representation of a master list record stored in a master list table in the database shown in Figure **1**;

Figure **20** is a tabular representation of an exemplary populated master list record;

Figure **21** is a tabular representation of a suppliers list record stored in the database shown in Figure **1**;

Figure **22** is a tabular representation of a specific supplier list record for a first supplier;

Figure **23** is a tabular representation of a specific supplier list record for a second supplier;

Figure **24** is a tabular representation of a specific supplier list record for a third supplier;

Figure **25** is a tabular representation of a routing message buffer for holding a routing message identifying a plurality of possible suppliers that may carry the call;

Figure **26** is a tabular representation of a call block table record;

Figure **27** is a tabular representation of a call block table record for the Calgary subscriber;

Figure **28** is a tabular representation of a call forwarding table record;

Figure **29** is a tabular representation of an exemplary call forwarding table record specific to the Calgary subscriber;

Figure **30** is a tabular representation of a voicemail table record specifying voicemail parameters to enable the caller to leave a voicemail message for the callee;

Figure **31** is a tabular representation of an exemplary voicemail table record for the Calgary subscriber;

Figure **32** is a tabular representation of an exemplary routing message, held in a routing message buffer, indicating call forwarding numbers and a voicemail server identifier;

Figure **33** is a tabular representation of a SIP Bye message transmitted from any of the telephones to the call controller;

Figure **34** is a tabular representation of a SIP Bye message sent to the call controller from the callee or caller gateway;

Figure **35** is a flowchart of a process executed by the call controller for producing a RC Call Stop message in response to receipt of a SIP Bye message;

Figure **36** is a tabular representation of an exemplary RC Call Stop message;

Figure **37** is a tabular representation of an exemplary RC Call Stop message for the Calgary subscriber;

Figure **38** is a schematic representation of messages exchanged during a process for establishing audio paths between telephones and a media relay.

DETAILED DESCRIPTION

Referring to Figure **1**, a system for making voice over IP telephone calls including emergency calls is shown generally at **10**. The system includes a first supernode shown generally at **11** and a second supernode shown generally at **21**. The first supernode **11** is located in a geographical area, such as Vancouver B.C., for example and the second supernode **21** is located in London, England, for example. Different supernodes may be located in different geographical regions throughout the world to provide telephone service to subscribers in respective regions. These supernodes may be in communication with each other through high speed / high data throughput links including optical fiber, satellite and/or cable links, for example, forming a system backbone. These supernodes may alternatively or in addition be in communication with each other through conventional Internet services. In the embodiment shown, data communication media for providing for data communications between the first and second supernodes **11** and **21** are shown generally at **23** and may include very high speed data links, for example.

In the embodiment shown, the Vancouver supernode **11** provides telephone service to a geographical region comprising Western Canadian customers from Vancouver Island to Ontario and includes a Vancouver subscriber, a Calgary subscriber and an emergency response center (ERC) that is also a subscriber. The second supernode **21** may be located in London, England, for example, to service London and Glasgow subscribers, **22** and **25**, for example through their own service providers **9** and **29**. As will be seen below however, the emergency response center need not be a subscriber.

Other supernodes similar to the type shown may also be employed within the geographical area serviced by a supernode, to provide for call load sharing, for example within a region of the geographical area serviced by the supernode. However, in general, all supernodes are similar and have the properties described below in connection with the Vancouver supernode **11**.

In this embodiment, the Vancouver supernode includes a call controller (CC) **14**, a routing controller (RC) **16**, a database **18** and a media relay (MR) **17**. Subscribers such as the Vancouver subscriber, the Calgary subscriber and the Emergency Response Center subscriber communicate with the Vancouver supernode **11** using their own Internet Service Providers (ISPs) **13**, **19** and **31** respectively which route Internet Protocol (IP) traffic from these subscribers to the Vancouver Supernode over the Internet. To these subscribers the Vancouver supernode **11** is accessible through their ISP at a pre-determined IP address or a fully qualified domain name (FQDN). The subscriber in the city of Vancouver uses a telephone **12** that is capable of communicating with the Vancouver supernode **11** using Session Initiation Protocol (SIP) messages, and the Calgary and Emergency Response Center subscribers use similar telephones **15** and **33** respectively, to communicate with the Vancouver supernode from their locations. The London supernode **21** also has a call controller **24**, a routing controller **26** and a database **28** and functions in a manner similar to the Vancouver supernode **11**.

It should be noted that throughout the description of the embodiments of this invention, the IP/UDP addresses of all elements such as the caller and callee telephones, call controller, media relay, and any others, will be assumed to be valid IP/UDP addresses directly accessible via the Internet or a private IP network, for example, depending on the specific implementation of the system. As such, it will be assumed, for example, that the caller and callee telephones will have IP/UDP addresses directly accessible by the call controllers and the media relays on their respective supernodes, and those addresses will not be obscured by Network Address Translation (NAT) or similar mechanisms. In other words, the IP/UDP information contained in SIP messages (for example the SIP Invite message or the RC Request message which will be described below) will match the IP/UDP addresses of the IP packets carrying these SIP messages.

It will be appreciated that in many situations, the IP addresses assigned to various elements of the system may be in a private IP address space, and thus not directly accessible from other elements. Furthermore, it will also be appreciated that NAT is commonly used to share a "public" IP address between multiple devices, for example between home PCs and IP telephones sharing a single Internet connection. For example, a home PC may be assigned an IP address such as **192.168.0.101** and a Voice over IP telephone may be assigned an IP address of **192.168.0.103**. These addresses are located in so called "non-routable" (IP) address space and cannot be accessed directly from the Internet. In order for these devices to communicate with other computers located on the Internet, these IP addresses have to be converted into a "public" IP address, for example **24.10.10.123** assigned by the Internet Service Provider to the subscriber, by a device performing NAT, typically a home router. In addition to translating the IP addresses, NAT typically also translates UDP port numbers, for example an audio path originating at a VoIP telephone and using a UDP port **12378** at its private IP address, may have been translated to UDP port **23465** associated with the public IP address of the NAT device. In other words, when a packet originating from the above VoIP telephone arrives at an Internet-based supernode, the source IP/UDP address contained in the IP packet header will be **24.10.10.123:23465**, whereas the source IP/UDP address information contained in the SIP message inside this IP packet will be **192.168.0.103:12378**. The mismatch in the IP/UDP addresses may cause a problem for SIP-based VoIP systems because, for example, a supernode will attempt to send messages to a private address of a telephone – the messages will never get there.

It will be appreciated that a number of methods are available to overcome this problem. For example, the SIP NATHelper open source software module may run on the supernode to correlate public IP/UDP address contained in the headers of the IP packets arriving from SIP devices with private IP/UDP addresses in the SIP messages contained in these packets. Therefore, the

embodiments of the invention described below will function whether or not any of the elements of the system are located behind NAT devices that obscure their real IP/UDP addresses.

Referring to Figure **1**, in an attempt to make a regular call by the Vancouver telephone **12** to the London telephone **22**, for example, the Vancouver telephone sends a SIP Invite message to the Vancouver supernode **11** and in response, the call controller **14** sends an RC Request message to the routing controller **16** which makes various enquiries of the database **18** to produce a routing message which is sent to the call controller. The call controller **14** then causes a communications link, including audio paths, to be established through the media relay **17** which may include the same Vancouver supernode **11**, a different supernode or a communications supplier gateway, for example, to carry voice traffic to and from the call recipient or callee.

In an attempt to make an emergency call, generally the call is made by dialling a short number such as **911** and the call is routed to an emergency response center (ERC) associated with the caller such as the emergency response center associated with the telephone **33**. However, as will be appreciated from the description below, this system will permit emergency calls originating from subscribers associated with one supernode to be received by emergency response centers associated with a different supernode, if necessary.

<u>Subscriber Telephone</u>

Referring to Figure **2**, in this embodiment, the telephone **12** includes a processor circuit shown generally at **30** comprising a microprocessor **32**, program memory **34**, an input/output (I/O) interface **36**, parameter memory **38** and temporary memory **40**. The program memory **34**, I/O interface **36**, parameter memory **38** and temporary memory **40** are all in communication with the microprocessor **32**. The I/O interface **36** has a dial input **42** for receiving a dialed telephone number from a keypad, for example, or from a

voice recognition unit or from pre-stored telephone numbers stored in the parameter memory **38**, for example. For simplicity, a box labelled dialling functions **44** represents any device capable of informing the microprocessor **32** of a callee identifier, e.g., a callee telephone number.

The processor **32** stores the callee identifier in a dialed number buffer **41**. Where the callee is the London subscriber, the callee identifier may be **4401 1062 4444**, for example, identifying the London subscriber or the callee identifier may be a standard telephone number, or where the callee is the Emergency Response Center, the callee identifier may be **911**, for example.

The I/O interface **36** also has a handset interface **46** for receiving and producing signals from and to a handset that receives user's speech to produce audio signals and produces sound in response to received audio signals. The handset interface **46** may include a BLUETOOTH™ wireless interface, a wired interface or speakerphone, for example. The handset **45** acts as a termination point for an audio path (not shown) which will be appreciated later.

The I/O interface **36** also has a network interface **48** to an IP network, and is operable, for example, to connect the telephone to an ISP via a high speed Internet connection. The network interface **48** also acts as a part of the audio path, as will be appreciated later.

The parameter memory **38** has a username field **50**, a password field **52**, an IP address field **53** and a SIP proxy address field **54**. The username field **50** is operable to hold a username associated with the telephone **12**, which in this case is **2001 1050 8667**. The username is assigned upon subscription or registration into the system and, in this embodiment includes a twelve digit number having a prefix **61**, a country code **63**, a dealer code **70** and a unique number code **74**. The prefix **61** is comprised of the first or left-most digit of the username in this embodiment. The prefix may act as a continent code in

some embodiments, for example. The country code **63** is comprised of the next three digits. The dealer code **70** is comprised of the next four digits and the unique number code **74** is comprised of the last four digits. The password field **52** holds a password of up to **512** characters, in this example. The IP address field **53** stores an IP address of the telephone **30**, which for this explanation is **192.168.0.20**. The SIP proxy address field **54** stores an IP address of a SIP proxy which may be provided to the telephone **12** through the network interface **48** as part of a registration procedure, for example.

The program memory **34** stores blocks of codes for directing the microprocessor **32** to carry out the functions of the telephone **12**, one of which includes a firewall block **56** which provides firewall functions to the telephone, to prevent unauthorized access through the network interface **48** to the microprocessor **32** and memories **34**, **38** and **40**. The program memory **34** also stores codes **57** for establishing a call ID. The call ID codes **57** direct the microprocessor **32** to produce call identifiers, that may, for example have the format of a hexadecimal string and an IP address of the telephone stored in IP address field **53**. Thus, an exemplary call identifier for a call might be FF**10** @ **192.168.0.20**.

Generally, in response to activating the handset **45** and using the dialling function **44**, the microprocessor **32** produces and sends a SIP Invite message **59** as shown in Figure **3**, to the routing controller (RC) **14** shown in Figure **1**.

Referring to Figure **3**, the SIP Invite message includes a caller identifier field **60**, a callee identifier field **62**, a digest parameters field **64**, a call ID field **65**, a caller IP address field **67** and a caller UDP port field **69**. In this embodiment, the caller identifier field **60** includes the username **2001 1050 8667**, which is the username stored in the username field **50** of the parameter memory **38** in the Vancouver telephone **12** shown in Figure **2**. In addition, as an example, referring back to Figure **3**, where the call is a normal, non-emergency call to the London subscriber the callee identifier field **62** includes the username

4401 1062 4444 which is the dialed number of the London subscriber stored in the dialed number buffer **41** shown in Figure **2**. The digest parameters field **64** includes digest parameters and the call ID field **65** includes a code comprising a generated prefix code (FF**10**, for example) and a suffix which is the IP address of the telephone **12** stored in the IP address field **53**. The IP address field 67 and UDP port field 69 define a socket for audio communications. The IP address field **67** holds the IP address assigned to the telephone, in this embodiment **192**.**168**.**0**.**20**, and the caller UDP port field **69** includes a UDP port identifier identifying a UDP port at which the audio path will be terminated at the caller's telephone.

Call Controller

Referring to Figure **4**, a call controller circuit of the call controller **14** (Figure **1**) is shown in greater detail at **100**. The call controller circuit **100** includes a microprocessor **102**, program memory **104**, random access memory **105** and an I/O interface **106**. The call controller circuit **100** may include a plurality of microprocessors, a plurality of program memories and a plurality of I/O interfaces to be able to handle a large volume of calls. However, for simplicity, the call controller circuit **100** will be described as having only one microprocessor, program memory and I/O interface, it being understood that there may be more.

Generally, the I/O interface **106** includes an input **108** for receiving messages, such as the SIP Invite message shown in Figure **3**, from the telephone **12** shown in Figure **2**. The I/O interface **106** also has an RC Request message output **110** for transmitting an RC Request message to the routing controller **16** in Figure **1**, an RC message input **112** for receiving routing messages from the RC **16**, a MR output **114** for transmitting messages to the media relay **17** (Figure **1**) to advise the media relay to establish an audio path, and a MR input **116** for receiving messages from the media relay to which a message has been sent to attempt to establish the audio path. The I/O interface **106** further includes a SIP output **118** for transmitting SIP messages to the

telephone **12** (Figure **2**) to advise the telephone of the IP address of the media relay **17** (Figure **1**) which will establish the audio path.

While certain inputs and outputs have been shown as separate, it will be appreciated that some may be associated with a single IP address and TCP or UDP port. For example, the messages sent and received from the RC **16** may be transmitted and received at the same single IP address and TCP or UDP port.

The program memory **104** of the call controller circuit **100** includes blocks of code for directing the microprocessor **102** to carry out various functions of the call controller **14**. For example, these blocks of code include a first block **120** for causing the call controller circuit **100** to execute a SIP Invite to RC request process to produce a RC Request message in response to a received SIP Invite message. In addition, there is a Routing Message to Media Relay message block **122** which causes the call controller circuit **100** to produce an MR Query message in response to a received routing message from the routing controller **16**.

Referring to Figure **5**, the SIP Invite-to-RC Request process is shown in more detail at **120**. On receipt of a SIP Invite message of the type shown in Figure **3**, block **132** of Figure **5** directs the call controller circuit **100** of Figure **4** to authenticate the user operating the telephone from which the SIP Invite message originated. This may be done, for example, by prompting the user for a password by sending a message back to the caller telephone **12** in Figure **1**, which is interpreted at the telephone as a request for password entry or the password may automatically be sent to the call controller **14** from the telephone, in response to the message. The call controller **14** may then make enquiries of the database **18** to determine whether or not the user's password matches a password stored in the database. Various functions may be used to pass encryption keys or hash codes back and forth to ensure the secure

transmission of passwords. Authentication may be bypassed when the call is to the ERC.

Should the authentication process fail, the call controller circuit **100** is directed to an error handling block **134** which causes messages to be displayed at the caller telephone **12** to indicate that there was an authentication error. If the authentication process is successful, block **131** directs the call controller circuit **100** of Figure **4** to determine whether or not the contents of the caller identifier field **60** of the SIP Invite message shown in Figure **3** is a validly formatted IP address. If it is a valid IP address, then block **133** of Figure **5** directs the call controller circuit **100** of Figure **4** to associate a type code with the call to indicate that the call type is a third party invite.

If at block **131** the caller identifier field **60** contents do not identify an IP address (for example, they may identify a PSTN number or Emergency Calling short number such as **911**), then block **135** directs the call controller circuit **100** to associate a type code with the call to indicate the call type is a regular invite. Then, block **136** directs the call controller circuit **100** to establish a call ID by reading the call ID provided in the call ID field **65** of the SIP Invite message from the telephone **12**, and at block **138** the call controller circuit is directed to produce a routing request message of the type shown in Figure **6** that includes that call ID. Block **139** of Figure **5** then directs the call controller circuit **100** of Figure **4** to send the RC Request message to the routing controller **16** of Figure **1**.

Referring to Figure **6**, a routing request message is shown generally at **150** and includes a caller identifier field **152**, a callee identifier field **154**, a digest field **156**, a call ID field **158** and a type field **160**. The caller, callee, digest, and call ID fields **152**, **154**, **156** and **158** contain copies of the caller, callee, digest parameters and call ID fields **60**, **62**, **64** and **65** of the SIP Invite message shown in Figure **3**. The type field **160** contains the type code established at blocks **133** or **135** of Figure **5** to indicate whether the call is from a third party

or system subscriber, respectively. For a normal non-emergency call the callee identifier field **154** may include a PSTN number or a system subscriber username as shown, for example. For an emergency call, the callee identifier field **154** includes the Emergency short number **911**, in this embodiment.

Routing Controller

Referring to Figure **7**, the routing controller **16** is shown in greater detail and includes an RC processor circuit shown generally at **200**. The RC processor circuit **200** includes a processor **202**, program memory **204**, a table memory **206**, a DID identifier buffer **203**, a caller ID buffer **205**, a callee ID buffer **209**, an emergency call flag **211**, a DID identifier buffer **203**, a and an I/O interface **208**, all in communication with the processor. (As earlier indicated, there may be a plurality of processors (**202**), memories (**204**), etc.) Separate caller ID buffers **205**, callee id buffers **209** and emergency call flags **211** are instantiated for each call and are associated with respective call IDs.

The I/O interface **208** includes a database output port **210** through which a request to the database **18** (Figure **1**) can be made and includes a database response port **212** for receiving a reply from the database. The I/O interface **208** further includes an RC Request message input **214** for receiving the routing request message from the call controller **14**. Thus, the routing controller receives a routing request message including a caller identifier and a callee identifier. The I/O interface **208** further includes a routing message output **216** for sending a routing message back to the call controller **14**.

The program memory **204** includes blocks of codes for directing the RC processor circuit **200** to carry out various functions of the routing controller **16**. One of these blocks includes an RC Request message handler process **250** which directs the RC processor circuit to produce a routing message in response to a received routing request message of the type shown at **150** in Figure **6**. The RC Request message handler process is shown in greater detail at **250** in Figures **8**A through **8**D.

RC Request Message Handler

Referring to Figure **8**A, the routing request message handler **250** begins with a first block **252** that directs the RC processor circuit **200** (Figure **7**) to store the contents of the RC Request message **150** (Figure **6**) in the callee ID buffer **209** and the caller buffer **205** buffers for separately storing the contents of the callee field (**154** in Figure **6**) and the caller field (**152** in Figure **6**) respectively of the RC Request message. Block **254** then directs the RC processor circuit **200** to use the contents of the caller field (**152** in Figure **6**)in the RC Request message **150**, to search the database **18** shown in Figure **1** and retrieve a dialling profile associated with the caller.

Referring to Figure **9**, a dialling profile is shown generally at **256** and includes system fields including a username field **258**, a domain field **260**, a national dialling digits (NDD) field **262**, an International dialing digits (IDD) field **264**, a country code field **266**, a local area codes field **267**, a caller minimum local length field **268**, a caller maximum local length field **270**, a reseller field **273**, a user address field **275**, an emergency call identifier field **277** and an emergency response center (ERC) field **279**.

An exemplary dialling profile for the Vancouver subscriber is shown generally at **276** in Figure **10** and indicates that the username field **258** includes the username **2001 1050 8667** which is the same as the contents of the username field **50** in the Vancouver telephone **12** shown in Figure **2**.

Referring back to Figure **10**, the domain field **260** includes a domain name as shown at **282**, including a supernode type identifier **284**, a location code identifier **286**, a system provider identifier **288** and a top level domain identifier **290**, identifying a domain or supernode associated with the user identified by the contents of the username field **258**.

In this embodiment, the supernode type identifier **284** includes the code "sp" identifying a supernode and the location code identifier **286** identifies the supernode as being in Vancouver (yvr). The system provider identifier **288** identifies the company supplying the service and the top level domain identifier **290** identifies the "com" domain.

The NDD field **262** in this embodiment includes the digit "**1**" and in general includes a digit specified by the International Telecommunications Union – Telecommunications Standardization Sector (ITU-T) E.**164** Recommendation which assigns national dialling digits to certain countries.

The IDD field **264** includes the code **011** and, in general, includes a code assigned by the ITU-T according to the country or geographical location of the subscriber.

The country code field **266** includes the digit "**1**" and, in general, includes a number assigned by the ITU-T to represent the country in which the subscriber is located.

The local area codes field **267** includes the numbers **604** and **778** and generally includes a list of area codes that have been assigned by the ITU-T to the geographical area in which the subscriber is located. The caller minimum and maximum local number length fields **268** and **270** each hold the number **10** representing minimum and maximum local number lengths permitted in the area code(s) specified by the contents of the local area codes field **267**. The reseller field **273** holds a code identifying a retailer of the telephone services, and in the embodiment shown, the retailer is "Klondike".

The address field **275** holds an address at which the subscriber telephone is normally located. The emergency short number field **277** holds the short emergency number such as "**911**" that the user is expected to dial in the event of an emergency. The ERC number field **279** holds a full PSTN number

associated with an emergency response center that would desireably be geographically nearest to the address specified in the address field **275**.

A dialling profile of the type shown at **256** in Figure **9** is produced whenever a user registers with the system or agrees to become a subscriber to the system. An ERC may register as a user, but need not do so since, as will be appreciated below, provisions are made for making VoIP to PSTN calls which may include calls to an ERC only available via the PSTN. Of importance here is that the contents of the emergency short number field **277** and the contents of the ERC number field **279** are assigned when the user registers with the system and thus it may be said that these numbers are "pre-assigned" to the user before the user makes any calls.

A user wishing to subscribe to the system may contact an office maintained by a system operator. Personnel in the office may ask the user certain questions about his location and service preferences, whereupon tables can be used to provide office personnel with appropriate information to be entered into the username, domain, NDD, IDD, country code, local area codes and caller minimum and maximum local length fields, emergency short number field and ERC number field **258**, **260**, **262**, **264**, **266**, **267**, **268**, **270**, **277**, **279** to establish a dialling profile for the user.

Referring to Figures **10**A, **11**, and **12**, dialling profiles for the ERC subscriber, Calgary subscriber, and the London subscriber, respectively for example, are shown.

In addition to creating dialling profiles when a user registers with the system, a direct-in-dial (DID) record of the type shown at **268** in Figure **13** may optionally be added to a direct-in-dial table in the database **18** to associate the username and a host name of the supernode, with which the user is associated, with an E.**164** number on the PSTN network. If the user does not

have such an E.**164** number, no DID record need be created at this time for that user.

In this embodiment, the DID bank table records include a username field **291**, a user domain field **272** and DID identifier field **274**, for holding the username, hostname of the supernode and E.**164** number respectively. Thus a DID bank table record pre-associates a DID identifier with a user (e.g. caller).

A DID bank table record may also include a creation time field and an expiration time field for use when the DID bank table record is a temporary record as will be explained below.

DID bank table records for the Vancouver, Calgary and London subscribers are shown in Figures **13**A, **13**B, and **14**, respectively

In addition to creating dialling profiles and DID records when a user registers with the system, call blocking records of the type shown in Figure **26**, call forwarding records of the type shown in Figure **28** and voicemail records of the type shown in Figure **30** may be added to the database **18** when a new subscriber is added to the system.

Referring back to Figure **8**A, after being directed at block **254** to retrieve a dialling profile associated with the caller, such as shown at **276** in Figure **10**, the RC processor circuit (**200**) is directed to block **255** which causes it to determine whether the contents of the callee ID buffer **209** shown in Figure **7** are equal to the contents of the emergency call identifier field **277** of the dialling profile **276** for the caller, shown in Figure **10**. If the contents of the callee ID buffer **209** are not equal to the contents of the emergency short number field **277**, the call is deemed not to be an emergency call and the RC processor circuit **200** is directed to location A in Figure **8**B to carry out further processing on the basis that the call is to be a normal, non-emergency call.

If the contents of the callee ID buffer **209** match the contents of the emergency call identifier field (**277** in Figure **10**), the call is deemed to be an emergency call and block **157** directs the RC processor circuit **200** to set a time to live (TTL) value to a high number such as **9999** to indicate that the call may have a long duration of **9999** seconds, for example. In addition block **157** directs the RC processor circuit **200** to set active the emergency call flag **211** in Figure **7**, to indicate that the call is an emergency call. Then, block **159** directs the RC processor circuit **200** to replace the contents of the callee ID buffer **209** with the contents of the ERC # field **279** of the caller dialling profile **276** (Figure **10**). Thus, the RC processor circuit produces an emergency response center identifier in response to the emergency call identifier by copying the emergency response center identifier from the ERC field **279** of the dialing profile **276** (Figure **10**) associated with the caller to the callee ID buffer **209** shown in Figure **7** so that effectively, the contents of the callee ID buffer are replaced with the Emergency Response Center number. The RC processor circuit **200** is then directed to location A in Figure **8**B.

In this embodiment, for regular and emergency call processing, beginning at location A in Figure **8**B, the RC processor circuit **200** is directed to perform certain checks on the callee identifier provided by the contents of the callee identifier buffer **209** shown in Figure **7**. Most of these checks are shown in greater detail in Figure **8**B and are used for regular non-emergency call handling. Emergency calls in which the ERC number has been substituted for the short emergency calling number (i.e., **911**) will pass all of the checks. Subjecting both emergency and non-emergency calls to these checks enables all calls, whether emergency or non-emergency, to be passed through the same process and, simplifies the introduction of emergency call handling processes into regular call processing routines depicted in Figures **8**A to **8**D. Alternatively, the RC processor circuit may be directed directly from block **159** to block **269** in Figure **8**B whenever the emergency call flag is set, as shown in broken outline in Figure **8**B.

Figure **8**B

IDD Testing

Referring to Figure **8**B, to start the first of the checks, the RC processor circuit **200** is directed to a first block **257** that causes it to determine whether a digit pattern of the callee identifier provided in the callee ID buffer **209** includes a pattern that matches the contents of the IDD field **264** in the caller dialling profile **276** shown in Figure **10**. If so, then block **259** directs the RC processor circuit **200** to set a call type identifier code (not shown) to indicate that the call is a long distance call, e.g., from the Vancouver subscriber to the London subscriber, and block **261** directs the RC processor circuit **200** to produce a reformatted callee identifier by reformatting the current callee identifier into a predetermined target format. In this embodiment, this is done by removing the pattern of digits matching the IDD field contents **264** of the caller dialling profile **276** to effectively shorten the number. Then, block **263** directs the RC processor circuit **200** to determine whether or not the reformatted callee identifier meets criteria establishing it as an E.**164** compliant number and if the length does not meet this criteria, block **265** directs the RC processor circuit **200** to send back to the call controller **14** a message indicating that the length of the call identifier is not correct. The process **250** is then ended. At the call controller **14**, routines may respond to the incorrect length message by transmitting a message back to the telephone **12** to indicate that an invalid number has been dialed, for example. Thus at the conclusion of block **263** a callee identifier having a pre-defined format should be available.

NDD Testing

Referring back to Figure **8**B, if at block **257**, the callee identifier specified by the contents of the callee buffer **209** Figure **7** does not begin with an IDD, block **381** directs the RC processor circuit **200** to determine whether or not the callee identifier begins with the same NDD code as assigned to the caller. To do this, the RC processor circuit is directed to refer to the caller dialling profile **276** shown in Figure **10**. In the embodiment shown, the NDD code stored in

an NDD field **262** is the digit **1**. Thus, if the callee identifier begins with the digit **1**, the RC processor circuit **200** is directed to block **382** in Figure **8**B.

Block **382** directs the RC processor circuit **200** to examine the callee identifier to determine whether or not digits following the NDD code identify an area code that is the same as any of the area codes identified in the local area codes field **267** of the caller dialling profile **276** shown in Figure **10**. If not, block **384** directs the RC processor circuit **200** to set a call type variable (not shown) to a code indicating the call is a national call. If the digits identify an area code that is the same as a local area code associated with the caller, block **386** directs the RC processor circuit **200** to set the call type variable to indicate that the call type is as a local call, national style. After executing blocks **384** or **386**, block **388** directs the RC processor circuit **200** to reformat the callee identifier by removing the national dial digit and prepending a caller country code identified by the country code field **266** of the caller dialling profile **276** shown in Figure **10**. The RC processor circuit **200** is then directed to block **263** to perform the processes described above beginning at block **263**. Again, at the conclusion of block **263** a callee identifier having a pre-defined format should be available.

Area Code Testing

If at block **381** the callee identifier does not begin with an NDD code, block **390** directs the RC processor circuit **200** to determine whether the callee identifier in the callee ID buffer **209** begins with digits that identify the same area code as the caller. Again, the reference for this is the caller profile **276** shown in Figure **10** and the RC processor circuit **200** determines whether or not the first few digits in the callee identifier identify an area code identified by the local area code field **267** of the caller profile **276**. If so, then block **392** directs the RC processor circuit **200** to set the call type to a code indicating the call is a local call and block **394** directs the RC processor circuit **200** to prepend the caller country code to the callee identifier, the caller country code being determined from the country code field **266** in the caller profile **276**. The

RC processor circuit **200** is then directed to block **263** for processing as described above beginning at block **263**. Emergency calls are likely to follow this path since the Emergency Response Center number that supplants the short emergency number (**911**) will normally be formatted to include an area code, but no IDD or NDD. Again at the conclusion of block **263** a callee identifier having a pre-defined length should be available.

Callee ID Length Testing

If at block **390**, the callee identifier does not have the same area code as the caller, as may be the case with non-emergency calls, block **396** directs the RC processor circuit **200** to determine whether the callee identifier in the callee ID buffer **209** has the same number of digits as the number of digits indicated in either the caller minimum local number length field **268** or the caller maximum local number length field **270** of the caller profile **276** shown in Figure **10**. If so, then block **398** directs the RC processor circuit **200** to set the call type to local and block **400** directs the processor to prepend to the callee identifier the caller country code as indicated by the country code field **266** of the caller profile **276** followed by the caller area code as indicated by the local area code field **267** of the caller profile shown in Figure **10**. The RC processor circuit **200** is then directed to block **263** for further processing as described above beginning at block **263**. Again at the conclusion of block **263** a callee identifier having a pre-defined length should be available.

Valid Subscriber Testing

If at block **396**, the callee identifier in the callee ID buffer **209** has a length that does not match the length specified by the contents of the caller minimum local number length field **268** or the caller maximum local number length field **270** of the caller profile **276**, block **402** directs the RC processor circuit **200** to determine whether or not the callee identifier identifies a valid username. To do this, the RC processor circuit **200** searches through the database **18** of dialling profiles to find a dialling profile having a username field **258** that matches the callee identifier. If no match is found, block **404** directs the RC

processor circuit **200** to send an error message back to the call controller (**14**). If at block **402**, a dialling profile having a username field **258** that matches the callee identifier is found, block **406** directs the RC processor circuit **200** to set the call type to a code indicating the call is a network call and the processor is directed to block **275** of Figure **8**A, to continue executing the RC message handler process **250**.

From Figure **8**B, it will be appreciated that there are certain groups of blocks of codes that direct the RC processor circuit **200** to determine whether the callee identifier in the callee ID buffer **209** has certain features such as an IDD code, a NDD code, an area code and a length that meet certain criteria and to reformat the callee identifier, as necessary, into a predetermined target format including only a country code, area code, and a normal telephone number, for example, to cause the callee identifier to be compatible with the E.**164** standard, in this embodiment. This enables the RC processor circuit **200** to have a consistent format of callee identifiers for use at block **269** in searching through the DID bank table records of the type **268** shown in Figure **13** to determine how to route calls for subscriber to subscriber calls on the same system. Recall that the ERC may be a subscriber.

Still referring to Figure **8**B, if the length of the reformatted callee identifier meets the length criteria set forth at block **263**, block **269** directs the RC processor circuit **200** to determine whether or not the reformatted callee identifier is associated with a direct-in-dial bank (DID) record of the type shown at **268** in Figure **13**.

Exemplary DID records for the Vancouver, Calgary and London subscribers are shown in Figures **13**A, **13**B and **14**. The username field **291** and user domain field **272** are as specified in the username and user domain fields **258** and **260** of the corresponding dialing profiles shown in Figures **10**, **11** and **12** respectively. Referring to Figure **13**A the contents of the DID field **274** include an E.**164** telephone number including a country code **293**, an area code **295**,

an exchange code **297** and a number **299**. If the user has multiple telephone numbers, then multiple records of the type shown at **276** would be included in the DID bank table in the database **18**, each having the same username and user domain, but different DID field **274** contents reflecting the different E.**164** telephone numbers associated with that user.

Referring back to Figure **8**B, at block **269**, if the RC processor circuit **200** determines that the current, (e.g.reformatted callee identifier produced at block **261**) can be found in a record in the DID bank table, then the callee is a subscriber to the system and block **279** directs the RC processor circuit **200** to copy the contents of the corresponding username field **291** from the DID bank table record into the callee ID buffer **209** shown in Figure **7**. Thus, the RC processor circuit **200** locates a subscriber username associated with the reformatted callee identifier. If the call is being made to the Emergency Response Center and the Emergency Response Center (ERC) is a subscriber to the system, a DID record would be found in the DID bank table, otherwise a DID record for the ERC would not be found. Assuming the Emergency Response Center is a subscriber to the system, the RC processor circuit **200** is directed to block **275** at point B in Figure **8**A for further processing now that it is known that the call is essentially a subscriber to subscriber call.

<u>Subscriber to Subscriber Calls Between Different Nodes</u>

Referring back to Figure **8**A, block **275** directs the RC processor circuit **200** to determine whether or not the username stored in the callee ID buffer **209** (in Figure **7**) is associated with the same supernode as the caller. To do this, the RC processor circuit **200** determines whether or not the prefix (i.e. the leftmost digit) of the username stored in the callee ID buffer **209** is the same as the prefix of the username of the caller specified by the caller identifier field **152** of the RC. Request message **150** shown in Figure **6**. If they are not the same, block **277** of Figure **8**A directs the RC processor circuit (**200)** to set a call type flag (not shown) to indicate that the call is a cross-domain call. Then, block **281** directs the RC processor circuit (**200**) to determine whether

the emergency call flag **211** shown in Figure **7** has been set and if so, block **283** of Figure **8**A directs the RC processor to determine whether the caller identifier is associated with a pre-associated direct inward dialing (DID) identifier. This is done by searching the DID bank table to attempt to locate a DID record having DID field (**274**) contents matching the contents of the caller identifier stored in the caller ID buffer (**205**). If such a DID record is found, the processor circuit **200** has effectively determined that the caller has a pre-associated DID identifier.

If no such DID record is found, the RC processor circuit **200** has effectively determined that the caller has no pre-associated DID identifier. In this case, block **285** then directs the RC processor circuit **200** to produce a DID identifier for the caller by associating a temporary DID identifier with the caller identifier by associating with the caller identifier a DID identifier from a pool of pre-determined DID identifiers. This is done by creating and associating with the caller a temporary DID record of the type shown in Figure **13**. The temporary DID record has a DID identifier field **274** populated with the DID identifier from the pool. The DID identifier from the pool may be **1 604 867 5309**, for example. The pool may be provided by causing the RC processor circuit **200** to maintain a list of pre-defined DID identifiers and pointers identifying a current read point in the list and a current write point in the list. The current read pointer may be incremented each time the pool is addressed to obtain a temporary DID identifier.

A temporary DID record may be canceled after a pre-defined period of time. For example, the temporary DID identifier records are desirably as shown in Figure **13** and may further include a creation time field and an expiry time field for holding a creation time value and an expiry time value respectively. The expiry time may be **2** hours after the creation time, for example, such that the temporary DID record is deleted two hours after it is created. A separate process, not shown, may continuously or periodically scan the DID records to determine whether any DID records have expiry times that have been

exceeded and if so, cause such temporary DID records to be cancelled or deleted. Thus, the RC processor produces a direct inward dialing identifier for the caller by associating a temporary DID identifier with the caller identifier when the emergency call flag is active and it is determined that the caller has no pre-associated DID identifier, or by associating a DID identifier pre-assigned to the caller identifier.

After a temporary DID record has been created and stored in the DID bank table in the database **18** shown in Figure **1**, or if the caller already had a DID record, block **287** of Figure **8**A directs the RC processor circuit to load the DID identifier buffer **203** with the contents of the field of DID temporary or pre-associated DID record. Then the RC processor circuit loads a routing message buffer with the contents of the DID identifier buffer **203** acting as the caller identifier and the contents of the callee ID buffer **209** as the callee identifier. This will provide for a PSTN call back number to be provided to the emergency response center.

Thus, where the caller identifier has no pre-assigned DID identifier, the RC processor produces a routing message including the emergency response center identifier and the temporary DID identifier for receipt by the routing controller to cause the routing controller to establish a route between the caller and the emergency response center.

Referring to Figure **15**, a routing message buffer is shown generally at **352** and includes a supplier prefix field **354**, a delimiter field **356**, a callee field **358**, at least one route field **360**, a time-to-live (TTL) field **362** and a caller ID field **364**. The supplier prefix field **354** holds a code for identifying supplier traffic. The delimiter field **356** holds a symbol that delimits the supplier prefix code from the callee field **358** and in this embodiment, the symbol is a number sign (#) as illustrated in Figure **25**. Referring back to Figure **15**, the callee field **358** holds a copy of the contents of the callee ID buffer **209** of Figure **7**. The route field **360** holds a domain name or an IP address of a gateway or supernode

that is to carry the call and the TTL field **362** holds a value representing the number of seconds the call is permitted to be active, based on subscriber available minutes and other billing parameters, for example.

Desirably, the time to live field holds a number indicating a maximum call time for the call and where the call is an emergency call, desirably the maximum call time exceeds a duration of an average non-emergency telephone call. The caller ID field **364** holds a caller identifier which in this case, is the temporary or pre-associated DID number from the DID record associated with the caller.

Referring to Figure **8**A and Figure **16**, a routing message produced by the RC processor circuit **200** at block **287** is shown generally at **366** and includes only the callee field **358**, route field **360**, TTL field **362** and caller ID field **364**.

The callee field **358** holds the full username of the callee, and where the call is an emergency call as shown, the full username of the callee is the username of the emergency response center. The route field **360** contains the identification of the domain with which the emergency response center is associated, i.e., sp.yvr.digifonica.com. The TTL field holds the value **9999** set at block **157** in Figure **8**A and the caller ID field **364** holds the DID identifier associated with the caller. Block **380** then directs the RC processor circuit to send the routing message shown in Figure **16** to the call controller **14** (Figure **1**).

Referring to Figure **8**A, if at block **281**, the emergency call flag is not set, the call is not an emergency call, and the RC processor is directed to block **350** which causes it to direct the RC processor circuit **200** to load the routing message buffer with information identifying the supernode in the system with which the callee is associated and to set a time to live for the call to a high value such as **9999**. The supernode, with which the callee is associated, is determined by using the callee username stored in the callee ID buffer **209** to

address a supernode table having records of the type as shown at **370** in Figure **17**.

Referring to Figure **17**, each prefix to a supernode table record **370** has a prefix field **372** and a supernode address field **374**. The prefix field **372** includes the first n digits of the callee identifier. In this case n=**1**. The supernode address field **374** holds a code representing the IP address or a fully qualified domain name (FQDN) of the supernode associated with the code stored in the prefix field **372**. Referring to Figure **18**, for example, if the prefix is **4**, the supernode address associated with that prefix is sp.lhr.digifonica.com, identifying the London supernode (**21** in Figure **1**), for example. After the routing message buffer has been loaded with identification of the supernode, block **380** of Figure **8**A directs the RC processor circuit to send the routing message shown in Figure **16**A to the call controller **14** (Figure **1**).

Subscriber to Subscriber Calls Within the Same Node

Referring back to Figure **8**A, if at block **275**, the callee identifier stored in the callee ID buffer **209** (Figure **7**) has a prefix that identifies the same supernode as that associated with the caller, block **559** directs the RC processor circuit **200** to determine whether or not the emergency call flag **211** of Figure **7** has been set. If at block **559**, the RC processor circuit **200** determines that the emergency call flag **211** is set, the RC processor circuit **200** is directed to resume processing at block **283** to scan the DID bank table to determine whether the caller has a DID record and to assign a temporary DID number if necessary, as described above and then to send a routing message of the type shown in Figure **16** to the call controller.

If at block **559** the emergency call flag has not been set, regular non-emergency call processing ensues beginning with block **600** which directs the RC processor circuit **200** to use the callee identifier to locate and retrieve a dialling profile for the callee identified by the callee identifier stored in the

callee ID buffer **209**. The dialling profile is of the type shown in Figure **9,** and may contain data as shown in Figure **11,** for example. In this case the same-node subscriber is the Calgary subscriber. Block **602** of Figure **8**A directs the RC processor circuit **200** to get call block, call forward and voicemail tables from the database **18** based on the username identified in the callee dialing profile retrieved by the RC processor circuit at block **600**. Call block, call forward and voicemail tables have records as shown in Figures **26**, **28** and **30** for example.

Referring to Figure **26**, the call block records include a username field **604** and a block pattern field **606**. The username field **604** holds a username matching the username in the username field **258** of the dialing profile (Figure **9**) associated with the callee, and the block pattern field **606** holds one or more E.**164**-compatible numbers or usernames identifying PSTN telephone numbers or system subscribers from whom the subscriber identified by the contents of the username field **604** does not wish to receive calls.

Referring back to Figure **8**A and referring to Figure **27**, block **608** directs the RC processor circuit **200** to determine whether or not the caller identifier matches a block pattern stored in the block pattern field **606** of the call block record associated with the callee identified by the contents of the username field **604** in Figure **26**. If the caller identifier matches a block pattern stored in the field **606**, block **610** directs the RC processor circuit **200** to send a drop call or non-completion message to the call controller **14** and the process **250** is ended. If the caller identifier does not match a block pattern associated with the callee, block **612** directs the RC processor circuit **200** to determine whether or not call forwarding is required.

Referring to Figure **28**, records in the call forwarding table include a username field **614**, a destination number field **616** and a sequence number field **618**. The username field **614** stores a code representing a username of a subscriber with whom the call forwarding record is associated. The destination

number field **616** holds a username or E.**164** number representing a number to which the current call should be forwarded, and the sequence number field **618** holds an integer number indicating the order in which the username associated with the corresponding destination number field should be attempted for call forwarding. The call forwarding table may have a plurality of records for a given subscriber. The RC processor circuit **200** uses the contents of the sequence number field **618** to place the records for a given subscriber in order. As will be appreciated below, this enables the call forwarding numbers to be tried in an ordered sequence.

Referring back to Figure **8**A and referring to Figure **28**, if at block **612**, the call forwarding record for the callee identified by the callee identifier contains no contents in the destination number field **616** and accordingly no contents in the sequence number field **618**, then there are no call forwarding entries and the RC processor circuit **200** is directed to load the routing message buffer shown in Figure **32** with the callee username, domain and time to live as shown at **650**. The RC processor circuit **200** is then directed to block **620** in Figure **8**C. However, if there are contents in the call forwarding record as shown in Figure **29**, block **622** shown in Figure **8**A directs the RC processor circuit **200** to search the dialling profile table in the database **18** to find a dialling profile record of the type shown in Figure **9**, for the callee identified in the destination number field **616** of the first call forwarding record and to store the contents in the routing message buffer. The RC processor circuit **200** is then directed to load the contents of the domain field **260** associated with the dialing profile specified by the contents of the destination number field **616** of the first call forwarding record into the routing message buffer as shown at **652** in Figure **32**. This process is repeated for each call forwarding record associated with the callee identified by the callee identifier to add to the routing message buffer all call forwarding usernames and domains associated with the callee.

Referring to Figure **8**C, at block **620** the RC processor circuit **200** is directed to determine whether or not the user identified by the callee identifier has paid for voicemail service and this is done by checking to see whether or not a flag **630** is set in a voicemail record of the type shown in Figure **30** in a voicemail table stored in the database **18** in Figure **1**.

Referring to Figure **30**, voicemail table records include a username field **624**, a voicemail server field **626**, a seconds-to-voicemail field **628** and an enabled field **630**. The username field **624** stores the username of the subscriber who purchased the service. The voicemail server field **626** holds a code identifying an IP address or a fully qualified domain name (FQDN) of a voicemail server associated with the subscriber identified by the username field **624**. The seconds-to-voicemail field **628** holds a code identifying the time to wait before engaging voicemail and the enable field **630** holds a code representing whether or not voicemail is enabled for the user identified by the contents of the username field **624**. Therefore, referring back to Figure **8**C, at block **620** the RC processor circuit **200** finds a voicemail record as shown in Figure **31** having username field **624** contents matching the callee identifier and examines the contents of the enabled field **630** to determine whether or not voicemail is enabled. If voicemail is enabled, then block **640** in Figure **8**C directs the RC processor circuit **200** to store the contents of the voicemail server field **626** of Figure **31**, and the contents of the seconds to voicemail field **628** of Figure **31** in the routing message buffer as shown at **654** in Figure **32**.

Referring back to Figure **8**C, block **642** then directs the processor to get time to live (TTL) values for each route specified by the routing message according to any of a plurality of criteria such as, for example, the cost of routing and the user's account balance. These TTL values are then appended to corresponding routes already stored in the routing message buffer. Block **643** then directs the RC processor circuit **200** to store the TTL value determined at

block **642** in the routing message buffer. In the routing message shown in Figure **32**, the time to live value is set at **60** seconds, for example.

Block **644** of Figure **8**C then directs the RC processor circuit **200** to store the IP address or FQDM of the current supernode in the routing message buffer as shown at **656** in Figure **32**. An exemplary routing message for a subscriber to subscriber call on the same node is thus shown in the routing message buffer shown in Figure **32**.

Subscriber to Non-Subscriber Calls

Not all calls will be subscriber-to-subscriber calls and this will be detected by the RC processor circuit **200** when it executes block **269** of Figure **8**B and does not find a DID bank table record associated with the callee in the DID bank table. This may be the case, for example, where the Emergency Response Center (ERC) is not a subscriber to the system. When this occurs, the RC processor circuit **200** is directed to block **408** in Figure **8**B which causes it to set the contents of the callee identifier buffer **209** equal to the reformatted callee identifier, i.e., the E.**164** compatible number produced prior to block **263** in Figure **8**B. Block **409** then directs the RC processor circuit **200** to determine whether the emergency call flag **211** in Figure **7** has been set. If the emergency call flag is set, block **411** in Figure **8**D directs the RC processor to search the DID bank table to attempt to locate a DID record having DID field (**274**, Figure **13**) contents matching the contents of the caller identifier stored in the caller ID buffer (**205** in Figure **7**).

If no such DID record is found, the RC processor circuit **200** has effectively determined that the caller identifier is not associated with a pre-associated DID identifier. In this case, block **413** then directs the RC processor circuit **200** to associate a temporary DID identifier with the caller identifier by associating with the caller identifier a DID identifier from the pool of pre-determined DID identifiers. Again, this is done by creating and associating with the caller a temporary DID record of the type shown in Figure **13**.

After a temporary DID record has been created or if the caller already has a DID record, block **415** directs the RC processor circuit to store the DID number (**274** in Figure **13**) in the caller ID buffer **209** in Figure **7**.

After having loaded the caller ID buffer **209** with the temporary or pre-associated DID number, or after having determined that the emergency call flag is not set, block **410** (Figure **8**B) directs the RC processor circuit **200** to initiate a process for identifying gateways to the PSTN through which the call will be established. This process begins with block **410** which directs the RC processor circuit **200** to address a master list having records of the type shown in Figure **19**.

Each master list record includes a master list ID field **500**, a dialling code field **502**, a country code field **504**, a national sign number field **506**, a minimum length field **508**, a maximum length field **510**, a NDD field **512**, an IDD field **514** and a buffer rate field **516**.

The master list ID field **500** holds a unique code such as **1019**, for example, identifying the record. The dialling code field **502** holds a predetermined number pattern that the RC processor circuit **200** uses at block **410** in Figure **8**B to find the master list record having a dialling code matching the first few digits of the reformatted callee identifier. The country code field **504** holds a number representing the country code associated with the record and the national sign number field **506** holds a number representing the area code associated with the record. (It will be observed that the dialling code **502** is a combination of the contents of the country code field **504** and the national sign number field **506**.) The minimum length field **508** holds a number representing the minimum number of digits that can be associated with the record and the maximum length field **510** holds a number representing the maximum number of digits in a number with which the record may be compared. The NDD field **512** holds a number representing an access code used to make a call within

the country specified by the country code **504** and IDD field **514** holds a number representing the international prefix needed to dial a call from the country indicated by the country code.

Thus, for example, a master list record may have a format as shown in Figure **20** with exemplary field contents as shown.

Referring back to Figure **8**B, using the country code and area code portions of the reformatted callee identifier that has been formatted for compatibility with the E.**164** standard, block **410** directs the RC processor circuit **200** to find a master list record such as the one shown in Figure **20** having a dialling code that matches the country code and area code of the reformatted callee identifier held in the callee identifier buffer **209**. Thus, in this example, the RC processor circuit **200** might find a master list record having an ID field with the number **1019**. This number may be also referred to as a route ID number. Thus, a route ID number is found in the master list record associated with a predetermined number pattern in the reformatted callee identifier.

After execution of block **410** in Figure **8**B, the process **250** continues as shown in Figure **8**D. Referring to Figure **8**D, block **412** directs the RC processor circuit **200** to use the route ID number determined at block **410** to locate at least one supplier record identifying a supplier operable to supply a communications link for this route. To do this, block **412** directs the RC processor circuit **200** to search a supplier ID table having records of the type shown in Figure **21**.

Referring to Figure **21**, supplier list records include a supplier ID field **540**, a master list ID field **542**, an optional prefix field **544**, a route identifier field **546**, a NDD/IDD rewrite field **548** and a rate field **550**. The supplier ID field **540** holds a code identifying the name of the supplier and the master list ID field **542** holds a code for associating the supplier record with the master list record. The prefix field **544** optionally holds a string used to identify the

supplier traffic and the route identifier field **546** holds an IP address of a gateway operated by the supplier indicated by the supplier ID field **540**. The NDD/IDD rewrite field **548** holds a code and the rate field **550** holds a code indicating the cost per second to the system operator to use the route through the gateway specified by the contents of the route identifier field **546**. Exemplary supplier records are shown in Figures **22**, **23** and **24** for Telus, Shaw and Sprint, respectively, for example.

Referring back to Figure **8**D, at block **412** the RC processor circuit **200** finds all supplier records that contain the master list ID found at block **410** of Figure **8**B.

Block **560** of Figure **8**D directs the RC processor circuit **200** to begin to produce routing messages. To do this, the RC processor circuit **200** loads a routing message buffer as shown in Figure **25** with a supplier prefix of the least costly supplier where the least costly supplier is determined from the rate fields **550** of the records associated with respective suppliers.

Referring to Figures **22-24**, in the embodiment shown, the supplier "Telus" has the lowest number in the rate field **550** and therefore the prefix **4973** associated with that supplier is loaded into the routing message buffer shown in Figure **25** first. At block **562**, the prefix **4973** is then delimited by the number sign (as defined by the contents of the delimiter field **356** in the routing message format **352** in Figure **15**) and the reformatted callee identifier is next loaded into the routing message buffer after the delimiter . Then, the contents of the route identifier field **546** of the record associated with the supplier Telus are added to the message after an @ sign delimiter and then block **564** in Figure **8**D directs the RC processor circuit **200** to get a TTL value (algorithm not shown), which in this embodiment may be **3600** seconds, for example. Block **566** of Figure **8**D then directs the RC processor circuit **200** to append this TTL value to the contents already in the routing message buffer shown in Figure **25**. Block **567** of Figure **8**D then directs the processor circuit to append

the contents of the caller ID buffer **205** of Figure **7** to the contents already in the routing message buffer shown in Figure **25**. Accordingly, the first part of the routing message is shown generally at **570** in Figure **25**.

Referring back to Figure **8**D, block **571** directs the RC processor circuit **200** back to block **560** and causes it to repeat blocks **560**, **562**, **564, 566** and **567** for each successive supplier until the routing message buffer is loaded with information pertaining to each supplier. Thus, the second portion of the routing message is shown at **572** in Figure **25** and this second portion relates to the second supplier identified by the record shown in Figure **23** and referring back to Figure **25**, the third portion of the routing message is shown at **574** which is associated with a third supplier as indicated by the supplier record shown in Figure **24**. Consequently, referring to Figure **25**, the routing message buffer holds a routing message identifying a plurality of different suppliers able to provide gateways to establish a communication link to permit the caller to contact the callee. Each of the suppliers is identified, in succession, according to rate contained in the rate field **550** of the supplier list record shown in Figure **21**, in this embodiment. Other criteria for determining the order in which suppliers are listed in the routing message may include preferred supplier priorities which may be established based on service agreements, for example.

<u>Response to Routing Message</u>

Referring back to Figure **1**, the routing message of the type shown in Figures **16**, **16**A, **25** or **32**, is received at the call controller **14**. It will be recalled that the call controller **14** already has the original SIP invite message shown in Figure **3**. Referring to Figure **4**, the program memory **104** of the call controller **14** includes a routing-to-media relay routine depicted generally at **122**.

Referring to Figure **38**, the routing to media relay routine **122** directs the processor to participate in a process for establishing audio paths. Assume the call is directed to the ERC.

As a first step in the process for establishing audio paths, a message **1100** is sent from the call controller **14** to the media relay **17**, the message including the call ID, the caller telephone IP address and UDP port as determined from the caller IP address field **67** and caller UDP port field **69** in the SIP Invite message **59** shown in broken outline.

In response, the media relay (MR) **17** sends a confirmation message **1102** back to the call controller **14**, the message including a media relay IP address (**192.168.2.10**) and UDP port number (**22123**) defining a callee socket that the media relay will use to establish an audio path to the ERC telephone or a PSTN gateway to the ERC, where the Emergency Response Center is only available through the PSTN

The call controller **14** then sends a SIP Invite message **1104** of type shown in Figure **3** to the callee telephone **15** (or PSTN gateway), to advise the calllee that telephone of the socket the media relay expects to use for audio communication with the caller telephone. The SIP invite message includes the caller and callee identifiers (**60** and **62),** the call ID **(65**) and the media relay **17** IP address (**192.168.2.10**) and the media relay UDP port number (**22123**) assigned to the callee socket as received from the confirmation message **1102**. The caller identifier may be that which was associated with the caller at blocks **413** in Figure **8**D or block **285** in Figure **8**A, for example, or may be the DID associated with the caller as determined from a DID record already associated with the caller. Such caller identifier, as obtained from the routing message, may be used as calling line identification (CLID) information and may be caused to appear on a display of the callee telephone, which is particularly advantageous where the callee telephone is one at an ERC. Such CLID information provides an ERC operator with callback information, enabling the operator to call back the caller who made the emergency call. Since the temporarily assigned DID records persist for some time after the emergency call has taken place, the ERC operator can call back the person

who made the emergency call during a period of time after the emergency call is terminated. In this embodiment, assume the callee telephone identifies its socket as IP address **192.168.3.10** and UDP port **33123**.

The callee (ERC) telephone **33** of Figure **1** (or PSTN gateway) stores the media relay **17** IP address (**192.168.2.10**) and assigned UDP port number (**22123**) and configures itself to create a socket for an audio path between the media relay. Referring to Figures **1** and **38** the callee telephone **15** (or PSTN gateway) then sends a SIP OK message **1106** back to the call controller **14**, the message including the CALL ID, the callee IP address (**192.168.3.10**) and UDP port number (**33123**) to advise the call controller of the socket at which it expects to use for audio communications with the media relay **17**.

The call controller **14** then sends a message **1108** to the media relay **17** including the IP address (**192.168.3.10**) and UDP port number (**33123**) identifying the socket at that the callee telephone **15** (or PSTN gateway) that is to be used for audio communications with the media relay. The media relay **17** then creates a caller socket identified by IP address **192.168.2.10** and UDP port number **22125** and creates an internal bridge for relaying audio traffic between the caller socket (**192.168.2.10**: **22125**) and the callee socket (**192.168.2.10**: **22123**).

The media relay **17** then sends a message **1110** including the call ID and the IP address (**192.168.2.10**) and UDP port number (**22125**) identifying the caller socket that the media relay assigned to the caller telephone **12**, back to the call controller **14** to indicate that the caller and callee sockets have been established and that the call can proceed.

The call controller **14** then sends a SIP OK message **1112** to the caller telephone **12** to indicate that the call may now proceed. The SIP OK message includes the caller and callee usernames, the call ID and the IP address

(**192.168.2.10**) and UDP port number (**22125**) identiying the caller socket at the media relay **17**.

Alternatively, referring back to Figure **1**, if the routing message is of a type that identifies a domain associated with another supernode in the system, the call controller **14** may communicate with a different media relay (for example **27**) adapted to establish the above-mentioned links between separate media relays associated with respective supernodes, where the IP network links are provided by the communications medium **23**.

In the case of an emergency call, the routing message is unlikely to identify a domain other than that of the caller.

In the case of a regular, non-emergency call, if the routing message is of the type shown in Figure **25** where there are a plurality of suppliers available, the process proceeds as described above with the exception that instead of communicating with the callee telephone directly, the call controller **14** communicates with a gateway provided by a supplier. If a SIP OK message is not received back from the first gateway, the processor is directed to send the SIP Invite message **1104** to a gateway of the next indicated supplier. For example, the call controller **14** sends the SIP Invite message **1104** to the first supplier, in this case Telus, to determine whether or not Telus is able to handle the call. If Telus does not send back an OK message **1106** or sends a message indicating that it is not able to handle the call, the call controller proceeds to send a SIP Invite message **1104** to the next supplier, in this case Shaw. The process is repeated until one of the suppliers responds with a SIP OK message **1106** indicating that it is available to carry the call and the process proceeds as shown in connection with messages **1108**, **1110** and **1112**.

Referring to Figure **2**, in response to receiving the SIP OK message **1112** at the network interface **48**, the microprocessor **32** of the caller telephone **12**

stores the media relay IP address (**192.168.2.10**) and UDP port number (**22125**) identifying the caller socket at the media relay in an audio path IP address buffer **47** in the temporary memory **40**. The microprocessor **32** is now ready to transfer audio signals and from the handset and the media relay **17** using the sockets created above.

Referring back to Figure **1**, if the call is a regular, non-emergency call, and the call controller **14** receives a message of the type shown in Figure **32**, i.e., a type which has one call forwarding number and/or a voicemail number, the call controller attempts to establish a call (using message **1104** in Figure **38**) to the callee telephone **15** and if no call is established (i.e., message **1106** in Figure **38** is not received) within the associated TTL (**3600** seconds), the call controller **14** attempts to establish a call with the next user identified in the call routing message. This process is repeated until all call forwarding possibilities have been exhausted after respective times to live, in which case an audio path is established with the voicemail server **19** identified in the routing message. The voicemail server **19** sends message **1106** in response to receipt of message **1104** and functions as described above in connection with the callee telephone **15** to permit an outgoing audio message provided by the voicemail server to be heard by the caller and to permit the caller to record an audio message on the voicemail server.

When audio paths are established, a call timer (not shown) maintained by the call controller logs the start date and time of the call and logs the call ID and an identification of the route (i.e., audio path IP address) for later use in billing, for example.

Terminating the Call

In the event that either the caller or the callee (or callee via the PSTN) terminates a call, the telephone of the terminating party (or gateway associated with the terminating party) sends a SIP Bye message to the call controller **14**. An exemplary SIP Bye message is shown at **900** in Figure **33**

and includes a caller field **902**, a callee field **904** and a call ID field **906**. The caller field **902** holds the caller username, the callee field **904** holds a PSTN compatible number or username, and the call ID field **906** holds a unique call identifier field of the type shown in the caller ID field **65** of the SIP Invite message shown in Figure **3**.

Thus, when terminating a regular non-emergency call, such as initiated by the Vancouver subscriber to the Calgary subscriber for example, referring to Figure **34**, a SIP Bye message is produced as shown generally at **908** and the caller field **902** holds a username identifying the Vancouver caller, in this case **2001 1050 8667**, the callee field **904** holds a username identifying the Calgary callee, in this case **2001 1050 2222**, and the callee ID field **906** holds the code FA**10** @ **192**.**168**.**0**.**20**, which is the call ID for the call.

The SIP Bye message shown in Figure **34** is received at the call controller **14** and the call controller executes a process as shown generally at **910** in Figure **35**. The process includes a first block **912** that directs the call controller circuit **100** to copy the caller, callee and call ID field contents from the SIP Bye message **900** shown in Figure **33** received from the terminating party to corresponding fields of an RC Call Stop message buffer (not shown). Block **914** then directs the call controller circuit **100** to copy the call start time from the call timer and to obtain a Call Stop time from the call timer. Block **916** then directs the call controller to calculate a communication session time by determining the difference in time between the call start time and the call stop time. This communication session time is then stored in a corresponding field of the RC Call Stop message buffer. Block **918** then directs the call controller circuit **100** to copy the route identifier from the call log. An RC Call Stop message produced as described above is shown generally at **1000** in Figure **36**. An RC Call Stop message specifically associated with the call made to the Calgary callee is shown generally at **1020** in Figure **37**.

Referring to Figure **36**, the RC Call Stop message includes a caller field **1002**, callee field **1004**, a call ID field **1006**, an account start time field **1008**, an account stop time field **1010**, a communication session time **1012** and a route field **1014**. The caller field **1002** holds a username, the callee field **1004** holds a PSTN-compatible number or system number, the call ID field **1006** holds the unique call identifier received from the SIP Invite message shown in Figure **3**, the account start time field **1008** holds the date and start time of the call, the account stop time field **1010** holds the date and time the call ended, the account session time field **1012** holds a value representing the difference between the start time and the stop time, in seconds, and the route field **1014** holds the IP address for the communications link that was established.

Referring to Figure **37**, an exemplary RC stop call message for the Calgary callee is shown generally at **1020**. In this example the caller field **1002** holds the username **2001 1050 8667** identifying the Vancouver caller and the callee field **1004** holds the username **2001 1050 2222** identifying the Calgary callee. The contents of the call ID field **1006** are FA**10** @ **192.168.0.20**. The contents of the accounting start time field **1008** are **2006-12-30 12:12:12** and the contents of the accounting stop time field are **2006-12-30 12:12:14**. The contents of the communication session time field **1012** are **2** to indicate **2** seconds call duration and the contents of the route field are **72.64.39.58**.

Referring back to Figure **35**, after having produced an RC Call Stop message, block **920** directs the call controller circuit **100** to send the RC stop message contained in the RC Call Stop message buffer to the routing controller **16**.

The routing controller **16** receives the Call Stop message and an RC Call Stop message process is invoked at the RC to deal with charges and billing for the call.

Block **922** directs the call controller circuit **100** to send a Bye message back to the party that did not terminate the call.

Block **924** then directs the call controller circuit **100** to send a "Bye" message of the type shown in Figure **33** to the media relay **17** to cause the media relay to delete the caller and callee sockets it established for the call and to delete the bridge between the sockets.

While specific embodiments of the invention have been described and illustrated, such embodiments should be considered illustrative of the invention only and not as limiting the invention as construed in accordance with the accompanying claims.

What is claimed is:

1. A process for handling emergency calls from a caller in a voice over IP system, the method comprising:

receiving a routing request message including a caller identifier and a callee identifier;

setting an emergency call flag active in response to said callee identifier matching an emergency call identifier pre-associated with the caller;

producing an emergency response center identifier in response to said emergency call identifier;

determining whether said caller identifier is associated with a pre-associated direct inward dialing (DID) identifier;

producing a direct inward dialing (DID) identifier for said caller by associating a temporary DID identifier with said caller identifier when said emergency call flag is active and it is determined that said caller has no pre-associated DID identifier;

producing a routing message including said emergency response center identifier and said temporary DID identifier for receipt by a routing controller operable to cause a route to be established between the caller and said emergency response center.

2. The process of claim **1** wherein setting said emergency call flag active comprises retrieving a dialing profile associated with the caller and setting said emergency call flag active when the contents of an

emergency call identifier field of said dialing profile match said callee identifier.

3. The process of claim **2** wherein determining whether said caller identifier is associated with a pre-associated DID identifier comprises searching a database for a DID record associating a DID identifier with said caller and determining that said caller identifier is associated with a pre-associated DID identifier when said record associating a DID identifier with said caller is found.

4. The process of claim **3** wherein associating a pre-assigned DID identifier with said caller identifier comprises copying said pre-associated DID identifier from said DID record to a DID identifier buffer.

5. The process of claim **4** wherein producing said routing message comprises causing the contents of said DID identifier buffer to define said DID identifier in said routing message.

6. The process of claim **2** wherein determining whether said caller identifier is associated with a pre-associated DID identifier comprises searching a database for a DID record associating a DID identifier with said caller and determining that said caller identifier is not associated with a pre-associated DID identifier when a record associating a DID identifier with said caller is not found.

7. The process of claim **6** wherein associating a temporary DID identifier with said caller identifier comprises associating with said caller identifier a DID identifier from a pool of pre-determined DID identifiers.

8. The process of claim **7** wherein associating said DID identifier from said pool comprises associating a temporary DID record with said

caller, said temporary DID record having a DID identifier field populated with said DID identifier from said pool.

9. The process of claim **8** wherein associating said DID identifier from said pool comprises copying said DID identifier from said temporary DID record to a DID identifier buffer.

10. The process of claim **9** wherein producing said routing message comprises causing the contents of said DID identifier buffer to define said DID identifier in said routing message.

11. The process of claim **8** further comprising canceling said temporary DID record after a pre-defined period of time.

12. The process of claim **2** wherein producing said emergency response center identifier comprises obtaining an emergency response center identifier from an emergency response center field of said dialing profile associated with said caller.

13. The process of claim **12** wherein obtaining comprises copying an emergency response center identifier from said dialing profile associated with said caller to a routing message buffer such that the emergency response center identifier is included in the routing message.

14. The process of claim **1** wherein producing said routing message comprises causing said routing message to specify a maximum call time for said emergency call, said maximum call time exceeding a duration of an average non-emergency telephone call.

15. An apparatus for handling emergency calls from a caller in a voice over IP system, the apparatus comprising:

means for receiving a routing request message including a caller identifier and a callee identifier;

setting means for setting an emergency call flag active in response to said callee identifier matching an emergency call identifier pre-associated with the caller;

means for producing an emergency response center identifier in response to said emergency call identifier;

means for determining whether said caller identifier is associated with a pre-associated direct inward dialing (DID) identifier; and

means for producing a direct inward dialing (DID) identifier for said caller including:

means for associating a temporary DID identifier with said caller identifier in response to said emergency call flag being active and said caller not being pre-associated with a direct inward dialing identifier; and

means for producing a routing message including said emergency response center identifier and said temporary DID identifier or said pre-assigned DID identifier for receipt by a routing controller operable to cause a route to be established between the caller and said emergency response center.

16. The apparatus of claim **15** further comprising means for accessing a database of dialing profiles associated with respective subscribers to

said system, each of said dialing profiles including an emergency call identifier field and an emergency call center field and wherein said setting means comprises means for retrieving a dialing profile associated with the caller and for setting said emergency call flag active when the contents of said emergency call identifier field of said dialing profile match said callee identifier.

17. The apparatus of claim **16** further comprising database accessing means for accessing a database including direct inward dialing (DID) records associated with at least some subscribers to said system, each of said direct inward dialing records comprising a system username and a direct inward dialing number, and wherein said determining means comprises searching means for a database for a DID record associating a DID identifier with said caller and wherein said determining means is operably configured to determine that said caller identifier is associated with a pre-associated DID identifier when said record associating a DID identifier with said caller is found.

18. The apparatus of claim **17** further comprising a DID identifier buffer and wherein said means for associating a pre-assigned DID identifier with said caller identifier comprises means for copying said pre-associated DID identifier from said DID record to said DID identifier buffer.

19. The apparatus of claim **18** wherein said means for producing said routing message comprises means for causing the contents of said DID identifier buffer to define said DID identifier in said routing message.

20. The apparatus of claim **16** further comprising database accessing means for accessing a database including direct inward dialing records associated with at least some subscribers to said system, each of said direct inward dialing records comprising a system username and a

direct inward dialing number and wherein said determining means comprises searching means for searching a database for a DID record associating a DID identifier with said caller and wherein said determining means is operably configured to determine that said caller identifier is not associated with a pre-associated DID identifier when a record associating a DID identifier with said caller is not found.

21. The apparatus of claim **18** further comprising means for accessing a pool of pre-determined DID identifiers and wherein said means for associating a temporary DID identifier with said caller identifier comprises means for associating a DID identifier from said pool of pre-determined DID identifiers with said caller identifier.

22. The apparatus of claim **20** wherein said means for associating said DID identifier from said pool comprises means for associating a temporary DID record with said caller, said temporary DID record having a DID identifier field populated with said DID identifier from said pool.

23. The apparatus of claim **22** wherein said means for associating comprises means for copying said DID identifier from said temporary DID record to a DID identifier buffer.

24. The apparatus of claim **22** wherein said means for producing said routing message comprises means for causing the contents of said DID identifier buffer to define said DID identifier in said routing message.

25. The apparatus of claim **22** further comprising means for canceling said temporary DID record after a period of time.

26. The apparatus of claim **16** wherein said means for producing said emergency response center identifier comprises means for obtaining

an emergency response center identifier from an emergency response center field of said dialing profile associated with said caller.

27. The apparatus of claim **26** further comprising a routing message buffer and wherein said means for obtaining comprises means for copying the contents of said emergency response center field of said dialing profile associated with said caller to the routing message bufer such that said contents of said emergency response center field are included in said routing message.

28. The apparatus of claim **27** wherein said means for producing said routing message comprises means for causing said routing message to include a maximum call time for said emergency call, said maximum call time exceeding a duration of an average non-emergency telephone call.

29. An apparatus for handling emergency calls from a caller in a voice over IP system, the apparatus comprising a processor circuit operably configured to:

receive a routing request message including a caller identifier and a callee identifier;

set an emergency call flag active in response to said callee identifier matching an emergency call identifier pre-associated with the caller;

produce an emergency response center identifier in response to said emergency call identifier;

determine whether said caller identifier is associated with a pre-associated direct inward dialing (DID) identifier;

produce a direct inward dialing (DID) identifier for said caller by associating a temporary DID identifier with said caller identifier when said emergency call flag is active and it is determined that said caller has no pre-associated DID identifier; and

produce a routing message including said emergency response center identifier and said temporary DID identifier for receipt by a routing controller operable to cause a route to be established between the caller and said emergency response center.

30. The apparatus of claim **29** wherein said processor circuit is operably configured to retrieve a dialing profile associated with the caller and set said emergency call flag active when the contents of an emergency call identifier field of said dialing profile match said callee identifier.

31. The apparatus of claim **30** wherein said processor circuit is operably configured to search a database for a DID record associating a DID identifier with said caller and determine that said caller identifier is associated with a pre-associated DID identifier when said record associating a DID identifier with said caller is found.

32. The apparatus of claim **31** wherein said processor circuit is operably configured to copy said pre-associated DID identifier from said DID record to a DID identifier buffer.

33. The apparatus of claim **32** wherein said processor circuit is operably configured to cause the contents of said DID identifier buffer to define said DID identifier in said routing message.

34. The apparatus of claim **30** wherein said processor circuit is operably configured to search a database for a DID record associating a DID

identifier with said caller and determine that said caller identifier is not associated with a pre-associated DID identifier when a record associating a DID identifier with said caller is not found.

35. The apparatus of claim **32** wherein said processor circuit is operably configured to associate with said caller identifier a DID identifier from a pool of pre-determined DID identifiers.

36. The apparatus of claim **35** wherein said processor circuit is operably configured to associate a temporary DID record with the caller, said temporary DID record having a DID identifier field populated with said DID identifier from said pool.

37. The apparatus of claim **36** wherein said processor circuit is operably configured to copy said DID identifier from said temporary DID record to a DID buffer.

38. The apparatus of claim **35** wherein said processor circuit is operably configured to cause the contents of said DID identifier buffer to define said DID identifier in said routing message.

39. The apparatus of claim **36** wherein said processor circuit is operably configured to cancel said temporary DID record after a period of time.

40. The apparatus of claim **30** wherein said processor circuit is operably configured to obtain an emergency response center identifier from an emergency response center field of said dialing profile associated with said caller.

41. The apparatus of claim **40** further comprising a routing message buffer and wherein said processor circuit is operably configured to copy an emergency response center identifier from said dialing profile

associated with said caller to said routing message buffer such that said emergency response center identifier is included in said routing message.

42. The apparatus of claim **29** wherein said processor circuit is operably configured to cause said routing message to include a maximum call time for said emergency call, said maximum call time exceeding a duration of an average non-emergency telephone call.

43. A computer readable medium encoded with codes for directing a processor circuit to handle emergency calls from callers in a voice over IP system, said codes directing said processor circuit to:

receive a routing request message including a caller identifier and a callee identifier;

set an emergency call flag active in response to said callee identifier matching an emergency call identifier pre-associated with the caller;

produce an emergency response center identifier in response to said emergency call identifier;

determine whether said caller identifier is associated with a pre-associated direct inward dialing (DID) identifier;

produce a direct inward dialing (DID) identifier for said caller by associating a temporary DID identifier with said caller identifier when said emergency call flag is active and it is determined that said caller has no pre-associated DID identifier; and

produce a routing message including said emergency response center identifier and said temporary DID identifier for receipt by a routing controller operable to cause a route to be established between the caller and said emergency response center.

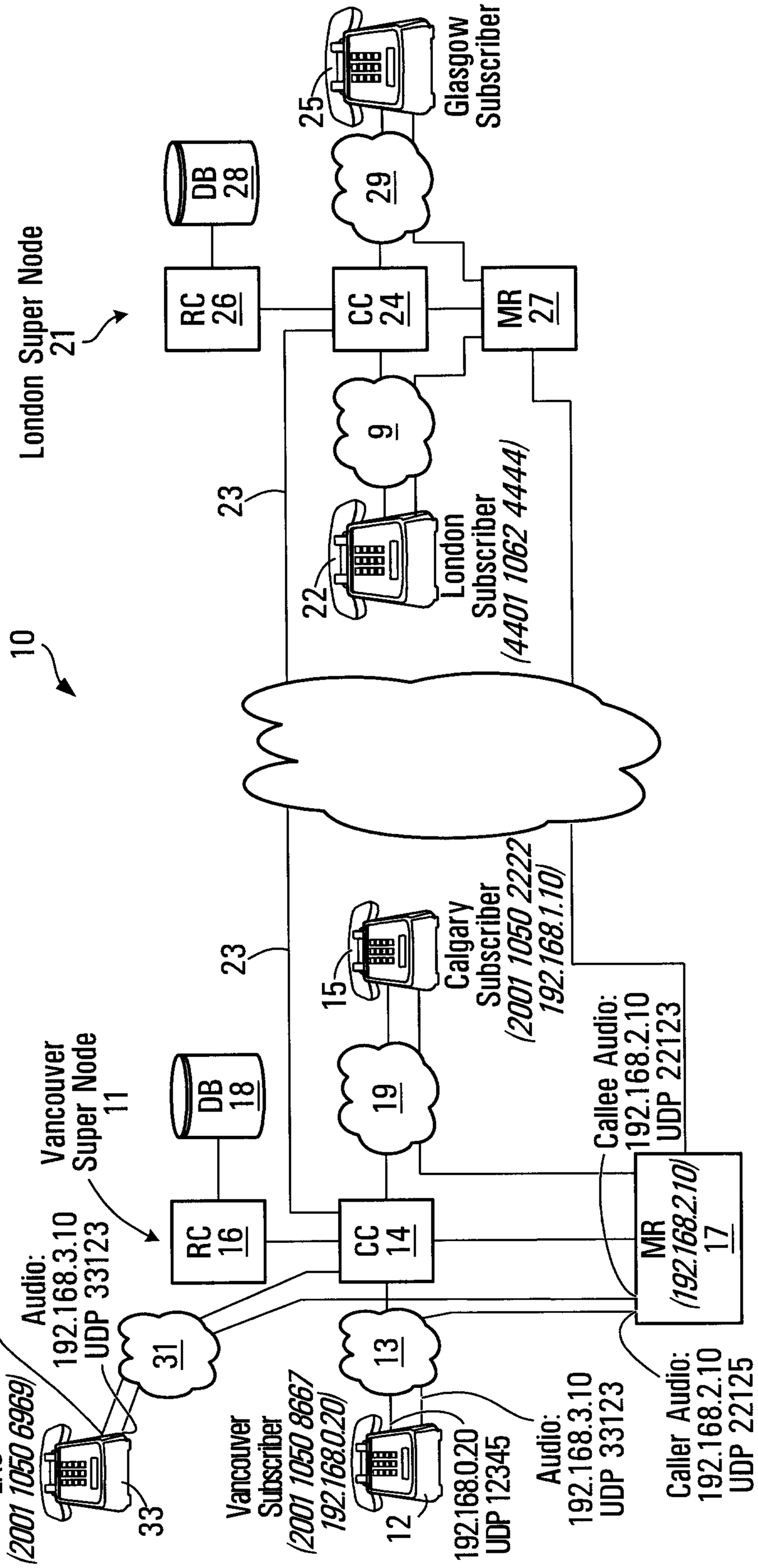
London Super Node
21
DB
28
RC
26
CC
24
MR
27
29
Glasgow
Subscriber
25
9
23
London
Subscriber
(4401 1062 4444)
22
10
Vancouver
Super Node
11
DB
18
RC
16
CC
14
MR
17
19
31
13
23
Calgary
Subscriber
(2001 1050 2222
192.168.1.10)
15
Callee Audio:
192.168.2.10
UDP 22123
(192.168.2.10)
ERC
(2001 1050 6969)
192.163.0.30
Audio:
192.168.3.10
UDP 33123
33
Vancouver
Subscriber
(2001 1050 8667
192.168.0.20)
12
192.168.0.20
UDP 12345
Audio:
192.168.3.10
UDP 33123
Caller Audio:
192.168.2.10
UDP 22125

FIG. 1

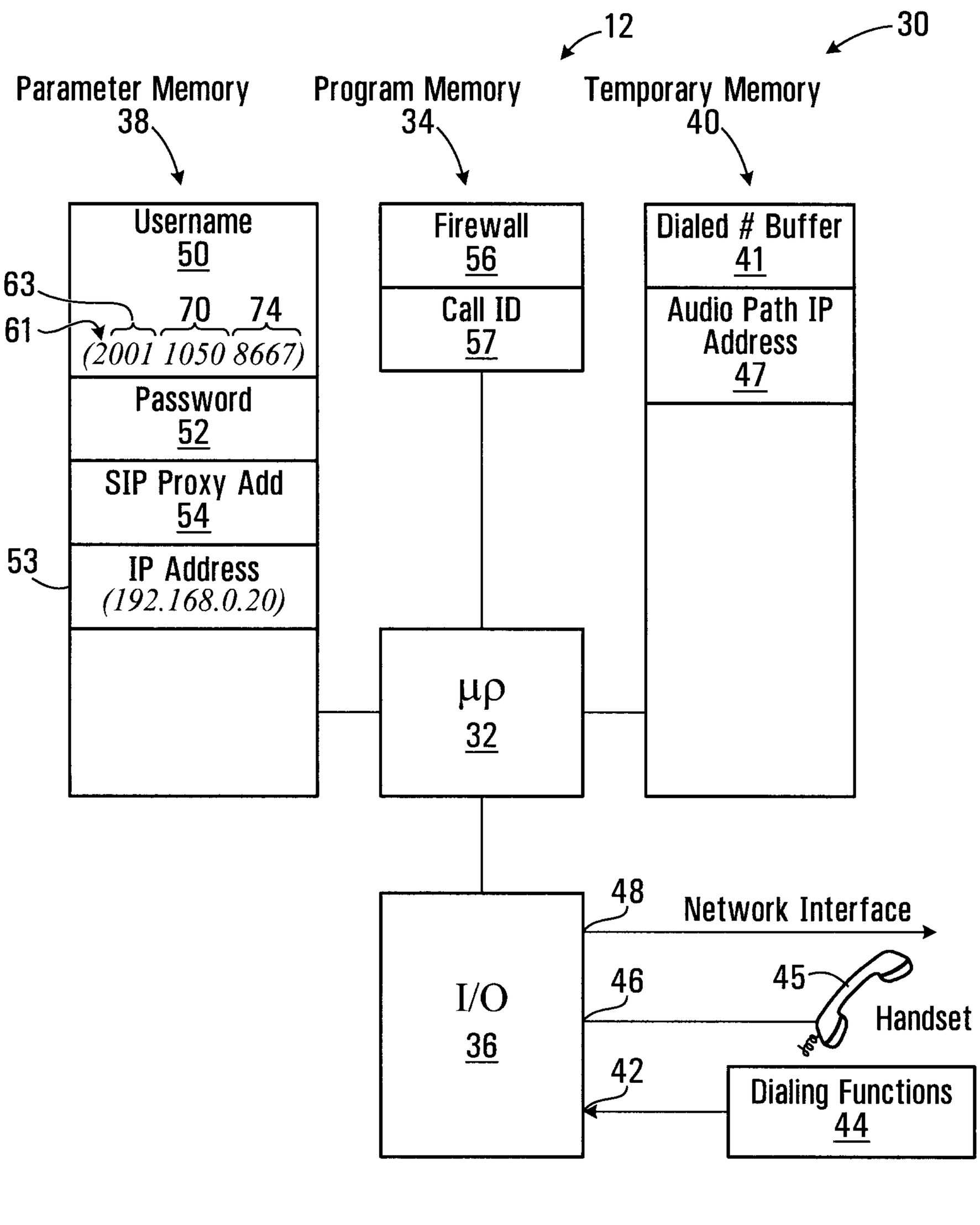
Phone
12
30
Parameter Memory
Program Memory
Temporary Memory
38
34
40
Username
50
63
61
70
74
(2001 1050 8667)
Password
52
SIP Proxy Add
54
53
IP Address
(192.168.0.20)
Firewall
56
Call ID
57
Dialed # Buffer
41
Audio Path IP Address
47
μρ
32
I/O
36
48
Network Interface
46
45
Handset
42
Dialing Functions
44

FIG. 2

SIP Invite Message 59

60	Caller	2001 1050 8667
62	Callee	4401 1062 4444
64	Digest Parameters	XXXXXXX
65	Call ID	FF10@ 192.168.0.20
67	Caller IP Address	192.168.0.20
69	Caller UDP port	12345

FIG. 3

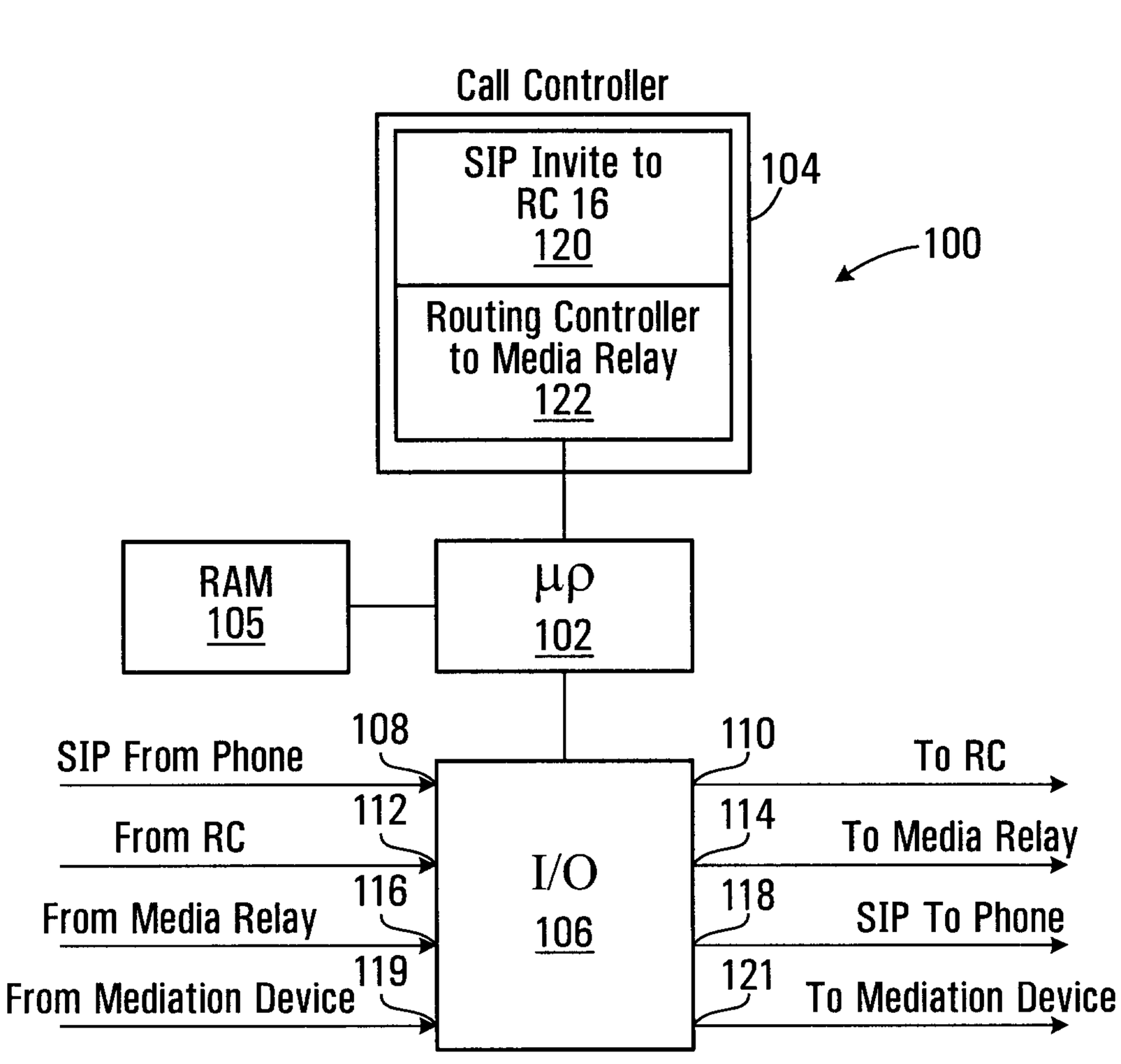

FIG. 4

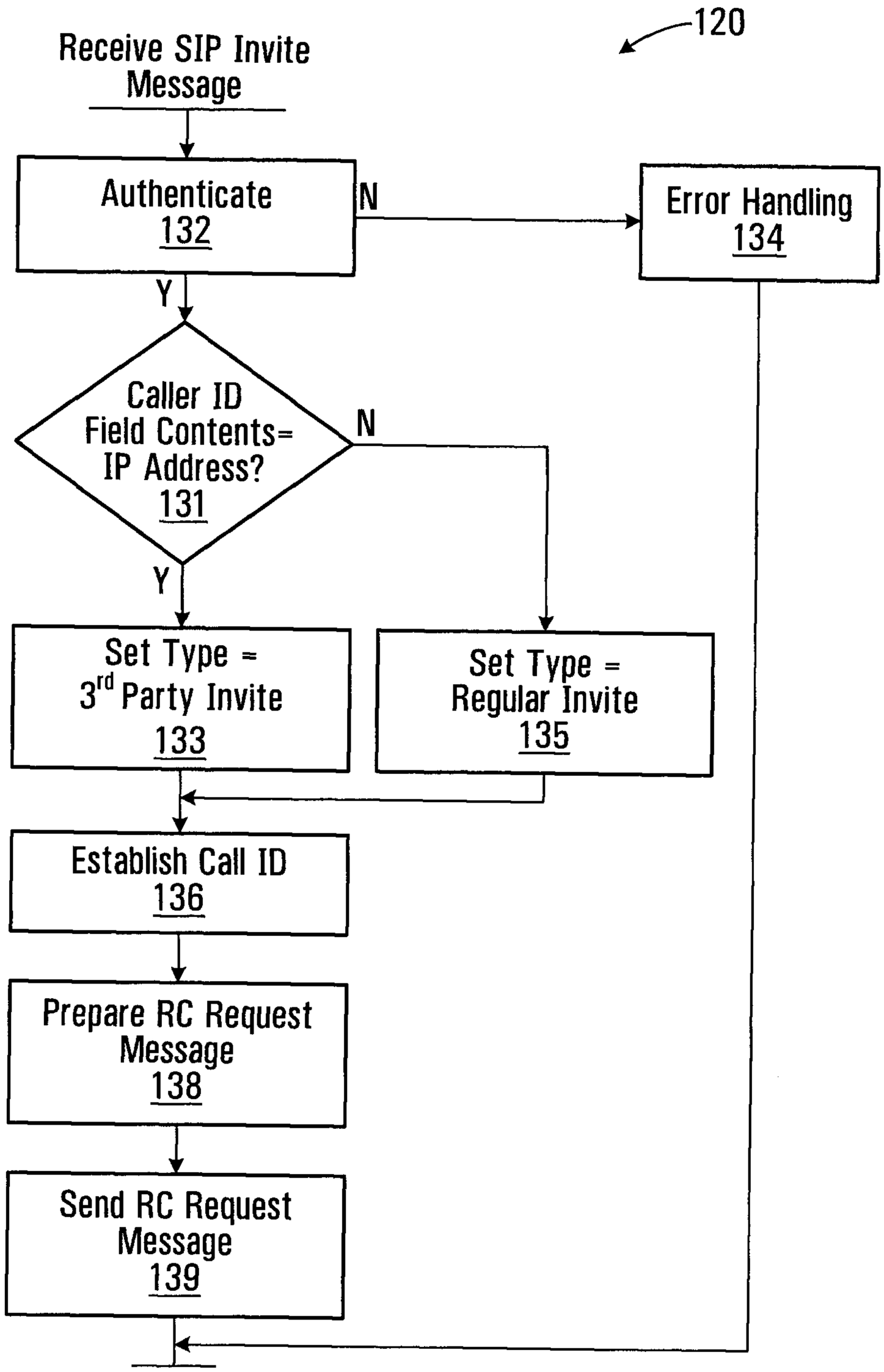
Call Controller
Receive SIP Invite Message
120
Authenticate
132
N
Error Handling
134
Y
Caller ID Field Contents= IP Address?
131
N
Y
Set Type = 3rd Party Invite
133
Set Type = Regular Invite
135
Establish Call ID
136
Prepare RC Request Message
138
Send RC Request Message
139

FIG. 5

150

RC Request Message

152	Caller	2001 1050 8667
154	Callee	4401 1062 4444 (911)
156	Digest	XXXXXXX
158	Call ID	FF10@ 192.168.0.20
160	Type	Subscriber

FIG. 6

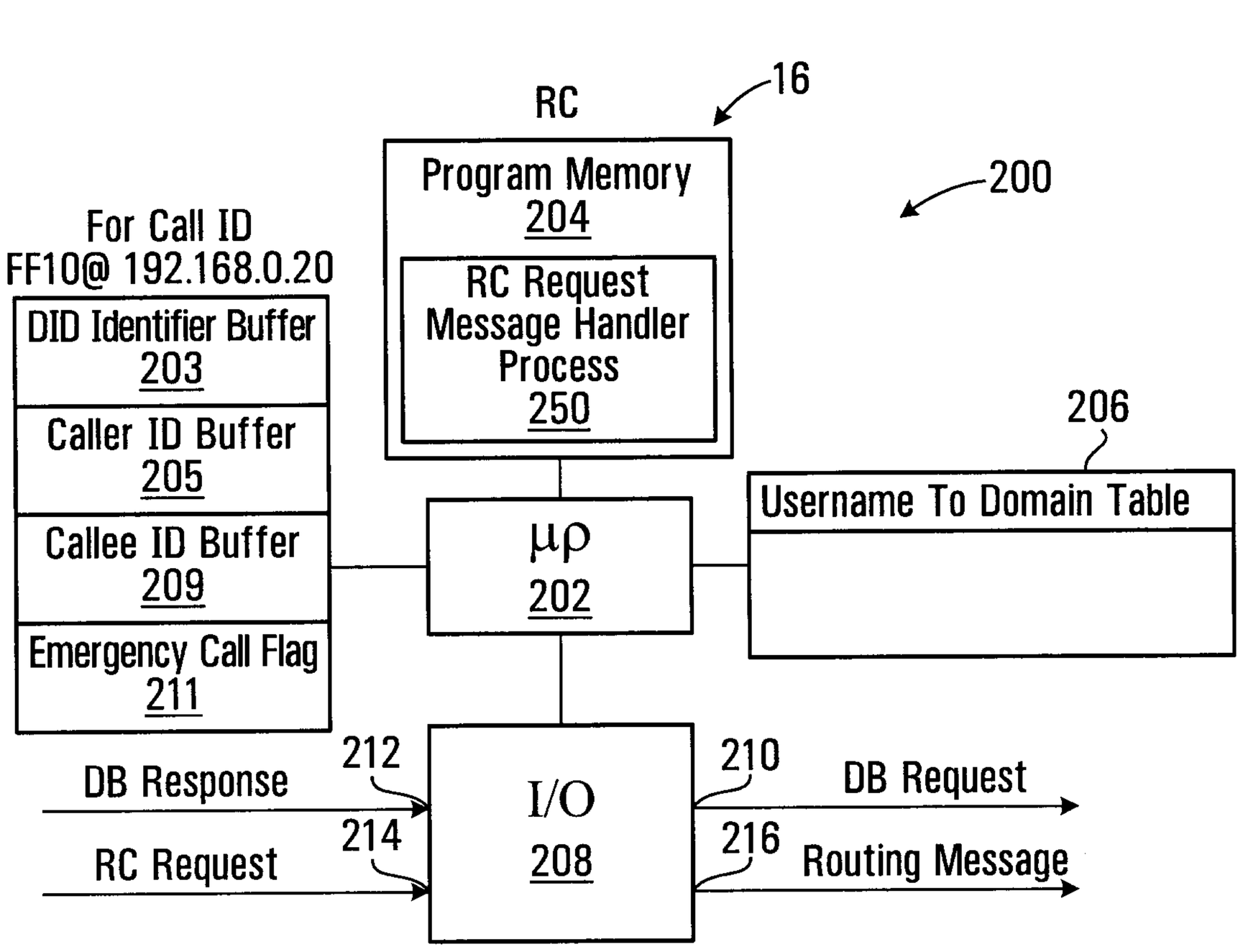

FIG. 7

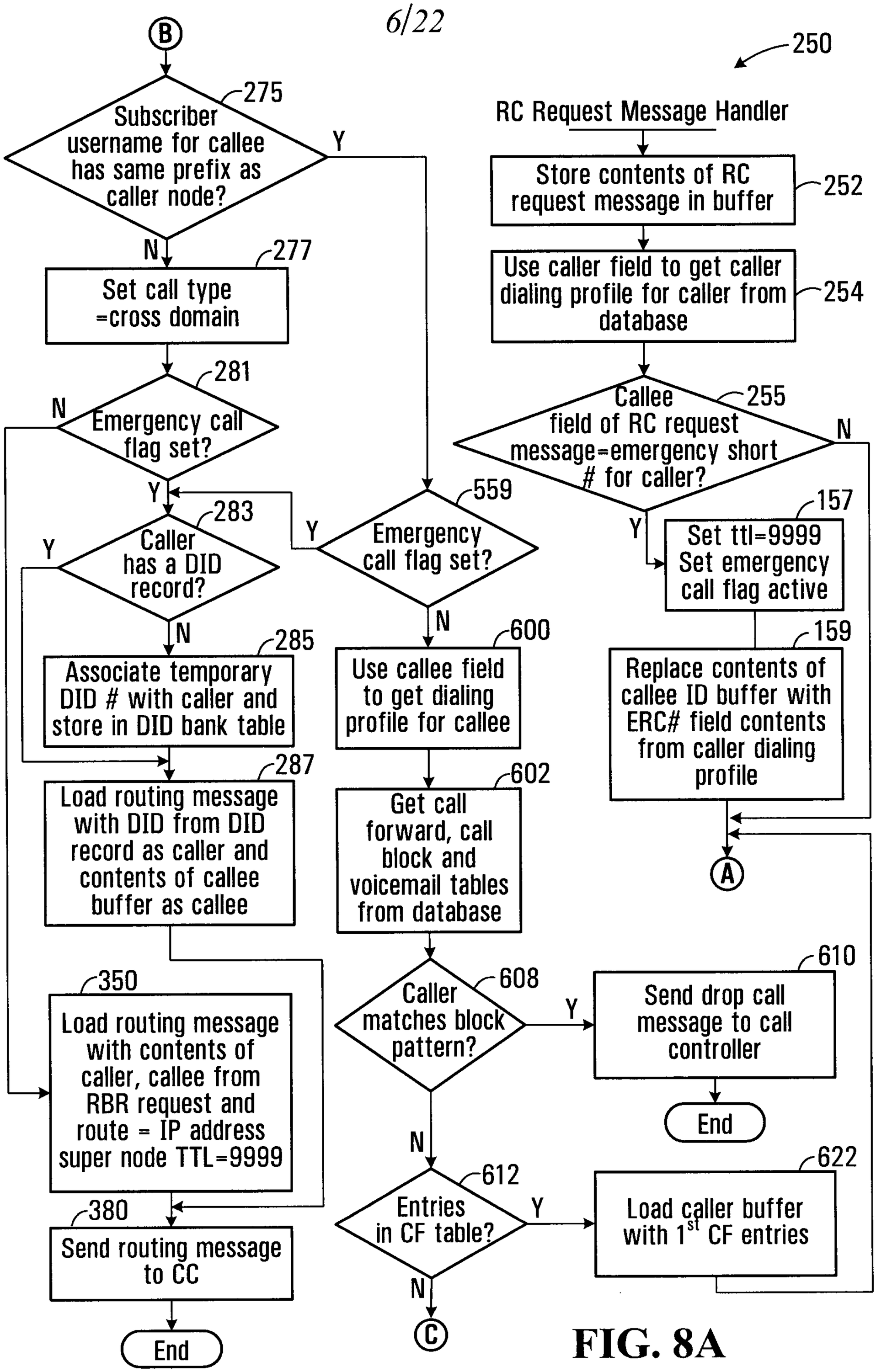
B
275
Subscriber username for callee has same prefix as caller node?
Y
N
277
Set call type =cross domain
281
Emergency call flag set?
N
Y
283
Caller has a DID record?
Y
N
285
Associate temporary DID # with caller and store in DID bank table
287
Load routing message with DID from DID record as caller and contents of callee buffer as callee
350
Load routing message with contents of caller, callee from RBR request and route = IP address super node TTL=9999
380
Send routing message to CC
End
559
Emergency call flag set?
Y
N
600
Use callee field to get dialing profile for callee
602
Get call forward, call block and voicemail tables from database
608
Caller matches block pattern?
Y
N
612
Entries in CF table?
Y
N
C
610
Send drop call message to call controller
End
622
Load caller buffer with 1st CF entries
250
RC Request Message Handler
252
Store contents of RC request message in buffer
254
Use caller field to get caller dialing profile for caller from database
255
Callee field of RC request message=emergency short # for caller?
Y
N
157
Set ttl=9999 Set emergency call flag active
159
Replace contents of callee ID buffer with ERC# field contents from caller dialing profile
A

FIG. 8A

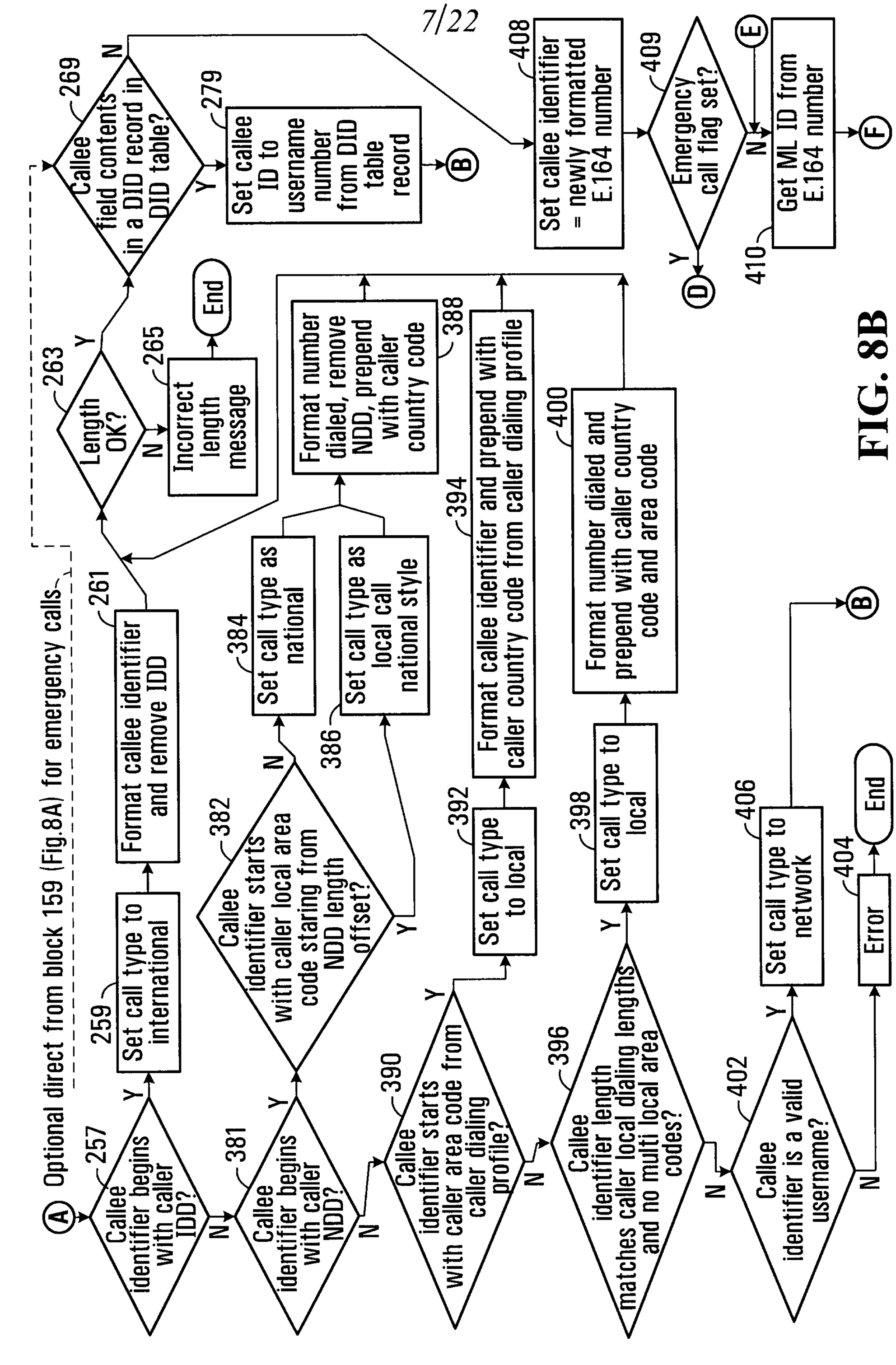
Optional direct from block 159 (Fig.8A) for emergency calls
Callee identifier begins with caller IDD?
257
Y
N
Callee identifier begins with caller NDD?
381
Y
N
Callee identifier starts with caller area code from caller dialing profile?
390
Y
N
Callee identifier length matches caller local dialing length and no multi local area codes?
396
Y
N
Callee identifier is a valid username?
402
Y
N
Set call type to network
406
Error
404
End
Callee identifier starts with caller local area code staring from NDD length offset?
382
Y
N
Set call type to local
392
Set call type to local
398
Set call type as national
384
Set call type as local call national style
386
Format callee identifier and prepend with caller country code from caller dialing profile
394
Format number dialed and prepend with caller country code and area code
400
Format number dialed, remove NDD, prepend with caller country code
388
Set callee identifier = newly formatted E.164 number
408
Emergency call flag set?
409
Y
N
Get ML ID from E.164 number
410
Format callee identifier and remove IDD
261
Set call type to international
259
Callee field contents in a DID record in DID table?
269
Y
N
Set callee ID to username number from DID table record
279
Length OK?
263
Y
N
Incorrect length message
265
End
A
B
C
D
E
F

FIG. 8B

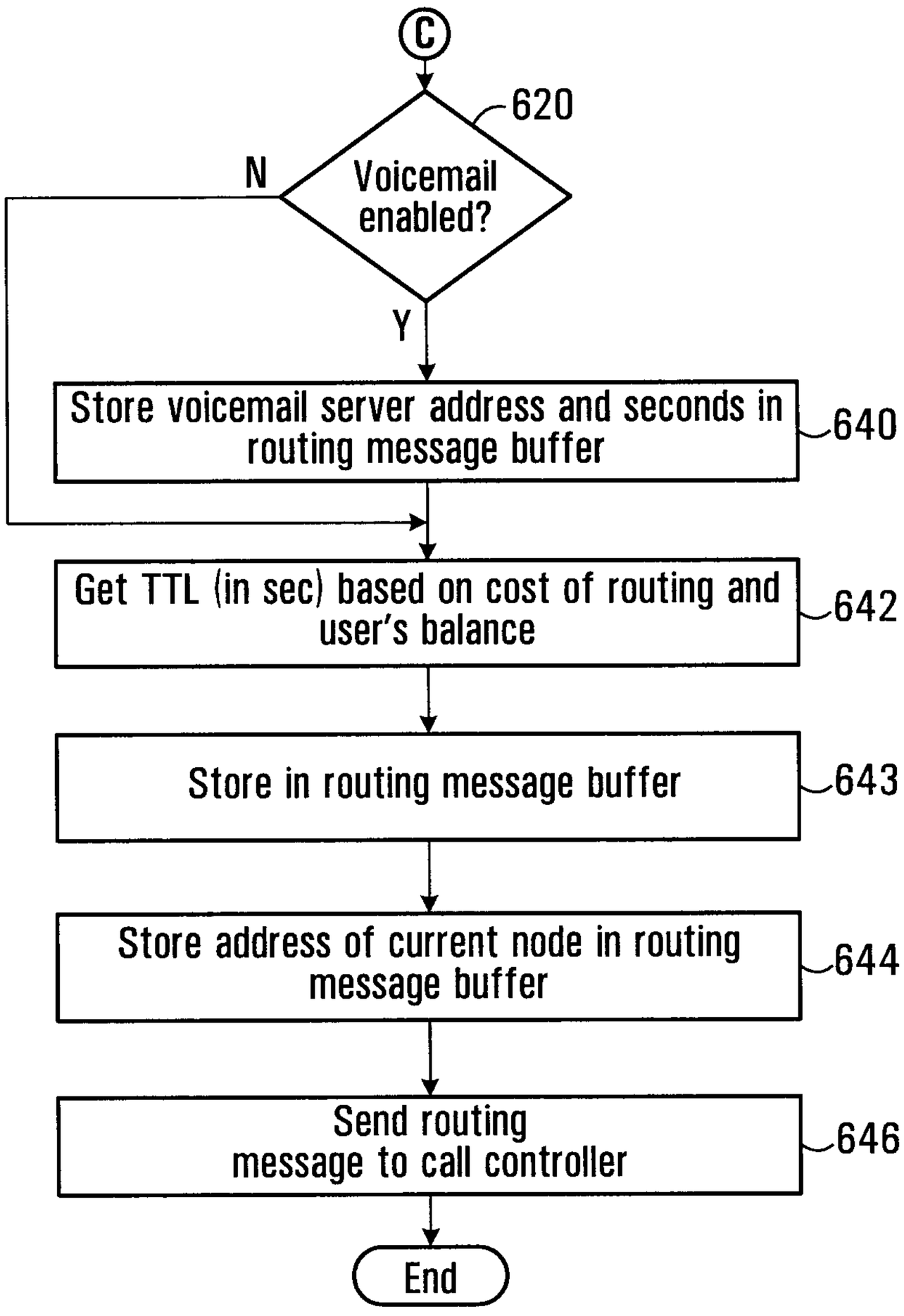
C
620
N
Voicemail enabled?
Y
Store voicemail server address and seconds in routing message buffer
640
Get TTL (in sec) based on cost of routing and user's balance
642
Store in routing message buffer
643
Store address of current node in routing message buffer
644
Send routing message to call controller
646
End

FIG. 8C

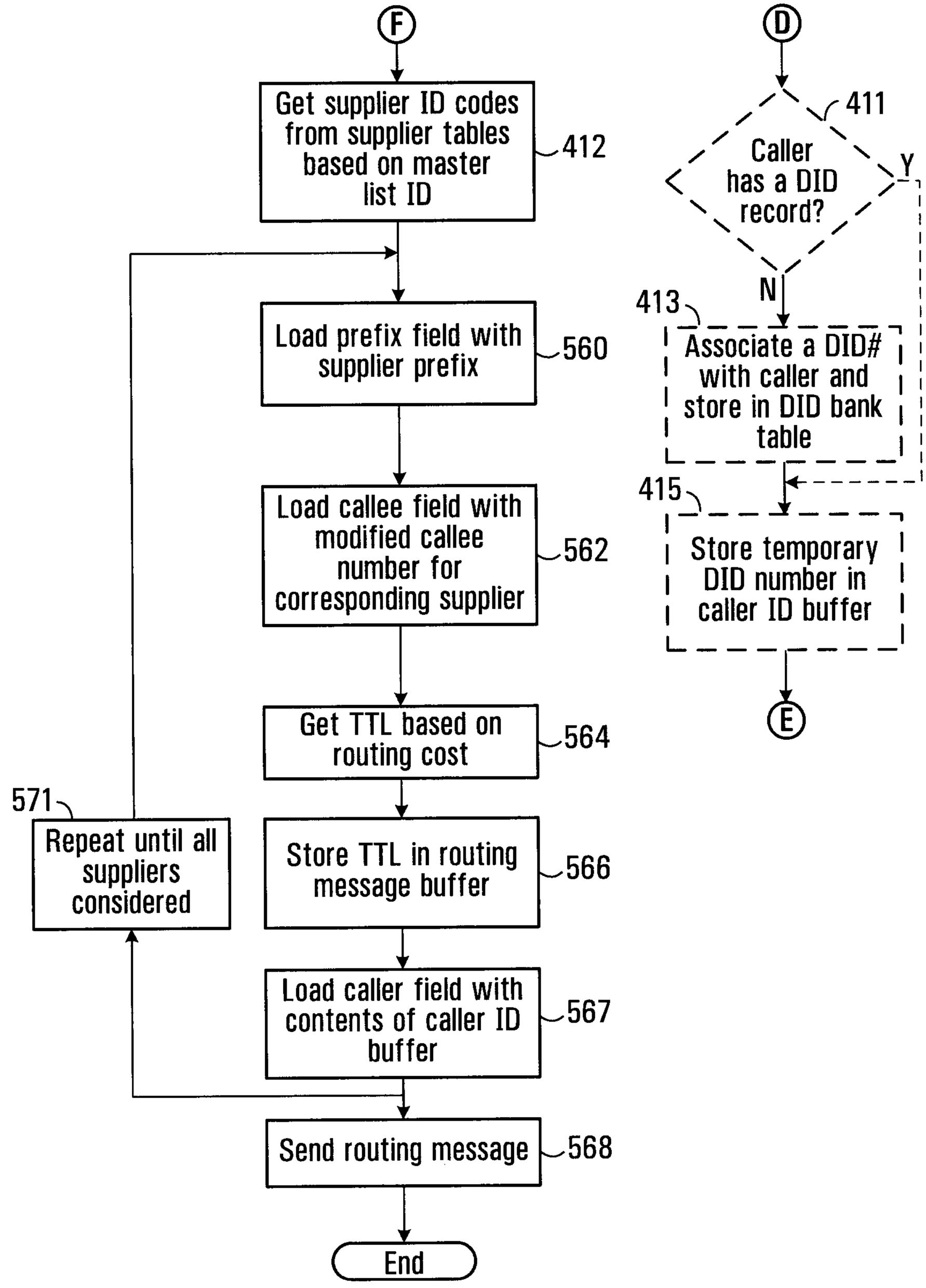
F
Get supplier ID codes from supplier tables based on master list ID
412
Load prefix field with supplier prefix
560
Load callee field with modified callee number for corresponding supplier
562
Get TTL based on routing cost
564
Store TTL in routing message buffer
566
Load caller field with contents of caller ID buffer
567
Send routing message
568
End
571
Repeat until all suppliers considered
D
411
Caller has a DID record?
Y
N
413
Associate a DID# with caller and store in DID bank table
415
Store temporary DID number in caller ID buffer
E

FIG. 8D

256

Dialing Profile for a User

258	**Username**	Assigned on Subscription
260	**Domain**	Domain Associated with User
262	**NDD**	1
264	**IDD**	011
266	**Country Code**	1
267	**Local Area Codes**	604;778
268	**Caller Minimum Local Length**	10
270	**Caller Maximum Local Length**	10
273	**Reseller**	Retailer
275	**Subscriber Address**	The Users Street Address
277	**Emergency Short#**	Local Emergency No. (e.g. 911)
279	**ERC#**	Emergency Response Center Number

FIG. 9

Dialing Profile for Vancouver Subscriber

276

61

284 63 70 74

258	**Username**	2001 1050 8667
260	**Domain**	sp yvr digifonica com → 282
262	**NDD**	1 (286, 288, 290)
264	**IDD**	011
266	**Country Code**	1
267	**Local Area Codes**	604;778 (Vancouver)
268	**Caller Minimum Local Length**	10
270	**Caller Maximum Local Length**	10
273	**Reseller**	Klondike
275	**User Address**	2200 650 Georgia St. Van. B.C. Canada V4M 3G8
277	**Emergency Call Identifier#**	911
279	**ERC#**	604 666 3655

FIG. 10

Dialing Profile for ERC Subscriber

Username	2001 1050 6969
Domain	sp.yvr.digifonica.com
NDD	1
IDD	011
Country Code	1
Local Area Codes	604
Caller Minimum Local Length	7
Caller Maximum Local Length	10
Reseller	Klondike
User Address	#Epson downs, Tripson Falls B.C. Canada V0N 2N3
Emergency Call Identifier#	911
ERC#	604 666 3655

FIG. 10A

Dialing Profile for Calgary Subscriber

Username	2001 1050 2222
Domain	sp.yvr.digifonica.com
NDD	1
IDD	011
Country Code	1
Local Area Codes	403
Caller Minimum Local Length	7
Caller Maximum Local Length	10
User Address	1210 Deerfoot Trail SE, Calgary Alberta Canada HOH OHO
Emergency Short#	911
ERC#	403 123 4567

FIG. 11

Dialing Profile for London Subscriber

Username	4401 1062 4444
Domain	sp.lhr.digifonica.com
NDD	0
IDD	00
Country Code	44
Local Area Codes	20 (London)
Caller Minimum Local Length	10
Caller Maximum Local Length	11
User Address	21 Basil Rd. Faulty Towers, London NW1 4NS
Emergency Short#	911
ERC#	7487-7973

FIG. 12

268

DID Bank Table Record Format

291	Username	System subscriber
272	User Domain	Host name of supernode
274	DID	E164#
For temporary DID records only	Creation Time	Current time when record is created
	Expiration Time	Time at which record is to be deleted

FIG. 13

276

DID Bank Table Record for Vancouver Subscriber

291	Username	2001 1050 8667
272	User Domain	sp.yvr.digifonica.com
274	DID	1 604 321 3353

293 295 297 299

FIG. 13A

276

DID Bank Table Record for Calgary Subscriber

291	Username	2001 1050 2222
272	User Domain	sp.yvr.digifonica.com
274	DID	1 403 516 0744

293 295 297 299

FIG. 13B

276

DID Bank Table Record for London Subscriber

291	Username	4401 1062 4444
272	User Domain	sp.lhr.digifonica.com
274	DID	44 020 7487 7900

293 295 297 299

FIG. 14

352

Routing Message Buffer

354	Supplier Prefix (optional)	Code identifying supplier traffic
356	Delimiter	Symbol separating fields
358	Callee	PSTN compatible number or Digifonica number
360	Route	Domain name and IP address
362	Time to Live(TTL)	In seconds
364	Caller ID	DID number or username (contents of callee ID buffer)

FIG. 15

366

Routing Message for Emergency Call

200110506969@sp.yvr.digifonica.com;ttl=9999;CLI=16043213353

358 360 362 364

FIG. 16

366

Routing Message Different Node

440110624444@sph.lhr.digifonica.com;ttl=9999;CLI=200110508667

358 360 362 364

FIG. 16A

370

Prefix to Supernode Table Record Format

372	Prefix	First n digits of callee identifier
374	Supernode Address	IP address or fully qualified domain name

FIG. 17

Prefix to Supernode Table Record for London Subscriber

Prefix	4
Supernode Address	sp.lhr.digifonica.com

FIG. 18

Master List Record Format

500	ml_id	1019
502	Dialing code	1604
504	Country code	The country code is the national prefix to be used when dialing TO a particular country FROM another country.
506	Nat Sign #(Area Code)	604
508	Min Length	7
510	Max Length	7
512	NDD	The NDD prefix is the access code used to make a call **WITHIN** that country from on city to another (when calling another city in the same vicinity, this may not be necessary).
514	IDD	The **IDD prefix** is the international prefix needed to dial a call **FROM** the country listed **TO** another country.
516	Buffer rate	Safe charge rate above the highest rate charged by suppliers

FIG. 19

Example: Master List Record with Populated Fields

ml_id	1019
Dialing code	1604
Country code	1
Nat Sign #(Area Code)	604
Min Length	7
Max Length	7
NDD	1
IDD	011
Buffer rate	$0.009/min

FIG. 20

Suppliers List Record Format

540	Sup_id	Name code
542	MI_id	Numeric code
544	Prefix (optional)	String identifying supplier's traffic #
546	Route	IP address
548	NDD/IDD rewrite	
550	Rate	Cost per second to Digifonica to use this route

FIG. 21

(Telus) Supplier Record

Sup_id	2010 (Telus)
MI_id	1019
Prefix (optional)	4973#
Route	72.64.39.58
NDD/IDD rewrite	011
Rate	$0.02/min

FIG. 22

(Shaw) Supplier Record

Sup_id	2011 (Shaw)
MI_id	1019
Prefix (optional)	4974#
Route	73.65.40.59
NDD/IDD rewrite	011
Rate	$0.025/min

FIG. 23

(Sprint) Supplier Record

Sup_id	2012 (Sprint)
MI_id	1019
Prefix (optional)	4975#
Route	74.66.41.60
NDD/IDD rewrite	011
Rate	$0.03/min

FIG. 24

356

Routing Message Buffer for Gateway Call

570 ~ 4973#011604666365 5@72.64.39.58;ttl=3600;16046827780
572 ~ 4974#011604666365 5@73.65.40.59;ttl=3600;16046827780
574 ~ 4975#011604666365 5@74.66.41.60;ttl=3600;16046827780

FIG. 25

Call Block Table Record Format

604 ~	**Username**	Digifonica #
606 ~	**Block Pattern**	PSTN compatible or Digifonica #

FIG. 26

Call Block Table Record for Calgary Subscriber

604 ~	**Username of Callee**	2001 1050 2222
606 ~	**Block Pattern**	2001 1050 8664

FIG. 27

Call Forwarding Table Record Format for Callee

614 ~	**Username of Callee**	Digifonica #
616 ~	**Destination Number**	Digifonica #
618 ~	**Sequence Number**	Integer indicating order to try this

FIG. 28

Call Forwarding Table Record for Calgary Subscriber	
614 Username of Callee	2001 1050 2222
616 Destination Number	2001 1055 2223
618 Sequence Number	1

FIG. 29

Voicemail Table Record Format	
624 Username of Callee	Digifonica #
626 Vm Server	domain name
628 Seconds to Voicemail	time to wait before engaging voicemail
630 Enabled	yes/no

FIG. 30

Voicemail Table Record for Calgary Subscriber	
624 Username of Callee	2001 1050 2222
626 Vm Server	vm.yvr.digifonica.com
628 Seconds to Voicemail	20
630 Enabled	1

FIG. 31

Routing Message Buffer for CF/VM Routing Message	
650	200110502222@sp.yvr.digifonica.com;ttl=3600
652	200110552223@sp.yvr.digifonica.com;ttl=3600
654	vm.yvr.digifonica.com;20;ttl=60
656	sp.yvr.digifonica.com

FIG. 32

900

Bye Message

902	**Caller**	Username
904	**Callee**	PSTN compatible # or Username
906	**Call ID**	unique call identifier (hexadecimal string@IP))

FIG. 33

908

Bye Message

902	**Caller**	2001 1050 8667
904	**Callee**	2001 1050 2222
906	**Call ID**	FA10@192.168.0.20

FIG. 34

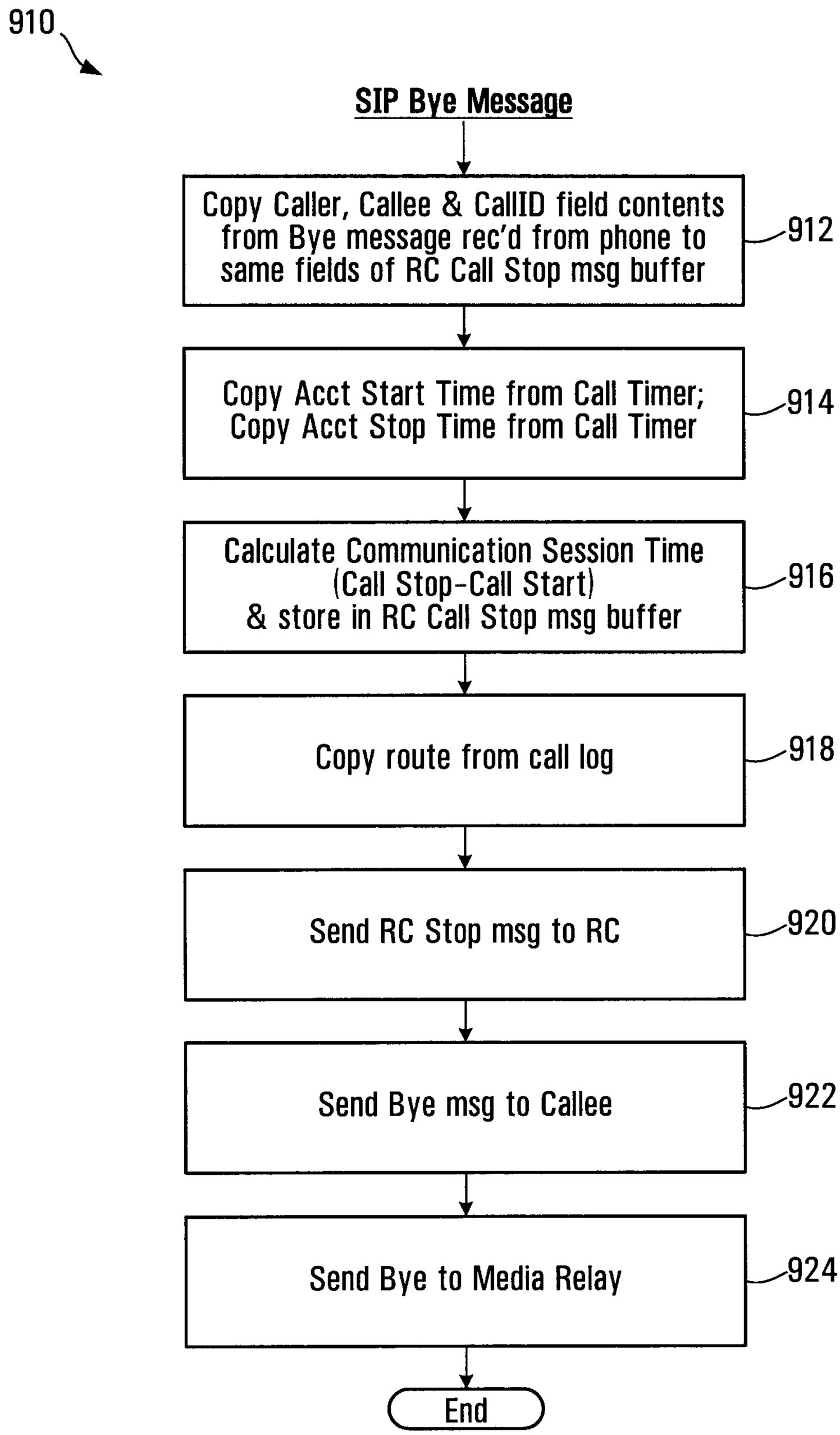
910
SIP Bye Message
Copy Caller, Callee & CallID field contents from Bye message rec'd from phone to same fields of RC Call Stop msg buffer
912
Copy Acct Start Time from Call Timer; Copy Acct Stop Time from Call Timer
914
Calculate Communication Session Time (Call Stop-Call Start) & store in RC Call Stop msg buffer
916
Copy route from call log
918
Send RC Stop msg to RC
920
Send Bye msg to Callee
922
Send Bye to Media Relay
924
End

FIG. 35

1000

RC Call Stop Message

1002	**Caller**	Username
1004	**Callee**	PSTN compatible # or Username
1006	**Call ID**	unique call identifier (hexadecimal string@IP)
1008	**Acct Start Time**	start time of call
1010	**Acct Stop Time**	time the call ended
1012	**Acct Session Time**	start time-stop time (in seconds)
1014	**Route**	IP address for the communications link that was established

FIG. 36

1020

RC Call Stop Message for Calgary Subscriber

1002	**Caller**	2001 1050 8667
1004	**Callee**	2001 1050 2222
1006	**Call ID**	FA10@192.168.0.20
1008	**Acct Start Time**	2006-12-30 12:12:12
1010	**Acct Stop Time**	2006-12-30 12:12:14
1012	**Acct Session Time**	2
1014	**Route**	72.64.39.58

FIG. 37

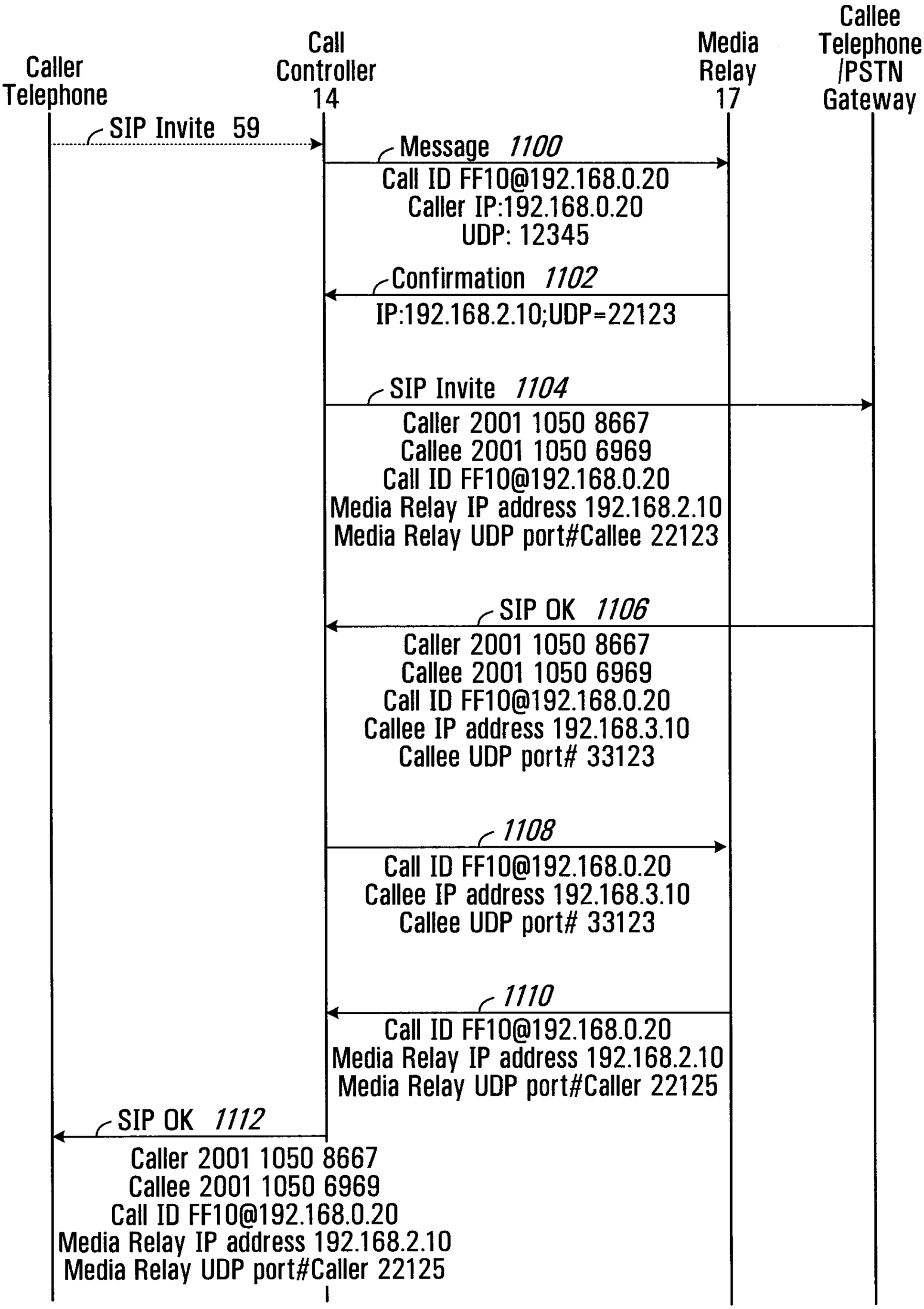
Caller Telephone
Call Controller 14
Media Relay 17
Callee Telephone /PSTN Gateway
SIP Invite 59
Message 1100
Call ID FF10@192.168.0.20
Caller IP:192.168.0.20
UDP: 12345
Confirmation 1102
IP:192.168.2.10;UDP=22123
SIP Invite 1104
Caller 2001 1050 8667
Callee 2001 1050 6969
Call ID FF10@192.168.0.20
Media Relay IP address 192.168.2.10
Media Relay UDP port#Callee 22123
SIP OK 1106
Caller 2001 1050 8667
Callee 2001 1050 6969
Call ID FF10@192.168.0.20
Callee IP address 192.168.3.10
Callee UDP port# 33123
1108
Call ID FF10@192.168.0.20
Callee IP address 192.168.3.10
Callee UDP port# 33123
1110
Call ID FF10@192.168.0.20
Media Relay IP address 192.168.2.10
Media Relay UDP port#Caller 22125
SIP OK 1112
Caller 2001 1050 8667
Callee 2001 1050 6969
Call ID FF10@192.168.0.20
Media Relay IP address 192.168.2.10
Media Relay UDP port#Caller 22125

FIG. 38

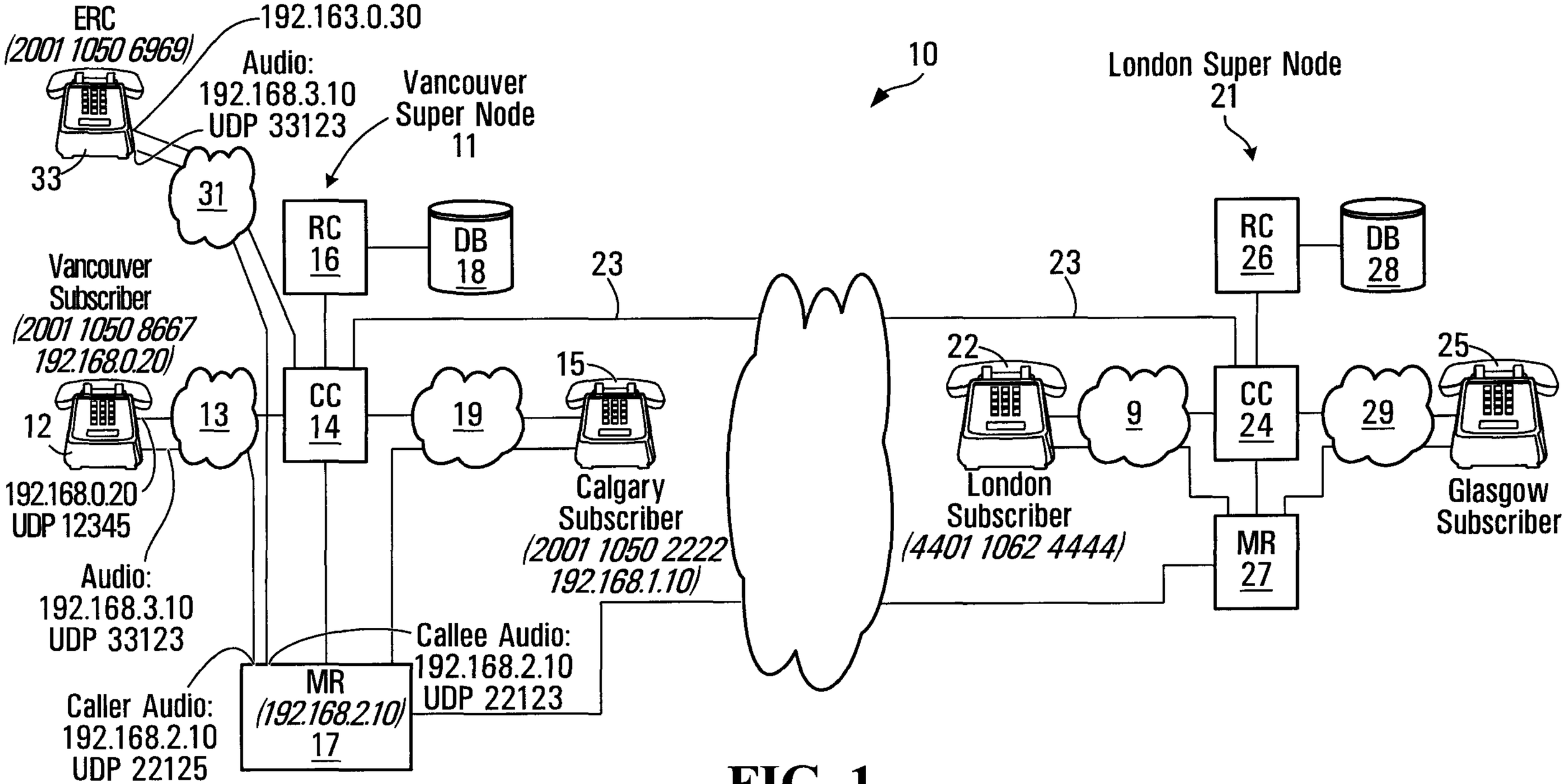
ERC
(2001 1050 6969)
192.163.0.30
Audio:
192.168.3.10
UDP 33123
33
31
Vancouver
Super Node
11
10
London Super Node
21
RC
16
DB
18
RC
26
DB
28
Vancouver
Subscriber
(2001 1050 8667
192.168.0.20)
23
23
22
15
25
12
13
CC
14
19
9
CC
24
29
192.168.0.20
UDP 12345
Calgary
Subscriber
(2001 1050 2222
192.168.1.10)
London
Subscriber
(4401 1062 4444)
Glasgow
Subscriber
MR
27
Audio:
192.168.3.10
UDP 33123
Callee Audio:
192.168.2.10
UDP 22123
Caller Audio:
192.168.2.10
UDP 22125
MR
(192.168.2.10)
17

FIG. 1