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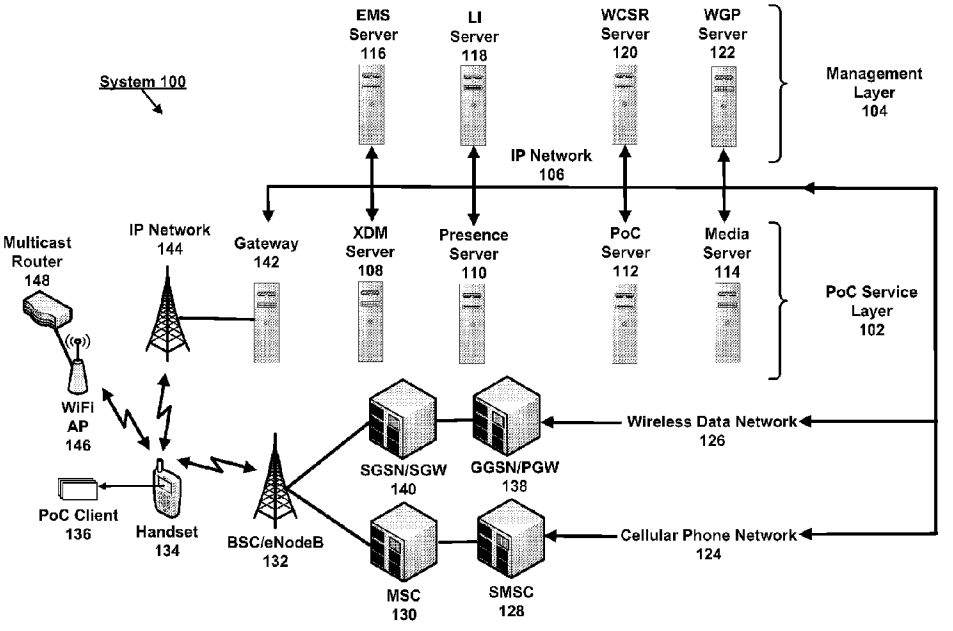
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(54) Title: RELAY-MODE AND DIRECT-MODE OPERATIONS FOR PUSH-TO-TALK-OVER-CELLULAR (POC) USING WIFI TECHNOLOGIES



(57) Abrégé/Abstract:
A system and method for relay-mode and direct-mode operations for Push-to-talkover-Cellular (PoC) using WiFi technologies. One or more servers interface to a wireless communications network to perform advanced voice services for mobile units therein, wherein the advanced voice services include an instant two-way half-duplex voice call within a group of the mobile units comprising a PoC call session. Both the servers and the mobile units that use the advanced group services communicate with each other using control messages within the wireless communications network. At least one of the servers switches voice messages for the advanced group services between the mobile units across the wireless communications network.

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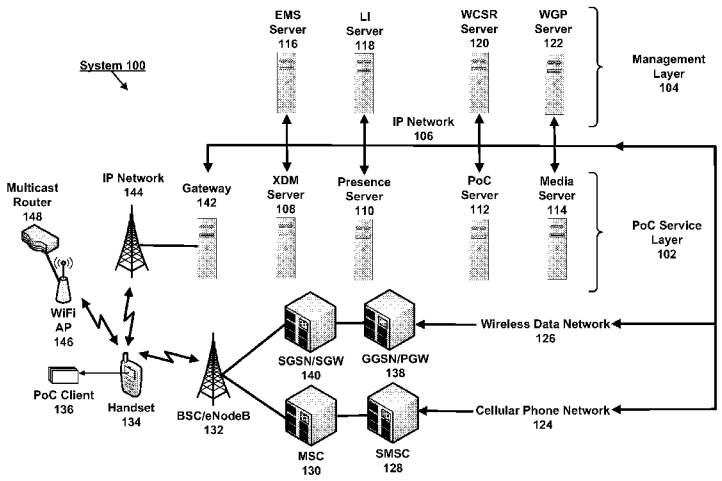


FIG. 1

(57) Abstract: A system and method for relay-mode and direct-mode operations for Push-to-talkover-Cellular (PoC) using WiFi technologies. One or more servers interface to a wireless communications network to perform advanced voice services for mobile units therein, wherein the advanced voice services include an instant two-way half-duplex voice call within a group of the mobile units comprising a PoC call session. Both the servers and the mobile units that use the advanced group services communicate with each other using control messages within the wireless communications network. At least one of the servers switches voice messages for the advanced group services between the mobile units across the wireless communications network.

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RELAY-MODE AND DIRECT-MODE OPERATIONS FOR PUSH-TO-TALK-OVER-CELLULAR (POC) USING WIFI TECHNOLOGIES

RELATED PATENT PUBLICATIONS

This application is related to the following commonly-assigned patents and patent publications:

United States Patent Publication Number **2005/0239485**, by Gorachand Kundu, Ravi Ayyasamy and Krishnakant Patel, entitled "DISPATCH SERVICE ARCHITECTURE FRAMEWORK", now United States Patent Number **7,787,896**, issued August **31, 2010**;

United States Patent Publication Number **2006/0189337**, by F. Craig Farrill, Bruce D. Lawler and Krishnakant M. Patel, entitled "PREMIUM VOICE SERVICES FOR WIRELESS COMMUNICATIONS SYSTEMS";

United States Patent Publication Number **2005/0202807**, by Ravi Ayyasamy and Krishnakant M. Patel, entitled "ARCHITECTURE, CLIENT SPECIFICATION AND APPLICATION PROGRAMMING INTERFACE (API) FOR SUPPORTING ADVANCED VOICE SERVICES (AVS) INCLUDING PUSH TO TALK ON WIRELESS HANDSETS AND NETWORKS", now United States Patent Number **7,738,892**, issued June **15, 2010**;

United States Patent Publication Number **2005/0221819**, by Krishnakant M. Patel, Gorachand Kundu, Ravi Ayyasamy and Basem Ardah, entitled "ROAMING GATEWAY FOR SUPPORT OF ADVANCED VOICE SERVICES WHILE ROAMING IN WIRELESS COMMUNICATIONS SYSTEMS", now United States Patent Number **7,403,775**, issued July **22, 2008**;

United States Patent Publication Number **2005/0254464**, by Krishnakant Patel, Vyankatesh V. Shanbhag, Ravi Ayyasamy, Stephen R. Horton and Shan-Jen Chiou, entitled "ADVANCED VOICE SERVICES ARCHITECTURE FRAMEWORK", now United States Patent Number **7,764,950**, issued July **27, 2010**;

United States Patent Publication Number **2005/0261016**, by Krishnakant M. Patel, Vyankatesh Vasant Shanbhag, and Anand Narayanan, entitled "SUBSCRIBER IDENTITY MODULE (SIM) ENABLING ADVANCED VOICE SERVICES (AVS) INCLUDING

PUSH-TO-TALK, PUSH-TO-CONFERENCE AND PUSH-TO-MESSAGE ON WIRELESS HANDSETS AND NETWORKS", now United States Patent Number **7,738,896**, issued June **15, 2010**;

United States Patent Publication Number **2006/0019654**, by F. Craig Farrill, entitled "PRESS-TO-CONNECT FOR WIRELESS COMMUNICATIONS SYSTEMS", now United States Patent Number **7,529,557**, issued May **5, 2009**;

United States Patent Publication Number **2006/0030347**, by Deepankar Biswaas, entitled "VIRTUAL PUSH TO TALK (PTT) AND PUSH TO SHARE (PTS) FOR WIRELESS COMMUNICATIONS SYSTEMS";

United States Patent Publication Number **2006/0234687**, by Krishnakant M. Patel, Bruce D. Lawler, Giridhar K. Boray, and Brahmananda R. Vempati, entitled "ENHANCED FEATURES IN AN ADVANCED VOICE SERVICES (AVS) FRAMEWORK FOR WIRELESS COMMUNICATIONS SYSTEMS", now United States Patent Number **7,813,722**, issued October **12, 2010**;

International Patent Publication Number WO/**2006/105287**, by Krishnakant M. Patel, Gorachand Kundu, Sameer Dharangaonkar, Giridhar K. Boray, and Deepankar Biswas, entitled "ADVANCED VOICE SERVICES USING AN USSD INTERFACE";

United States Patent Publication Number **2007/0037597**, by Deepankar Biswas, Krishnakant M. Patel, Giridhar K. Boray, and Gorachand Kundu, entitled "ARCHITECTURE AND IMPLEMENTATION OF CLOSED USER GROUP AND LIMITING MOBILITY IN WIRELESS NETWORKS", now United States Patent Number **7,689,238**, issued March **30, 2010**;

United States Patent Publication Number **2007/0037598**, by Ravi Ayyasamy and Krishnakant M. Patel, entitled "BREW PLATFORM ENABLING ADVANCED VOICE SERVICES (AVS) INCLUDING PUSH-TO-TALK, PUSH-TO-CONFERENCE AND PUSH-TO-MESSAGE ON WIRELESS HANDSETS AND NETWORKS", now United States Patent Number **8,036,692**, issued October **11, 2011**;

United States Patent Publication Number **2007/0190984**, by Ravi Ayyasamy, Bruce D. Lawler, Krishnakant M. Patel, Vyankatesh V. Shanbhag, Brahmananda R. Vempati, and Ravi Shankar Kumar, entitled "INSTANT MESSAGING INTERWORKING IN AN

ADVANCED VOICE SERVICES (AVS) FRAMEWORK FOR WIRELESS COMMUNICATIONS SYSTEMS";

United States Patent Publication Number **2007/0253347**, by Krishnakant M. Patel, Giridhar K. Boray, Ravi Ayyasamy, and Gorachand Kundu, entitled "ADVANCED FEATURES ON A REAL-TIME EXCHANGE SYSTEM", now United States Patent Number **7,853,279**, issued December **14, 2010**;

United States Patent Publication Number **2008/0064364**, by Krishnakant M. Patel, Deepankar Biswas, Sameer P. Dharangaonkar and Terakanambi Nanjanayaka Raja, entitled "EMERGENCY GROUP CALLING ACROSS MULTIPLE WIRELESS NETWORKS";

United States Patent Publication Number **2009/0149167**, by Krishnakant M. Patel, Gorachand Kundu, and Ravi Ayyasamy, entitled "CONNECTED PORTFOLIO SERVICES FOR A WIRELESS COMMUNICATIONS NETWORK";

United States Patent Publication Number **2009/0209235**, by Bruce D. Lawler, Krishnakant M. Patel, Ravi Ayyasamy, Harisha Mahabaleshwara Negalaguli, Binu Kaiparambil, Shiva Cheedella, Brahmananda R. Vempati, Ravi Shankar Kumar, and Avrind Shanbhag, entitled "CONVERGED MOBILE-WEB COMMUNICATIONS SOLUTION", now United States Patent Number **8,676,189**, issued March **18, 2014**;

United States Patent Publication Number **2010/0142414**, by Krishnakant M. Patel, Ravi Ayyasamy, Gorachand Kundu, Basem A. Ardah, Anand Narayanan, Brahmananda R. Vempati, and Pratap Chandana, entitled "HYBRID PUSH-TO-TALK FOR MOBILE PHONE NETWORKS";

United States Patent Publication Number **2010/0234018**, by Bruce D. Lawler, Krishnakant M. Patel, Ravi Ayyasamy, Harisha Mahabaleshwara Negalaguli, Binu Kaiparambil, Shiva K.K. Cheedella, Brahmananda R. Vempati, and Ravi Shankar Kumar, entitled "CONVERGED MOBILE-WEB COMMUNICATIONS SOLUTION", now United States Patent Number **8,670,760**, issued March **11, 2014**;

United States Patent Publication Number **2010/0304724**, by Bruce D. Lawler, Krishnakant M. Patel, Ravi Ayyasamy, Harisha Mahabaleshwara Negalaguli, Basem A. Ardah, Gorachund Kundu, Ramu Kandula, Brahmananda R. Vempati, Ravi Shankar Kumar, Chetal M. Patel, and Shiva K.K. Cheedella, entitled "ENHANCED GROUP CALLING

FEATURES FOR CONNECTED PORTFOLIO SERVICES IN A WIRELESS COMMUNICATIONS NETWORK", now United States Patent Number **8,498,660**, issued July **30, 2013**;

United States Patent Publication Number **2011/0183659**, by Ravi Ayyasamy, Bruce D. Lawler, Brahmananda R. Vempati, Gorachand Kundu and Krishnakant M. Patel, entitled "COMMUNITY GROUP CLIENT AND COMMUNITY AUTO DISCOVERY SOLUTIONS IN A WIRELESS COMMUNICATIONS NETWORK";

United States Patent Publication Number **2011/0217949**, by Narasimha Raju Nagubhai, Ravi Shankar Kumar, Krishnakant M. Patel, and Ravi Ayyasamy, entitled "PREPAID BILLING SOLUTIONS FOR PUSH-TO-TALK IN A WIRELESS COMMUNICATIONS NETWORK", now United States Patent Number **8,369,829**, issued February **5, 2013**;

United States Patent Publication Number **2011/0294494**, by Brahmananda R. Vempati, Krishnakant M. Patel, Pratap Chandana, Anand Narayanan, Ravi Ayyasamy, Bruce D. Lawler, Basem A. Ardah, Ramu Kandula, Gorachand Kundu, Ravi Shankar Kumar, and Bibhudatta Biswal, and entitled "PREDICTIVE WAKEUP FOR PUSH-TO-TALK-OVER-CELLULAR (PoC) CALL SETUP OPTIMIZATIONS", now United States Patent Number **8,478,261**, issued July **2, 2013**;

United States Patent Publication Number **2013/0155875**, by Ravi Ayyasamy, Gorachand Kundu, Krishnakant M. Patel, Brahmananda R. Vempati, Harisha M. Negalaguli, Shiva K. K. Cheedella, Basem A. Ardah, Ravi Shankar Kumar, Ramu Kandula, Arun Velayudhan, Shibu Narendranathan, Bharatram Setti, Anand Narayanan, and Pratap Chandana, entitled "PUSH-TO-TALK-OVER-CELLULAR (PoC)";

United States Patent Publication Number **2013/0337859**, by Krishnakant M. Patel, Brahmananda R. Vempati, Anand Narayanan, Gregory J. Morton, and Ravi Ayyasamy, entitled "RUGGEDIZED CASE OR SLEEVE FOR PROVIDING PUSH-TO-TALK (PTT) FUNCTIONS";

United States Patent Publication Number **2013/0196706**, by Krishnakant M. Patel, Harisha Mahabaleshwara Negalaguli, Brahmananda R. Vempati, Shiva Koteshwara Kiran Cheedella, Arun Velayudhan, Raajeev Kuppa, Gorachand Kundu, Ravi Ganesh

Ramamoorthy, Ramu Kandula, Ravi Ayyasamy, and Ravi Shankar Kumar, entitled "WiFi INTERWORKING SOLUTIONS FOR PUSH-TO-TALK-OVER-CELLULAR (PoC)";

United States Patent Publication Number **2014/0148210**, by Gorachand Kundu, Krishnakant M. Patel, Harisha Mahabaleshwara Negalaguli, Ramu Kandula, and Ravi Ayyasamy, entitled "METHOD AND FRAMEWORK TO DETECT SERVICE USERS IN AN INSUFFICIENT WIRELESS RADIO COVERAGE NETWORK AND TO IMPROVE A SERVICE DELIVERY EXPERIENCE BY GUARANTEED PRESENCE", now United States Patent Number **9,137,646**, issued September **15, 2015**;

International Patent Publication Number **WO/2014/179602**, by Krishnakant M. Patel, Harisha Mahabaleshwara Negalaguli, Arun Velayudhan, Ramu Kandula, Syed Nazir Khadar, Shiva Koteshwara Kiran Cheedella, and Subramanyam Narasimha Prashanth, entitled "VOIP DENIAL-OF-SERVICE PROTECTION MECHANISMS FROM ATTACK";

United States Patent Publication Number **2014/0348066**, by Krishnakant M. Patel, Ravi Ayyasamy and Brahmananda R. Vempati, entitled "METHOD TO ACHIEVE A FULLY ACKNOWLEDGED MODE COMMUNICATION (FAMC) IN PUSH-TO-TALK OVER CELLULAR (PoC)", now United States Patent Number **9,485,787**, issued November **1, 2016**;

International Patent Publication Number **WO/2015/013434**, by Gorachand Kundu, Giridhar K. Boray, Brahmananda R. Vempati, Krishnakant M. Patel, Ravi Ayyasamy, and Harisha M. Negalaguli, entitled "EFFECTIVE PRESENCE FOR PUSH-TO-TALK-OVER-CELLULAR (PoC) NETWORKS";

International Patent Publication Number **WO/2015/105970**, by Krishnakant M. Patel, Brahmananda R. Vempati, and Harisha Mahabaleshwara Negalaguli, entitled "OPTIMIZED METHODS FOR LARGE GROUP CALLING USING UNICAST AND MULTICAST TRANSPORT BEARERS FOR PUSH-TO-TALK-OVER-CELLULAR (PoC)";

International Number Patent Publication **WO/2015/013449**, by Gorachand Kundu, Giridhar K. Boray, Brahmananda R. Vempati, Krishnakant M. Patel, Ravi Ayyasamy, Harisha Mahabaleshwara Negalaguli, and Ramu Kandula, entitled "RADIO ACCESS

NETWORK AWARE SERVICE PUSH-TO-TALK-OVER-CELLULAR NETWORKS"; and

United States Patent Publication Number **2015/0256984**, by Krishnakant M. Patel, Brahmananda R. Vempati, Ravi Ayyasamy, and Bibhudatta Biswal, entitled "PUSH-TO-TALK-OVER-CELLULAR (POC) SERVICE IN HETEROGENEOUS NETWORKS (HETNETS) AND MULTIMODE SMALL CELL ENVIRONMENTS", now United States Patent No. **9,510,165**, issued November **29, 2016**.

BACKGROUND

1. Field.

This disclosure relates in general to advanced voice services in wireless communications networks, and more specifically, to relay-mode and direct-mode operations for Push-to-talk-over-Cellular (PoC) using WiFi technologies.

2. Description of Related Art.

Advanced voice services (AVS), also known as Advanced Group Services (AGS), such as two-way half-duplex voice calls within a group, also known as Push-to-talk-over-Cellular (PoC), Push-to-Talk (PTT), or Press-to-Talk (P2T), and one-way half-duplex voice calls within a group, also known as Broadcast, as well as other AVS functions, such as Push-to-Conference (P2C) or Instant Conferencing, Push-to-Message (P2M), etc., are described in the related patents and patent publications referenced above. These AVS functions have enormous revenue earnings potential for wireless communications systems, such as cellular networks, wireless data networks and IP networks.

One approach to PoC is based on packet or voice-over-IP (VoIP) technologies. This approach capitalizes on the "bursty" nature of PoC conversations and makes network resources available only during talk bursts and hence is highly efficient from the point of view of network and spectral resources. This approach promises compliance with newer and emerging packet-based standards, such as GPRS (General Packet Radio Service), UMTS (Universal Mobile Telecommunications System), 3G/4G/LTE (3rd Generation/4th Generation/Long Term Evolution), etc.

Nonetheless, there is a need in the art for improvements to the methods and systems for delivering the advanced voice services, such as PoC, that comply with both existing and emerging wireless packet-based standards and yet provide superior user experiences. Many existing implementations of PoC suffer from an inferior user experience. Embodiments disclosed in the present disclosure may satisfy the need for a superior user experience, and may also define procedures for practical implementation of PoC in commercial, standards-based, cellular networks.

SUMMARY

The present disclosure relates to a system and method for relay-mode and direct-mode operations for Push-to-talk-over-Cellular (PoC) using WiFi technologies. One or more servers interface to a wireless communications network to perform advanced voice services for mobile units therein, wherein the advanced voice services include an instant two-way half-duplex voice call within a group of the mobile units comprising a PoC call session. Both the servers and the mobile units that use the advanced group services communicate with each other using control messages within the wireless communications network. At least one of the servers switches voice messages for the advanced group services between the mobile units across the wireless communications network. At least one of the servers manages the call session by acting as an arbitrator for the call session and by controlling the sending of the control messages and the voice messages to and from the mobile units. At least one of the mobile units performs Relay-Mode or Direct-Mode operations using WiFi communications for delivery of the control messages and the voice messages to and from others of the mobile units, thereby enabling the advanced voice services when access to the wireless communications network by the others of the mobile units is limited.

In one embodiment, the mobile units communicate locally among themselves using the WiFi communications for the delivery of the control messages and the voice messages. The WiFi communications may include using a local WiFi network and/or using WiFi-Direct. At least one of the servers maintains a list of the mobile units communicating locally among themselves using the WiFi communications.

In one embodiment, the mobile units communicate locally among themselves using Relay-Mode or Direct Mode communications for the delivery of the control messages and the voice messages. At least one of the servers maintains a list of the mobile units communicating locally among themselves using the Relay-Mode or Direct Mode communications.

There may be more than one of the mobile units that performs Relay-Mode or Direct-Mode operations. In this embodiment, one of the mobile units that perform Relay-Mode or Direct-Mode operations is elected as a leader for communicating with the wireless communications network, and others of the mobile units that perform Relay-Mode or Direct-Mode operations communicate with the leader.

The mobile units that perform Relay-Mode or Direct-Mode operations may be assigned by at least one of the servers based on one or more criteria. Moreover, the server that assigns the mobile units that perform Relay-Mode or Direct-Mode operations informs others of the mobile units of that assignment.

The mobile units that perform Relay-Mode or Direct-Mode operations may provide a message duplication function. In addition, the mobile units that perform Relay-Mode or Direct-Mode operations may provide unicast tunneling of multicast messages from one or more of the servers.

In another embodiment, there is provided a system for providing communications services in at least one wireless communications network. The system includes one or more servers that interface to the wireless communications network to perform communications services for one or more mobile units therein. The communications services include an instant two-way half-duplex voice call within a group of the mobile units including a Push-to-Talk (PTT) call session. Both the servers and the mobile units that use the communications services communicate with each other using control messages within the wireless communications network, and at least one of the servers switches voice messages for the communications services between the mobile units across the wireless communications network. A first server manages the call session by acting as an arbitrator for the call session and by controlling the sending of the control messages and the voice messages to and from the group of the mobile units. A first mobile unit of the group of the

mobile units performs Relay-Mode operations for delivery of the control messages and the voice messages to and from other mobile units of the group of the mobile units. The Relay-Mode operations include: receiving, by the first mobile unit, a packet for the PTT call session from the first server over a wide area network (WAN); and forwarding, by the first mobile unit, the packet to at least one of the other mobile units over a local area network (LAN).

In another embodiment, there is provided a method of providing communications services in at least one wireless communications network. The method involves interfacing one or more servers to the wireless communications network to perform communications services for one or more mobile units therein. The communications services include a Push-to-Talk (PTT) or Broadcast call session to a group of the mobile units. Both the servers and the mobile units that use the communications services communicate with each other using control messages within the wireless communications network, and at least one of the servers switches voice messages for the communications services between the mobile units across the wireless communications network. A first server manages the call session by acting as an arbitrator for the call session and controls the sending of the control messages and the voice messages to and from the group of the mobile units. A first mobile unit of the group of the mobile units performs Relay-Mode operations for delivery of the control messages and the voice messages to and from other mobile units of the group of the mobile units. The Relay-Mode operations include: receiving, by the first mobile unit, a packet for the PTT call session or the Broadcast call session from the first server over a wide area network (WAN); and forwarding, by the first mobile unit, the packet to at least one of the other mobile units over a local area network (LAN).

BRIEF DESCRIPTION OF THE DRAWINGS

Referring now to the drawings in which like reference numbers represent corresponding parts throughout:

FIG. **1** illustrates the system architecture used in one embodiment.

FIG. **2** is a state diagram that illustrates the operation of a PoC call session according to one embodiment.

FIG. **3** illustrates Relay-Mode operation when there is limited radio access network (RAN) connectivity to a wide area network (WAN), but local WiFi connectivity to a LAN (local area network), for one or more handsets in a group, according to one embodiment.

FIG. **4** illustrates Relay-Mode operation when there is limited RAN connectivity to the WAN, with local WiFi connectivity to the LAN, and the unicast tunneling of multicast IP packets, for one or more handsets in a group, according to one embodiment.

FIG. **5** illustrates Direct-Mode operation when there is limited RAN connectivity to the WAN, without local WiFi connectivity to a LAN, but with Direct Mode connectivity using WiFi-Direct, for one or more handsets in a group, according to one embodiment.

DETAILED DESCRIPTION

In the following description of illustrative embodiments, reference is made to the accompanying drawings which form a part hereof, and in which is shown by way of illustration embodiments which may be practiced. It is to be understood that other embodiments may be utilized as structural changes may be made without departing from the scope of the present disclosure.

1 Overview

In one embodiment, there is provided a system for implementing advanced voice services in wireless communications networks that provides a feature-rich server architecture with a flexible client strategy. This system is an Open Mobile Alliance (OMA) standards-compliant solution which may be easily deployed, and may thereby enable carriers to increase their profits, improve customer retention and attract new customers without costly upgrades to their network infrastructure. This system can be built on a

proven, reliable all-IP (Internet Protocol) platform. The highly scalable platform may be designed to allow simple network planning and growth. Multiple servers can be distributed across operator networks for broad geographic coverage and scalability to serve a large and expanding subscriber base.

5

1.1 Definitions

The following table defines various acronyms, including industry-standard acronyms, that are used in this specification.

Acronym	**Description**
ATCA	Advanced Telecommunications Computing Architecture
DnD	Do not Disturb
DNS	Domain Name Server
DTLS	Datagram Transport Layer Security
MBMS/eMBMS	Multimedia Broadcast Multicast Services
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
HTTP	Hypertext Transport Protocol
HTTPS	Secure Hypertext Transport Protocol
IMSI	International Mobile Subscriber Identity
IP	Internet Protocol
IPA	Instant Personal Alert
MBCP	Media Burst Control Protocol
MCC	Mobile Country Code
MDN	Mobile Directory Number
MNC	Mobile Network Code
MS-ISDN	Mobile Station International Subscriber Directory Number
OMA	Open Mobile Alliance
PoC	Push-to-talk-over-Cellular
PGW	Packet GateWay
PTT	Push-To-Talk
RTCP	Realtime Transport Control Protocol
RTP	Realtime Transport Protocol
SDP	Session Description Protocol
SGW	Serving GateWay
SIM	Subscriber Identity Module
SIP	Session Initiation Protocol
SMMP	Short Message peer-to-peer Protocol
SMS	Small Message Service

Acronym	Description
SRTP	Secure Real-time Transport Protocol
SSID	Service Set Identifier
SSL	Secure Sockets Layer protocol
SSRC	Synchronization SouRCe
TLS	Transport layer security protocol
UDP	User Datagram Protocol
URI	Uniform Resource Identifier
VoIP	Voice-over-IP
XCAP	XML Configuration Access Protocol
XDM	XML Document Management
XML	Extensible Mark-up Language
4G/LTE	4th Generation/Long Term Evolution

The following table defines various terms, including industry-standard terms, that are used in this specification.

Term	Description
1-1 PoC Session	A feature enabling a PoC User to establish a PoC Session with another PoC User.
Ad Hoc PoC Group Session	A PoC Group Session established by a PoC User to PoC Users listed on the invitation. The list includes PoC Users or PoC Groups or both.
Answer Mode	A PoC Client mode of operation for the terminating PoC Session invitation handling.
Controlling PoC Function	A function implemented in a PoC Server, providing centralized PoC Session handling, which includes media distribution, Talk Burst Control, Media Burst Control, policy enforcement for participation in the PoC Group Sessions, and participant information.
Corporate	These subscribers will only receive contacts and groups from a corporate administrator. That means they cannot create their own contacts and groups from handset.
Corporate Public	These subscribers receive contacts and groups from a corporate administrator in addition to user-created contacts and groups.
Corporate Administrator	A user who manages corporate subscribers, their contacts and groups.
Firewall	A device that acts as a barrier to prevent unauthorized or unwanted communications between computer networks and external devices.
Home PoC Server	The PoC Server of the PoC Service Provider that provides PoC service to the PoC User.
Instant Personal Alert	A feature in which a PoC User sends a SIP based instant message to a PoC User requesting a 1-1 PoC Session.

Term	Description
Law Enforcement Agency	An organization authorized by a lawful authorization based on a national law to request interception measures and to receive the results of telecommunications interceptions.
Lawful Interception	The legal authorization, process, and associated technical capabilities and activities of Law Enforcement Agencies related to the timely interception of signaling and content of wire, oral, or electronic communications.
Notification	A message sent from the Presence Service to a subscribed watcher when there is a change in the Presence Information of some presentity of interest, as recorded in one or more Subscriptions.
Participating PoC Function	A function implemented in a PoC Server, which provides PoC Session handling, which includes policy enforcement for incoming PoC Sessions and relays Talk Burst Control and Media Burst Control messages between the PoC Client and the PoC Server performing the Controlling PoC Function. The Participating PoC Function may also relay RTP Media between the PoC Client and the PoC Server performing the Controlling PoC Function.
PoC Client	A functional entity that resides on the User Equipment that supports the PoC service.
Pre-Arranged PoC Group Identity	A SIP URI identifying a Pre-Arranged PoC Group. A Pre-Arranged PoC Group Identity is used by the PoC Client, e.g., to establish PoC Group Sessions to the Pre-Arranged PoC Groups.
Pre-Arranged PoC Group	A persistent PoC Group. The establishment of a PoC Session to a Pre-Arranged PoC Group results in the members being invited.
Pre-Established Session	The Pre-Established Session is a SIP Session established between the PoC Client and its Home PoC Server. The PoC Client establishes the Pre-Established Session prior to making requests for PoC Sessions to other PoC Users. To establish a PoC Session based on a SIP request from the PoC User, the PoC Server conferences other PoC Servers or users to the Pre-Established Session so as to create an end-to-end connection.
Presence Server	A logical entity that receives Presence Information from a multitude of Presence Sources pertaining to the Presentities it serves and makes this information available to Watchers according to the rules associated with those Presentities.
Presentity	A logical entity that has Presence Information associated with it. This Presence Information may be composed from a multitude of Presence Sources. A Presentity is most commonly a reference for a person, although it may represent a role such as "help desk" or a resource such as "conference room #**27**". The Presentity is identified by a SIP URI, and may additionally be identified by a tel URI or a pres URI.
Public	These subscribers create and manage their contacts and groups.
Serving Server	A set of primary and secondary servers.

Term	Description
Subscription	The information kept by the Presence Service about a subscribed watcher's request to be notified of changes in the Presence Information of one or more Presentities.
Watcher	Any uniquely identifiable entity that requests Presence Information about a Presentity from the Presence Service.
WiFi	A wireless local area network (WLAN).

2 System Architecture

FIG. **1** illustrates the system architecture used in accordance with one embodiment. This architecture conforms to the Advanced Telecommunications Computing Architecture (ATCA) standard to support the advanced voice services disclosed herein. ATCA is an open standards-based, high-availability telecommunications platform architecture.

The system **100** includes one or more PoC Service Layers **102** and one or more Management Layers **104**, each of which is comprised of one or more servers interconnected by one or more IP networks **106**. Specifically, the PoC Service Layer **102** includes one or more XML Document Management (XDM) Servers **108**, Presence Servers **110**, PoC Servers **112**, and Media Servers **114**, while the Management Layer **104** includes one or more Element Management System (EMS) Servers **116**, Lawful Intercept (LI) Servers **118**, Web Customer Service Representative (WCSR) Servers **120**, and Web Group Provisioning (WGP) Servers **122**. These various servers are described in more detail below.

The PoC Service Layer **102** and Management Layer **104** are connected to one or more wireless communications networks, such as cellular phone networks **124** and wireless data networks **126**, as well as one or more IP networks **106**. Note that the cellular phone networks **124** and wireless data networks **126** may be implemented in a single network or as separate networks. The cellular phone network **124** includes one or more Short Message Service Centers (SMSCs) **128**, Mobile Switching Centers (MSCs) **130**, and Base Station Components (BSCs) **132**, wherein the BSCs **132** include controllers and transceivers that communicate with one or more customer handsets **134** executing a PoC Client **136**. A handset **134** is also referred to as a mobile unit, mobile station, mobile phone, cellular phone, etc. and may comprise any wireless and/or wired device. The wireless data network **126**, depending on its type, e.g., GPRS or 4G/LTE, includes one or more Gateway GPRS

Support Nodes (GGSNs) or Packet Gateways (PGWs) **138** and Serving GPRS Support Nodes (SGSNs) or Serving GateWays (SGWs) **140**, which also communicate with customer handsets **134** via BSCs or eNodeBs **132**.

In one embodiment, the PoC Service Layer **102** and Management Layer **104** are connected to one or more Gateways **142**, which are coupled to one or more external IP networks **144**, in order to communicate with one or more PoC Clients **136** on one or more handsets **134**. Traffic to and from the wireless data networks **126** also traverses Gateways **142**.

In one embodiment, the handsets **134** may be WiFi-enabled and thus capable of communicating with local WiFi networks, which may be comprised of one or more WiFi Access Points (APs) **146**, as well as Multicast Routers **148**. Moreover, the handsets **134** may be able to communicate directly with other handsets **134** using WiFi-Direct or other Direct Mode communications protocols.

2.1 Cellular Phone Network

The PoC Service Layer **102** interacts with the SMSC **128** on the cellular phone network **124** to handle Short Message Service (SMS) operations, such as routing, forwarding and storing incoming text messages on their way to desired endpoints.

2.2 Wireless Data Network

The PoC Service Layer **102** also interacts with the following entities on the wireless data network **126**:

- The GGSN/PGW **138** transfers IP packets between the PoC Client **136** and the various servers:
  - SIP/IP signaling messages between the PoC Server **112** and PoC Client **136** for control traffic exchange (i.e., control packets) for PoC call sessions.
  - RTP/IP, RTCP/IP and MBCP/IP packets between the Media Server **114** and PoC Client **136** for bearer traffic exchange (i.e., voice packets) for PoC call sessions.

- SIP/IP signaling messages between the Presence Server **110** and PoC Client **136** for presence information.
- XCAP/HTTP/IP and SIP/IP signaling between the XDM Server **108** and PoC Client **136** for document management.

- The SMSC **128** handles authentication:
  - The XDM Server **108** communicates with the SMSC **128** via SMPP/IP for receiving the authentication code required for PoC Client **136** activation from the handset **134**.

2.3 WiFi Network

The PoC Service Layer **102** also interacts with the following entities on the IP network **144**:

- The Gateway **142** transfers IP packets between the PoC Client **136** and the various servers:
  - SIP/IP signaling messages between the PoC Server **112** and PoC Client **136** for control traffic exchange (i.e., control packets) for PoC call sessions.
  - RTP/IP, RTCP/IP and MBCP/IP packets between the Media Server **114** and PoC Client **136** for bearer traffic exchange (i.e., voice packets) for PoC call sessions.
  - SIP/IP signaling messages between the Presence Server **110** and PoC Client **136** for presence information.
  - XCAP/HTTP/IP and SIP/IP signaling between the XDM Server **108** and PoC Client **136** for document management.
  - SIP/IP signaling messages between the XDM Server **108** and PoC Client **136** for receiving the authentication code required for PoC Client **136** activation from the handset **134**.

2.4 PoC Service Layer Elements

As noted above, the PoC Service Layer **102** is comprised of the following elements:

- PoC Server **112**,
- Media Server **114**,
- Presence Server **110**,
- XDM Server **108**, and
- Gateway **142**.

These elements are described in more detail below.

2.4.1 PoC Server

The PoC Server **112** handles the PoC call session management and is the core for managing the PoC services for the PoC Clients **136** using SIP protocol. The PoC Server **112** implements a Control Plane portion of Controlling and Participating PoC Functions. A Controlling PoC Function acts as an arbitrator for a PoC Session and controls the sending of control and bearer traffic by the PoC Clients **136**. A Participating PoC Function relays control and bearer traffic between the PoC Client **136** and the PoC Server **112** performing the Controlling PoC Function.

2.4.2 Media Server

The Media Server **114** implements a User Plane portion of the Controlling and Participating PoC Functions. The Media Server **114** supports the Controlling PoC Function by duplicating voice packets received from an originator PoC Client **136** to all recipients of the PoC Session. The Media Server **114** also supports the Participating PoC Function by relaying the voice packets between PoC Clients **136** and the Media Server **114** supporting the Controlling PoC Function. The Media Server **114** also handles packets sent to and received from the PoC Clients **136** for floor control during PoC call sessions.

2.4.3 Presence Server

The Presence Server **110** implements a presence enabler for the PoC Service. The Presence Server **110** accepts, stores and distributes Presence Information for Presentities, such as PoC Clients **136**.

The Presence Server **110** also implements a Resource List Server (RLS), which accepts and manages subscriptions to Presence Lists. Presence Lists enable a "watcher" application to subscribe to the Presence Information of multiple Presentities using a single subscription transaction.

The Presence Server **110** uses certain XDM functions to provide these functions, which are provided by XDM Server **108**.

2.4.4 XDM Server

The XDM Server **108** implements an XDM enabler for the PoC Service. The XDM enabler defines a common mechanism that makes user-specific service-related information accessible to the functions that need them. Such information is stored in the XDM Server **108** where it can be located, accessed and manipulated (e.g., created, changed, deleted, etc.). The XDM Server **108** uses well-structured XML documents and HTTP protocol for access and manipulation of such XML documents. The XDM Server **108** also connects to the operator SMSC **128** for the purposes of PoC Client **136** activation using SMS. In addition, the XDM Server **108** maintains the configuration information for all PoC subscribers.

2.4.5 Gateway

The Gateway **142** implements a interworking solution for the PoC Service to communicate via one or more IP network **144** access points to the PoC Clients **136**. Specifically, the Gateway **142** provides PoC Service over an IP network **144** (such as an external WiFi network), as well as the wireless data networks **126**, and can function to support a seamless user experience while the transport of IP control messages and IP voice data is transitioned between different types of wireless communications networks, such as wireless data networks **126** comprising cellular data packet networks and IP networks **142**.

The Gateway **142** can also function to resolve security concerns that arise with such interworking solutions.

Such functionalities of the Gateway **142** can be necessary because the quality, performance and availability of the wireless data networks **126** typically vary from location to location based on various factors. In addressing these issues, the interworking solution implemented by the Gateway **142** can provide following additional functionalities:

- PoC Services can be available even in those locations where a wireless data network **126** is not available, but where a general purpose IP network **144** is available. This can be particularly more useful in enhancing in-building coverage for the PoC Service.
- By connecting over the IP network **144**, the available IP bandwidth, quality and performance can be more streamlined and controlled since the IP network **144** (typically) has a greater capacity and throughput as compared to the wireless data network **126**, which is more shared in nature.
- By utilizing the greater available bandwidth over the IP network **144**, as compared to the wireless data network **126**, it can be possible to provide additional services (such as sharing large files) which may otherwise be inefficient and costly on wireless data networks **126**.

These and other aspects of the interworking solution are described in more detail below.

2.5 Management Layer Elements

As noted above, the Management Layer **104** is comprised of the following elements:

- Element Management System (EMS) Server **116**,
- Lawful Intercept (LI) Server **118**,
- Web Group Provisioning (WGP) Server **122**, and
- Web Customer Service Representative (WCSR) Server **120**.

These elements are described in more detail below.

2.5.1 EMS Server

The EMS Server **116** is an operations, administration, and maintenance platform for the system **100**. The EMS Server **116** enables system administrators to perform system-related configuration, network monitoring and network performance data collection functions. The EMS Server **116**, or another dedicated server, may also provide billing functions. All functions of the EMS Server **116** are accessible through a web-based interface.

2.5.2 LI Server

The LI Server **118** is used for tracking services required by various Lawful Enforcement Agents (LEAs). The LI Server **118** generates and pushes an IRI (Intercept Related Information) Report for all PoC Services used by a target. The target can be added or deleted in to the PoC Server **112** via the LI Server **118** using a Command Line Interface (CLI).

2.5.3 WGP Server

The WGP Server **122** provides a web interface for corporate administrators to manage PoC contacts and groups. The web interface includes contact and group management operations, such as create, delete and update contacts and groups.

2.5.4 WCSR Server

The WCSR Server **120** provides access to customer service representatives (CSRs) for managing end user provisioning and account maintenance.

Typically, it supports the following operations:

- Create Subscriber account,
- Update Subscriber account,
- Delete Subscriber account,
- Mobile number change command,
- View Subscriber details (MDN, Group, Group members),
- Manage Corporate Accounts,

- Add CSR account,
- Delete CSR account.

3 System Functions

The following sections describe various functions performed by each of the components of the system architecture.

3.1 PoC Service Layer

3.1.1 PoC Server

The PoC Server **112** controls PoC call sessions, including **1-1**, Ad Hoc and Pre-Arranged PoC call sessions. The PoC Server **112** also controls Instant Personal Alerts.

The PoC Server **112** expects the PoC Clients **136** to setup "pre-established sessions" at the time of start up and use these sessions to make outgoing PoC calls. The PoC Server **112** also uses pre-established sessions to terminate incoming PoC calls to the PoC Clients **136**. The PoC Clients **136** are setup in auto-answer mode by default. The use of pre-established sessions and auto-answer mode together may allow for faster call setup for PoC call sessions.

The PoC Server **112** allocates and manages the media ports of the Media Services **114** associated with each SIP INVITE dialog for pre-established sessions and controls the Media Servers **114** to dynamically associate these ports at run time for sending RTP packets during PoC call sessions. Media ports are assigned and tracked by the PoC Server **112** at the time of setting up pre-established sessions. The PoC Server **112** instructs the Media Server **114** to associate the media ports of various subscribers dynamically into a session when a PoC call is originated and this session is maintained for the duration of the call. The PoC Server **112** also controls the floor states of the various participants in a PoC call session by receiving indications from the Media Servers **114** and sending appropriate requests back to the Media Servers **114** to send MBCP messages to the participants in the PoC call. The Media Server **114** uses the media ports association and current talker information to send the RTP packets from the talker's media port onto the listeners' media ports.

In addition, the PoC Server **112** handles the incoming and outgoing Instant Personal Alerts (IPAs) by routing SIP MESSAGE requests to the PoC Clients **136** and remote PoC Servers **112** for final delivery as applicable.

The PoC Server **112** uses static and dynamic data related to each subscriber to perform these functions. Static data include subscriber profile, contacts and groups. Dynamic data include the subscriber's registration state, PoC settings and SIP dialog states are maintained only on the PoC Server **112**.

3.1.2 Media Server

The Media Server **114** handles the flow of data to and from the PoC Clients **136** as instructed by the PoC Server **112**. Each Media Server **114** is controlled by a single PoC Server **112**, although multiple Media Servers **114** may be controlled by a PoC Server **112** simultaneously.

The Media Server **114** is completely controlled by the PoC Server **112**. As noted above, even the media ports of the Media Server **114** are allocated by the PoC Server **112** and then communicated to the Media Server **114**. Likewise, floor control requests received by the Media Server **114** from PoC Clients **136** are sent to the PoC Server **112**, and the PoC Server **112** instructs the Media Server **114** appropriately. Based on these instructions, the Media Server **114** sends floor control messages to the PoC Clients **136** and sends the RTP packets received from the talker to all the listeners.

3.1.3 Presence Server

The Presence Server **110** accepts presence information published by PoC Clients **136**, as well as availability information received from other entities. The Presence Server **110** keeps track of these presence states and sends notifications to various "watcher" applications whenever a presence state changes. The Presence Server **110** maintains separate subscriptions for each watcher and dynamically applies the presence authorization rules for each watcher independently.

The Presence Server **110** also accepts resource list subscriptions from the watchers, which identify one or more entities ("Presentities") whose presence should be monitored.

The Presence Server **110** then aggregates all the presence information into one or more presence notifications transmitted to each watcher. This may allow watchers to subscribe to large number of Presentities without straining the network as well as client and server resources.

5

3.1.4 XDM Server

The XDM Server **108** performs client authentication and subscription functions. The XDM Server **108** also stores subscriber and group information data. The XDM Server **108** also interacts with the SMSC **128** to receive PoC Client **136** activation commands.

10 All subscriber provisioning and CSR operations in the XDM Server **108** are performed through the WCSR Server **120**, while corporate administrative operations, as well as contacts and group management, are handled through the WGP Server **122**.

The XDM Server **108** includes a Subscriber Profile Manager module that provides subscriber management functionality, such as creation, deletion and modification of

15 subscriber profiles. The subscriber profile includes data such as the MDN, subscriber name, subscriber type, etc. This also determines other system-wide configurations applicable for the subscriber including the maximum number of contacts and groups per subscriber and the maximum number of members per group.

The XDM Server **108** includes a Subscriber Data Manager module that manages the

20 subscriber document operations, such as contact and group management operations, initiated by the PoC Clients **136** or the WGP Server **122**.

3.1.5 Gateway

The Gateway **142** performs interworking for the PoC service by communicating with

25 the PoC Clients **136** via one or more IP networks **142** and/or wireless data networks **126**.

The PoC Client **136** sets up one or more connections using the configured Fully Qualified Domain Name (FQDN), or absolute domain name, of the Gateway **142**, which may be publicly exposed to the Internet **142**. Secure transport protocols may (or may not) be used for the connections across the IP networks **142** and/or wireless data networks **126**.

30 For example, the PoC Clients **136** may use the Transport Layer Security (TLS) and/or

Secure Sockets Layer (SSL) protocols for encrypting information transmitted over the connections between the PoC Client **136** and the Gateway **142**.

In such an embodiment, all SIP signaling and voice data (RTP and RTCP) would be tunneled over the SSL/TLS connections between the PoC Client **136** and the Gateway **142**. XCAP signaling may be transmitted using a Hypertext Transfer Protocol Secure (HTTPS) protocol, which results from layering the Hypertext Transfer Protocol (HTTP) on top of the SSL/TLS connections. This may add the security capabilities of SSL/TLS to standard HTTP communications.

Consequently, the Gateway **142** performs as an encryption/decryption off-loader that provides end-to-end encryption for all traffic transmitted to and from the PoC Client **136**. Specifically, all of the traffic sent to the PoC Client **136** is encrypted at the Gateway **142** and all the traffic received from the PoC Client **136** is decrypted at the Gateway **142**.

The Gateway **142** terminates the SSL/TLS connections and aggregates or dis-aggregates the PoC Client **136** traffic to the appropriate Servers **108**, **110**, **112**, **114**, **116**, **118**, **120** and **122**. Specifically, the Gateway **142** can act as an intelligent traffic distributor for SIP signaling and RTP/RTCP traffic by forwarding the traffic to the appropriate Servers **108**, **110**, **112**, **114**, **116**, **118**, **120** and **122**, depending on the message types and the availability of the Servers **108**, **110**, **112**, **114**, **116**, **118**, **120** and **122**. Consequently, the Gateway **142** can function as a single point-of-contact for all traffic to and from the PoC Clients **136** at an IP transport layer via the IP networks **142** and/or wireless data networks **126**.

Typically, the SSL/TLS connections are persisted and used for any bidirectional data transfer between the Gateway **142**, or other Servers, and the PoC Clients **136**. Thus, a PoC Client **136** maintains an "always-on" connection with the Gateway **142** by periodically sending "keep-alive" messages over the SSL/TLS connections.

The system may also simplify the use of the WiFi APs **144** and Multicast Routers **146**.

3.2 Management Layer

3.2.1 EMS Server

The EMS Server **116** is the central management entity in the system and includes the following modules:

- A central application where all management business logic resides.
- A web server for serving the network operator's internal users. A corresponding client provides a user interface for viewing fault, configuration, performance and security information.
- A subsystem is provided for health monitoring of network elements deployed in the system and also to issue any maintenance commands as applicable.

3.2.2 WCSR Server

The WCSR Server **120** provides a web user interface for customer service representatives (CSRs) to carry out various operations. The web user interface provides access to CSRs for managing subscriber provisioning and account maintenance. Typically, it supports the following operations.

- Create Subscriber account,
- Update Subscriber account,
- Delete Subscriber account,
- Mobile number change command,
- Forced synchronization of a Subscriber,
- Deactivate a Subscriber account,
- Reactivate a Subscriber account,
- View Subscriber details, such as MDN, Group, Group members.

3.2.3 WGP Server

The WGP Server **122** allows provides for central management of all corporate subscribers and associated contacts and groups within a corporation. The WGP Server **122** allows corporate administrators to manage contacts and groups for corporate subscribers.

The WGP Server **122** includes a Corporate Administration Tool (CAT) that is used by corporate administrators to manage contacts and groups of corporate subscribers. The CAT has a Web User Interface for corporate administrators that supports the following operations:

- Group management,
- Contact management, and
- Associations between corporations.

With regard to group management, the CAT of the WGP Server **122** includes the following operations:

- Create, Update, Delete and View Corporate Groups,
- Add, Update, Delete and View Members of a Corporate Group,
- Manage Subscribers,
- Activate and Deactivate a Corporate Subscriber,
- Change a Subscriber type from "Corporate" to "Corporate And Public", and vice versa,
- Restrict Availability, i.e., do not allow subscriber to change their presence status, and
- Manage number porting or name change via phone assignment.

With regard to contact management, the CAT of the WGP Server **122** includes the following operations:

- Phone list management,
- NxN Contact Add (e.g., N contacts may be members of N groups),
- Add, Update, Delete and View Contacts for a specific subscriber, and
- Export and Import contacts at both the subscriber and corporate level.

With regard to associations between corporations, the CAT of the WGP Server **122** includes the following operations:

- Corporate Associations Attributes,
- Association Name,
- Association ID,

- Association Mode (e.g., One-way, Two-way), and
- Restricted List.

Once the association is created and accepted, corporate administrators can create contacts and groups using the association policies. Administrators from other corporations can view the contacts, and may or may not have the capability to add, update or delete the contacts.

- Corporate ID associated per corporate subscriber,
- Central management of corporate subscribers, groups, and contacts,
- Intercorporate associations, including contacts and white-lists,
- Phone list management (e.g., NxN contact add),
- Restrict Availability, and
- Import and Export contacts at both the subscriber and corporate level.

Note that, if the association is deleted, then usually all intercorporate contacts and group members will be deleted.

3.3 PoC Client

The PoC Client **136** is an OMA-compatible client application executed on a handset **134**. The following features are supported by the PoC Client **136**:

- PoC Calls and Instant Personal Alert,
- Presence, and
- Contact and Group Management.

The PoC Client **136** includes a database module, a presence module, an XDM module and a client module.

The database module stores configuration information, presence information, contact and group information, user settings, and other information in an optimized and persistent way. Information is preserved when the user unregisters with the PoC Server **112** or power cycles the device. The database module also has a mechanism to reset the data and synchronize from the XDM Server **108** when the data in the database module is corrupt or unreadable.

The presence module creates and maintains the presence information for the subscriber. Typically, the presence information supports Available, Unavailable and Do-not-Disturb (DnD) states. The presence module also subscribes to the Presence Server **110** as a "watcher" of all contacts in the handset **134** and updates the user interface of the handset **134** whenever it receives a notification with such presence information.

The XDM module communicates with the XDM Server **108** for management of contacts and groups. The XDM module may subscribe with the XDM Server **108** to send and receive any changes to the contacts or group list, and updates the user interface of the handset **134** based on the notifications it receives from the XDM Server **108**.

The client module provides the function of making and receiving PoC calls. To support PoC calls, the client module creates and maintains pre-established sessions with the PoC Server **112**. The client module supports **1-1**, Ad Hoc and Pre-Arranged PoC calls. The client module also supports sending and receiving Instant Personal Alerts (IPA).

4 State Diagram For A PoC Call Session

FIG. **2** is a state diagram that illustrates the operation of a PoC call session according to one embodiment.

State **200** represents a PoC Client **136** in a NULL state, i.e., the start of the logic. A transition out of this state is triggered by a user making a request to originate a PoC call, or by a request being made to terminate a PoC call at the handset **134**. A request to originate a PoC call is normally made by pressing a PoC button, but may be initiated in this embodiment by dialing some sequence of one or more numbers on the handset **134** that are interpreted by the PoC Server **112**, by pressing one or more other keys on the handset **134** that are interpreted by the PoC Server **112**, by speaking one or more commands that are interpreted by the PoC Server **112**, or by some other means.

State **202** represents the PoC Client **136** in an active group call state, having received a "floor grant" (permit to speak). In this state, the user receives a chirp tone that indicates that the user may start talking. The user responds by talking on the handset **134**. The handset **134** uses the reverse traffic channel to send voice frames to the Media Server **114**,

and the Media Server **114** switches voice frames only in one direction, i.e., from talker to one or more listeners, which ensures the half-duplex operation required for a PoC call.

State **204** represents the group "floor" being available to all members of the group. When the talking user signals that the floor is released, the floor is available to all group members. The signal to release the floor is normally made by releasing the PoC button, but may be performed in this embodiment by voice activity detection, e.g., by not speaking for some time period (which is interpreted by the PoC Server **112** as a release command). All members of the group receive a "free floor" tone on their handset **134**. A user who requests the floor first (in the "free-floor" state), for example, is granted the floor, wherein the system **100** sends a chirp tone to the successful user. The signal to request the floor is normally made by pressing the PoC button, but may be performed in this embodiment by voice activity detection, e.g., by speaking for some time period (which is interpreted by the PoC Server **112** as a request command).

State **206** represents the PoC Client **136** being in an active group call state. In this state, the user is listening to the group call. If a non-talking user requests the floor in the active group call state, the user does not receive any response from the system **100** and remains in the same functional state. As noted above, the signal to request the floor is normally made by pressing the PoC button, but may be performed in this embodiment by voice activity detection, e.g., by speaking for some time period (which is interpreted by the PoC Server **112** as a request command).

State **208** represents a user receiving an "unsuccessful bidding" tone on his handset **134**, after the user has requested the floor, but was not granted the floor, of the group call. The user subsequently listens to the voice message of the talking user.

Non-talking users (including the talking user who must release the floor to make it available for others) can request the system **100** to end their respective call legs explicitly.

State **210** represents a terminating leg being released from the call after the user ends the call.

State **212** also represents a terminating leg being released from the call after the user ends the call.

State **214** represents all terminating legs being released from the call when no user makes a request for the within a specified time period, or after all users have ended their respective call legs.

5 Group Calls Using Relay-Mode And Direct-Mode

5.1 Overview

The disclosed embodiments may provide solutions for performing group calls using Relay-Mode and/or Direct-Mode operations. Specifically, the disclosed embodiments may provide call delivery methods for group calls using Relay-Mode and Direct-Mode operations with a local area network (LAN), which may be a local WiFi network **146**, or with a network of handsets **134** communicating using Direct Mode communications. Using Relay-Mode and Direct-Mode operations, not all participants' devices are required to be connected directly to a wide area network (WAN), such as the cellular phone network **124**, wireless data network **126**, or IP network **144**.

5.2 Introduction

Advanced voice services (AVS), especially Advanced Group Services (AGS), such as Push-to-talk-over-Cellular (PoC), Push-to-Talk (PTT), or Press-to-Talk (P2T), as well as Broadcast Calls, can burden network and server resources due to the large number of control and voice messages, especially group calls that involve a large number of participants. The burden on both network and server resources can cause intermittent failures or more serious issues where service could become completely unusable.

When the group calls are PoC or PTT calls, there will be only one talker at a time and there will be multiple listeners, wherein the participants of the call can take turns talking (transmitting) using the floor control mechanisms described above, while other participants will only listen. In PoC or PTT calls, the PoC Server **112** is required to replicate the voice packets received from the talker leg to one or more listener legs, for example, using the Media Server **114**, so that the PoC Client **136** or other applications in the handsets **134** can receive the packets and play the voice. When a unicast network bearer is used, the voice packets need to duplicated for each of the listener legs separately. When a multicast

network bearer is used, the voice packets need to be duplicated for each of the multicast streams, wherein a single multicast stream may service a set of one or more listener legs.

When the group calls are broadcast calls, which are a variant of PoC and PTT calls, there will be only one talker and the rest of the members of the group are only allowed to listen. Like PoC and PTT calls, the PoC Server **112** is required to replicate the voice packets received from the talker leg to one or more listener legs, for example, using the Media Server **114**, so that the PoC Client **136** or other applications in the handsets **134** can receive the packets and play the voice. Like PoC and PTT calls, the voice packets need to duplicated for each of the listener legs separately when a unicast network bearer is used, and the voice packets need to be duplicated for each of the multicast streams, wherein a single multicast stream may service a set of one or more listener legs, when a multicast network bearer is used. In the case of broadcast calling, based on the nature of its usage, the requirement to deliver the voice packets in real-time may be less stringent than interactive group calls. On the other hand, the number of participants in the group could be much larger, including potentially thousands of users.

Such simultaneous transmission of voice packets to large numbers of listener legs may strain network resources, especially for Radio Access Networks (RANs), such as cellular wireless networks **124** and wireless data networks **126**, which are designed for highly optimized usage of the wireless spectrum and usage of the air interface (wireless spectrum) is scheduled for each user based various factors in the network, such as available spectrum bandwidth, overall load conditions, priority of the user, etc. This could cause service quality degradation or the complete loss of service to participants.

Network congestion problems would likely be more severe when the RAN used to deliver the call comprises the cellular phone network **124**. Typically, the cellular phone network **124** is not equipped to handle sudden large surge of IP traffic.

In addition, the packet delivery ability of the RAN is influenced by various factors. Such factors may include the load on the network, the distance of the handset **134** from the network antenna **132**, path losses due to the surrounding environment, and other factors.

Generally, in such circumstances it may be beneficial to utilize a Relay-Mode or Delay-Mode operation, as described in more detail below.

5.3 Relay-Mode

In Relay-Mode operation, one or more of the handsets **134** of a group is assigned to be a Relay Device that routes a group call between the WAN and other handsets **134** of the group that are accessible only by the LAN. The Relay Device allows handsets **134** that may not currently have access to the WAN, but do have access to the Relay Device via the LAN, to participate in the group call.

In this embodiment, some or all of the handsets **134** that comprise a group may be enabled to use any or all of the networks **124**, **126** and/or **142** that comprise the WAN. In addition, some or all of the handsets **134** that comprise a group may be WiFi-enabled, such that they can communicate locally among themselves using the local WiFi network **146** that comprises the LAN. However, some of the handsets **134** in the group may be blocked from and currently not have access to the WAN. On the other hand, some of these handsets **134** in the group may have access to the LAN. In Relay-Mode operation, the handsets **134** that are Relay Devices route IP packets between themselves and other handsets **134** using the LAN and, in turn, relay these IP packets to the WAN.

In effect, the Relay Devices act as routers for the other handsets **134**, thereby enabling access to the group call for handsets **134** that are blocked from and currently do not have access to the WAN.

Relay-Mode operation may also allow the possibility of utilizing IP Multicast Mode packet delivery for broadcast calls over the LAN, without requiring any special network configurations to tunnel the IP Multicast Mode packets over the WAN.

5.3.1 Relay-Mode Operation With Limited RAN Connectivity And Local WiFi Connectivity

FIG. **3** illustrates Relay-Mode operation when there is limited RAN connectivity to the WAN, but local WiFi connectivity to the LAN, for one or more handsets in a group, according to one embodiment.

In this embodiment, at least one handset **134**a that includes a PoC Client **136** is assigned a role as a Relay Device **134**a. The role of Relay Device **134**a is assigned by the PoC Server **112**, although that function may be delegated to other servers as well.

The PoC Server **112** maintains a list of all handsets **134** with PoC Clients **136** connected through the LAN, but not the WAN. The local WiFi network **146** may be identified, for example, by the WiFi Service Set Identifier (SSID), which comprises the WiFi network **146** name.

The role of Relay Device **134**a is assigned by the PoC Server **112** based on one or more criteria, such as signal strength, battery power level, type of handset **134**a, etc. The PoC Server **112** may assign the role of Relay Device **134**a to more than one handset **134** within the WiFi SSID.

The PoC Server **112** then informs all of the other handsets **134**b within the group of the Relay Device **134**a. The other handsets **134**b that lack RAN connectivity to the WAN, but have local WiFi network **146** connectivity to the LAN, connect instead with the Relay Device **134**a through the LAN. The use of the Relay Device **134**a thus extends the coverage for group calling to handsets **134**b in a larger area.

The Relay Device **134**a may establish a secure IP connection (e.g., TLS, DTLS, SRTP, etc.) with the PoC Server **112**, Media Server **114**, Gateway**140**, and/or the other handsets **134**b to accomplish its functions. The Relay Device **134**a may connect to the PoC Server **112**, Media Server **114**, Gateway**140**, through the WAN, i.e., via the cellular phone network **124**, the wireless data network **126** and/or the IP network **144**.

The Relay Device **134**a performs an IP forwarding function, i.e., it receives IP packets from the PoC Server **112** and/or Media Server **114** via the WAN, and forwards the IP packets to other handsets **134**b via the LAN. Similarly, the Relay Device **134**a receives the IP packets from the other handsets **134**b via the LAN, and relays the IP packets to the PoC Server **112** and/or Media Server **114** via the WAN.

The Relay Device **134**a may also provide a packet duplication function for media and floor control. For example, the leader Relay Device **134**a may receive an IP packet stream for a group call from the PoC Server **112** and/or Media Server **114**, and then duplicate the IP stream to the other handsets**134**b within the group that are covered under

the relay. The duplicated IP streams could be unicast to each of the other handsets **134**b; alternatively, the IP streams could be multicast to all of the other handsets **134**b.

In one embodiment, there may be multiple Relay Devices **134**a, wherein the Relay Devices **134**a communicate with each other, in order to elect one of the handsets **134**a as a leader Relay Device **134**a. The election of the leader Relay Device **134**a can be based on specified WiFi network **146** conditions, at the Relay Devices **134**a or the WiFi AP **146**, such as signal strength, battery level, quality of Internet/WAN access, etc. The leader Relay Device **134**a then communicates with the PoC Server **112** and/or the Media Server **114** over the WAN.

The other handsets **134**b that lack RAN connectivity to the WAN, but have local WiFi connectivity to the LAN, connect to one or more of other Relay Devices **134**a, or the leader Relay Device **134**a. In turn, the other Relay Devices **134**a connect to the leader Relay Device **134**a. Each of the Relay Devices **134**a keeps track of the handsets **134**b connected through them to the leader Relay Device **134**a.

5.3.3 Relay-Mode Operation With Unicast Tunneling Of Multicast Packets

FIG. **4** illustrates Relay-Mode operation when there is limited RAN connectivity to the WAN, with local WiFi connectivity to the LAN, and the unicast tunneling of multicast IP packets, for one or more handsets in a group, according to one embodiment.

In this embodiment, the use of the Relay Device **134**a can also enable seamless transportation of multicast IP packets to the local WiFi network **146**. For example, multicast IP packets often cannot be sent over the Internet to a private WiFi network **146** directly, because most routers drop such multicast IP packets.

Using the Relay Device **134**a, however, may remove the requirement of special network configuration to tunnel multicast IP packets to the private WiFi network **146**. For example, the PoC Server **112** and/or Media Server **114** may encapsulate multicast IP packets within unicast IP packets transmitted to the Relay Device **134**a. The Relay Device **134**a then forwards the multicast IP packets to one or more Multicast Routers **148** within the private WiFi network **146**. In turn, the Multicast Routers **148** route the multicast IP packets locally to the other handsets **134**b within the private WiFi network **146**.

Otherwise, the Relay Device **134**a operate in the same manner as described above in FIG. **3**.

5.4 Direct-Mode

Sometimes it is necessary to provide PoC calls when the WAN and/or the LAN is severely congested, or the WAN and/or the LAN is completely inaccessible, leading to either complete loss of service or serious degradation of service quality. During such network congestion conditions, Direct-Mode operation for PoC calls may be used, in which one or more of the participants' handsets **134** is chosen as an Anchoring Point, such that it can route IP packets between participants' handsets **134** that cannot be accessed using the local WiFi network **146** using WiFi-Direct.

In Direct-Mode operation, one or more of the handsets **134** of a group is assigned to be an Anchoring Point that routes a group call between the WAN and other handsets **134** of the group that are accessible only by WiFi-Direct or other direct modes of communication (such as Family Radio Service (FRS), General Mobile Radio Service (GMRS), or Terrestrial Trunked Radio (TETRA)). The Anchoring Point allows handsets **134** that may not currently have access to either the WAN or the LAN, but do have access to the Anchoring Point via WiFi-Direct, to participate in the group call.

In this embodiment, some or all of the handsets **134** that comprise a group may be enabled to use any or all of the networks **124**, **126** and/or **142** that comprise the WAN. In addition, some or all of the handsets **134** that comprise a group may be WiFi-enabled, such that they can communicate locally among themselves using the local WiFi network **146** that comprises the LAN and/or WiFi-Direct. However, some of the handsets **134** in the group may be blocked from and currently not have access to the WAN. In addition, some of these handsets **134** in the group may not have access to the LAN, but do have connectivity to other handsets **134**. In Direct-Mode operation, the handsets **134** that are Anchoring Points route IP packets between themselves and other handsets **134** using WiFi-Direct and, in turn, relay these IP packets to the WAN or the LAN.

In effect, the Anchoring Points act as routers for the other handsets **134**, which may enable access to the group call for handsets **134** that are blocked from and currently do not have access to the WAN.

5.4.1 Direct-Mode Operation With Limited RAN Connectivity And No Local WiFi Connectivity

FIG. **5** illustrates Direct-Mode operation when there is limited RAN connectivity to the WAN, and no local WiFi connectivity to the WAN through the LAN, but there is Direct-Mode connectivity using WiFi-Direct, for one or more handsets in a group, according to one embodiment.

In this embodiment, each of the handsets **134** has a device-to-device capability for Direct-Mode operations using WiFi-Direct communications, where two handsets **134** interact with each other without requiring an intervening LAN infrastructure. This capability is useful as a backup in the event of emergencies, such as disaster situations, or simply when the handsets **134** are outside the LAN coverage area, but at least one of the handsets **134**a is within the WAN coverage area.

At least one handset **134**a that includes a PoC Client **136** is assigned a role as an Anchoring Point **134**a. Specifically, in the absence of a local WiFi network **146**, when the handsets **134** have the capability to perform WiFi-Direct, for local WiFi connectivity, the Anchoring Points **134**a are handsets **134**a that act as Direct-Mode access points, e.g., "hot spots," for the other handsets **134**b.

The role of Anchoring Point **134**a is assigned by the PoC Server **112**, although that function may be delegated to other servers as well. The PoC Server **112** maintains a list of all handsets **134** with PoC Clients **136** connected through the Anchoring Point **134**a, but not the WAN. The list of all handsets **134** may be identified, for example, as a Direct-Mode Communication Group (DMCG) using a unique identifier assigned and maintained by the PoC Server **112**.

The role of Anchoring Point **134**a is assigned by the PoC Server **112** based on one or more criteria, such as battery capacity, antenna capability, type of handset **134**a, etc. The

PoC Server **112** may assign the role of Anchoring Point **134**a to more than one handset **134** within the DMCG.

The PoC Server **112** then informs all of the other handsets **134**b within the DMCG of the Anchoring Point **134**a. The other handsets **134**b that lack RAN connectivity to the WAN, and that lack local WiFi network **146** connectivity to the LAN, connect instead with the Anchoring Point **134**a using WiFi-Direct. The use of the Anchoring Point **134**a thus extends the coverage for group calling to handsets **134**b in a larger area.

The Anchoring Point **134**a may establish a secure IP connection (e.g., TLS, DTLS, SRTP, etc.) with the PoC Server **112**, Media Server **114**, Gateway**140**, and/or the other handsets **134**b to accomplish its functions. The Anchoring Point **134**a may connect to the PoC Server **112**, Media Server **114**, Gateway**140**, through the WAN, i.e., the cellular phone network **124**, the wireless data network **126** and/or the IP network **144**.

The Anchoring Point **134**a performs an IP forwarding function, i.e., it receives IP packets from the PoC Server **112** and/or Media Server **114** via the WAN, and forwards the IP packets to other handsets **134**b via WiFi-Direct. Similarly, the Anchoring Point **134**a receives the IP packets from the other handsets **134**b via WiFi-Direct, and relays the IP packets to the PoC Server **112** and/or Media Server **114** via the WAN.

The Anchoring Point **134**a may also provide a packet duplication function for media and floor control. For example, the leader Anchoring Point **134**a may receive an IP packet stream for a group call from the PoC Server **112** and/or Media Server **114**, and then duplicate the IP stream to the other handsets**134**b within the group that are connected via WiFi-Direct. The duplicated IP streams could be unicast to each of the other handsets **134**b; alternatively, the IP streams could be multicast to all of the other handsets **134**b.

In one embodiment, there may be multiple Anchoring Points **134**a, wherein one of the handsets **134**a is pre-selected by the PoC Server **112** as a leader Anchoring Point **134**a. The selection of the leader Anchoring Point **134**a can be based on DMCG criteria, such as battery capacity, antenna capability, type of handset **134**, etc. The leader Anchoring Point **134**a then communicates with the PoC Server **112** and/or the Media Server **114** over the WAN.

The other handsets **134**b that lack RAN connectivity to the WAN, and that lack local WiFi network **146** connectivity to the LAN, connect to the leader Anchoring Point **134**a, or one or more of the other Anchoring Points **134**a, via WiFi-Direct. In turn, the other Anchoring Points **134**a connect to the leader Anchoring Point **134**a. Each of the Anchoring Points **134**a keeps track of the handsets **134**b connected through them to the leader Anchoring Point **134**a.

Note that in certain embodiments, the participants' handsets **134** may need to be pre-provisioned, prior to entering to the Direct-Mode of operation, with a required configuration that enables them to discover each other and communicate with each other. This can be achieved by having the handset **134**, when connected to the PoC Server **112** via the WAN, download the necessary configuration information to the PoC Client **136**. The PoC Client **136** on the handset **134** stores this configuration information in order to later invoke Direct-Mode operation.

Specifically, this configuration information may comprise pre-provisioned security credentials that allow the PoC Clients **136** on the handsets **134** to identify and authenticate each other prior to the Direct-Mode operation. Moreover, this configuration information may comprise the pre-assigned unique identification for the DMCG for all handsets **134** in the group.

In alternative embodiments, participants' handsets **134** that are members of a group can communicate with each either directly using the WiFi-Direct communications, or by communicating through the WiFi AP **146**, or by some combination of the two modes of communication. For example, the WiFi AP **146** can be used to extend the coverage for Direct-Mode operations, with the use of one or more Relay Devices **134**a in the WiFi AP **146** coverage area, combined with the use of one or more Anchoring Points **134**a in the WiFi-Direct coverage area. In such an embodiment, the leader Anchoring Point **134**a receives a list of all handsets **134** that belong to the DMCG and may enable some of those handsets **134** with Relay-Mode capability as Relay Devices **134**a. All the handsets **134** within the DMCG are informed about available Relay-Devices **134**a within the DMCG, which enables the handsets **134** to fallback to Relay-Mode operation if possible, during

conditions when Direct-Mode communications with the leader Anchoring Point **134**a are not possible.

5.5 Group Call Delivery Using PoC Calling

In both the Relay-Mode and Direct-Mode operations discussed above, group call origination can be performed by the originating PoC Client **136** using normal PoC call origination methods.

When pre-established PoC sessions are employed, the group call origination involves sending a SIP REFER message with the Group Id (or URI) to the PoC Server **112** and then following the normal SIP/MBCP/RTP mechanisms used for PoC calls. The voice packets are transmitted using RTP packets as in normal PoC calls. The same can also be achieved using an on-demand PoC session that involves sending a SIP INVITE message with the Group Id (or URI) to the PoC Server **112** and then following normal PoC signaling and media transfer mechanisms. The PoC Server **112** may buffer the voice packets for the group call received from the originator until the voice packets are delivered to all participants of the group call. Group call delivery is performed to the terminating PoC Clients **136** and handsets **134** using normal PoC call termination methods.

5.6 Group Call Delivery Using A Messaging Framework

Group call delivery can also be implemented over a messaging framework.

When group calling starts, the PoC Client **136** sets up a messaging session. The PoC Client **136** records media into a file, which it sends periodically to the PoC Server **112**. The PoC Server **112** sends the media files one-by-one in sequence to the recipients over the messaging session. The receiving PoC Clients **136** play the media files one-by-one in the order received.

Various methods may be used to transport media files. For example, media files may be transported using SIP/MSRP or HTTP file upload/download methods.

In the SIP/MSRP method, the originating PoC Client **136** establishes a PoC call session to transfer the media files to the PoC Server **112**. The originating PoC Client **136** will keep the session established until the large group call is terminated. The PoC Server

112 delivers the media files to the recipients by establishing a PoC call session with each recipient. The transfer of the media files from the originating PoC Client **136** to the PoC Server **112** and from the PoC Server **112** to receiving PoC Clients **136** requires the setting up of MSRP sessions as well.

In the HTTP file upload/download method, the originating PoC Client **136** establishes an HTTP session to transfer the media files to the PoC Server **112**. The originating PoC Client **136** may keep the HTTP session established until the group call is terminated. To deliver the media files to the recipients, the PoC Server **112** notifies the recipients via SIP (e.g. SIP NOTIFY) with an HTTP link to download the media files and other information regarding the group call. The recipient PoC Client **136** downloads the media files via an HTTP download mechanism, and then plays the media files.

5.7 Group Call Delivery And Floor Exchange Using Multicast And/Or Unicast

As noted above, a multicast PoC group call may be initiated by a PoC Client **136** using a unicast mechanism. When the PoC Server **112** determines that some or all of the group members have joined a multicast group destination, it sends a single MBCP Connect message to each of the multicast IP addresses being used by the group members. The PoC Server **112** also sends separate MBCP Connect messages via unicast to remaining group members who have not joined the multicast group destination. Similarly, the PoC Client **136** that currently has the floor sends voice packets using unicast to the PoC Server **112**, wherein the voice packets are duplicated and delivered by the PoC Server **112** to the other participants via multicast and/or unicast. This continues when the floor is released and subsequently taken by another PoC Client **136**. That is, upstream voice packets are always unicast, while downstream voice packets are multicast or unicast.

5.8 Group Call Delivery Using Multicast Over WiFi Networks

As noted above, group call delivery may be performed using multicast methods over a WiFi network **146**. Each handset **134** that is group member receives the group call delivery from the PoC Server **112**, wherein there is one multicast address per pre-defined

group. The same multicast group destination is used across all of the networks to which group members may be connected.

The originator initiates the group call through unicast signaling to the PoC Server **112**. The PoC Server **112** sends an incoming call indication to the group members, using a multicast delivery method via the WiFi AP **146** and Multicast Router **148**, or a handset **134** using WiFi-Direct. Handsets **134** that have already joined the multicast group listen for packets at the designated multicast address, and thus they receive the indication. The originator (or the current talker) sends all voice messages (and control messages) by unicast to the PoC Server **112**. In turn, the PoC Server **112** sends all voice messages (and control messages) received from the originator (or the current talker) to the listeners using a multicast delivery method, and the messages are subsequently received by all listeners.

5.9 Multicast IP Address Provisioning To PoC Clients

In one embodiment, a multicast IP address can be reserved and allocated per group or based on other criteria (such as corporation Id). In such instances, the following steps may be performed:

For each SSID of a WiFi network:

1. Configure a tunneling mechanism such as VPN/GTP.

2. If a VPN is used, configure the shared passwords, the security scheme being used, the IP address of the point of contact, etc.

3. If a GTM is used, configure the IP address of the point of contact, such as an IP address for the Multicast Router **148**.

4. The PoC Server **112** may automatically assign a multicast IP address in the following manner:

- One multicast address per group, and
- A unique port number per group (e.g. if there are **10** multicast-capable groups, then **10** different ports are allocated).

5.10 Group Call Delivery Using LTE eMBMS

A multicast PoC group call may also use LTE eMBMS on the wireless data network **126**. Multimedia Broadcast Multicast Services (MBMS) is a point-to-multipoint interface specification for wireless data networks **126**, which may be designed to provide efficient delivery of broadcast and multicast services, both within a cell as well as within the core network. eMBMS is the LTE version of MBMS.

The MBMS feature is split into the MBMS Bearer Service and the MBMS User Service. The MBMS Bearer Service includes Multicast and Broadcast Modes with only the Broadcast mode available over LTE. The MBMS Bearer Service uses multicast IP addresses for the IP flows. The advantage of the MBMS Bearer Service compared to unicast bearer services is that the transmission resources in the network are shared, and one MBMS packet flow may be replicated as needed by GGSNs **138**, SGSNs **140**, and radio network controllers such as BSCs or eNodeBs **132**.

The MBMS User Service offers both Streaming and Download Delivery Methods. The Streaming Delivery method can be used for continuous transmissions, while the Download Method may be used for and may be intended for "Download and Play" services.

5.11 Security Aspects Of Group Call Delivery Using Multicast

Since current multicast network bearer technology allows any client devices to listen to multicast IP packets, it is possible that unintended recipients also can listen to the multicast voice packets that are sent by the PoC Server **112**. As a result, encryption of voice and control packets may be required with the decryption keys distributed only to intended recipients of the group call. One approach is to allocate an encryption key for each group, wherein the keys are generated and managed by the PoC Server **112** and the PoC Server **112** distributes the keys to the PoC Clients **136** either at the beginning of the call or beforehand, e.g., during registration, in which case the keys can be refreshed periodically for additional security. A standard SRTP mechanism may be used for encryption and decryption of the RTP and RTCP packets to carry voice and MBCP messages. Keys are communicated to the PoC Client **136** over secure unicast bearer either using SIP over TLS or SIP over DTLS.

5.12 The Combination Of Multiple Transports

Group calling methods may be combined based on the participants' access network types and the distribution of members of the group across various access networks. The PoC Server **112** employs mechanisms to track the access network type for group call participants, as well as participants' concentration within a location area covered by an access network or subdivision thereof (such as a cell, sector, access point, etc.).

Consequently, the appropriate calling method may employed to establish calls with each of the participants. For example, the participants' access network type can be tracked during login, periodic registration, on every call origination, or every time the handset **134** changes location, at a subdivision level. In such cases, the PoC Server **112** may intelligently decide the appropriate mechanism to be used for each of the participants.

One approach is to utilize unicast methods where the use of multicast is not necessary or multicast is not available. Further, the PoC Server **112** can also take into account the number of group calls occurring in same area, whenever such information is available, to make best efforts to avoid network congestion.

For example, the PoC Server **112** may take the following decision steps in order to use an appropriate calling method based on a participant's network access type:

- The PoC Server **112** may determine the total number of online/available participants of the group call. If the number of participants is small enough, so that network congestion is not possible for any of the access networks of the participants, then group calling can be establishing using normal PoC calling methods.
- The PoC Server **112** may categorize the potential participants by network access type. If the number of users for each of the access network type does not exceed the limit set for that access network type, then normal PoC calling methods can be used for those participants. Otherwise, a delivery method that avoids network congestion can be employed and the chosen calling method can be based on the participant's access network type:
    - For participants concentrated in a UMTS cell, message or PoC call based group calling methods can be employed.

- For participants concentrated in an LTE Cell that supports multicast, an eMBMS based calling method can be employed.
- For participants concentrated in a WiFi SSID that supports multicast, a WiFi multicast calling method can be employed.
- For participants concentrated in a WiFi SSID that does not support multicast, a PoC calling/message based group calling method can be employed.
- For participants that are distributed across various locations and network access types, a unicast based regular PoC calling method can be employed.

- Alternatively, the PoC Server **112** might be configured to always use certain calling methods regardless of number of users in an access network type. For example, the PoC Server **112** can be configured to use a multicast based call delivery method for all WiFi users on certain SSIDs. In another example, the PoC Server **112** can be configured to use either PoC calling or message based methods for all users on UMTS.
- All limits are configurable in the PoC Server **112**.
- The availability of multicast methods are configured in the PoC Server **112** based on the access network type and network identifier, such as SSID for WiFi, and Mobile Network Code (MNC) or Location Area Code (LAC) or Global Cell Id for 4G/LTE. The PoC Client **136** may aid the PoC Server **112** in developing such network capability learning by reporting such information to the PoC Server **112**.

5.13 Broadcast Calling Overview

Broadcast calling has a number of key requirements. It must support large numbers of members or recipients, possibly up to **10,000** users or more. Moreover, all of the recipients of the broadcast call should able to receive the broadcast call message or voice completely and clearly, with minimal or no voice/packet loss.

The solutions for providing broadcast calling should be RAN and network friendly. The maximum number of simultaneous users that can receive the media/call should not to exceed the RAN/network capacity. Moreover, there should be near real-time delivery reports for each call, so that the originator can monitor the progress of delivery.

There should be options for the originator to review the broadcast call or message before transmitting the broadcast call or message. Possible options include: replay, delete, re-record, etc.

Other options may include:

- Guaranteed delivery of the broadcast call or message,
- Automatic retry attempts when the broadcast call or message is not delivered to the recipient,
- Deferred delivery, i.e. delivery of the broadcast call or message when an offline recipient becomes online,
- Additional discrete media types that can be added to the broadcast call or message, such as picture, text, video or any other media files, for example, a video message that can be transmitted in a broadcast call, instead of or along with, the voice message,
- Delivery that can be scheduled for a future time by the system.

5.14 Broadcast Group Management

A number of management tools are needed to support broadcast calling. For example, there may be control mechanisms to limit the capability to originate/send broadcast calls:

- Only privileged members of the group (e.g. administrators, etc.) can originate broadcast calling.
- There could be multiple privileged users in the group.
- Accessibility of the broadcast group participant list:
  - The broadcast group may be special type of group, which are maintained by administrators (e.g. using a CAT) with full authority.

The broadcast group member list can be also manipulated by certain privileged users such as supervisors, as determined by administrators.

- The visibility of the complete list of broadcast group members may be access controlled. Based on an administrator's preference, the list can be made visible to the all members or only privileged members or only to the administrators.
- The users having access to the complete participant list may have full list readily available in the user's device (or client) or downloaded on demand by the user.
- Optionally, other users who do not have full access to the list may only have access to the basic information of the group such as group name or list of participants, etc.

For large group call delivery, the following tools may support broadcast call originations:

- An originating PoC Client **136** may record the broadcast message.
- Any options for the user to review, record, etc., may be provided before the request is established with the PoC Server **112**.
- The originating PoC Client **136** may send the broadcast message to the PoC Server **112** as a PoC call originated to the broadcast group, or as a message sent to the broadcast group.
- The PoC Server **112** may buffer or record the complete broadcast call.

6 Conclusion

The foregoing description of the illustrative embodiments of the invention has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Many modifications and variations are possible in light of the above teaching. It is intended that the scope of the invention be limited not with this detailed description, but rather by the claims appended hereto.

EMBODIMENTS IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A method comprising:

providing, by a server in a telecommunications platform, push-to-talk (PTT) services to a plurality of mobile units;

assigning, by the server, a first mobile unit of the plurality of mobile units to relay PTT services messages from the server to one or more second mobile units of the plurality of mobile units;

transmitting, by the server, a PTT message to the first mobile unit using a wide area network (WAN); and

instructing, by the server, the first mobile unit to relay the PTT message to the one or more second mobile units using a communications mechanism different than the WAN.

2. The method of claim 1 further comprising assigning the first mobile unit of the plurality of mobile units to relay PTT messages from the server to the one or more second mobile units based on signal strength of the first mobile unit, battery power level of the first mobile unit, antenna capability of the first mobile unit, mobile unit type of first mobile unit, network conditions of the communications mechanism, or a combination thereof.

3. The method of claim 1, wherein the communications mechanism different than the WAN comprises a local area network (LAN), a direct mode of communication, or a combination thereof.

4. The method of claim 1 further comprising maintaining, by the server, a list of the one or more second mobile units connected to the server through the first mobile unit using the communications mechanism different than the WAN.

5. The method of claim 4 further comprising assigning, by the server, a unique identifier associating the one or more second mobile units with the first mobile unit.

6. The method of claim 1 further comprising provisioning, by the server, direct mode configuration information, security credentials, a decryption key, or a combination thereof on the one or more second mobile units when the one or more second mobile units are connected to the WAN.

7. The method of claim 1, wherein the server instructs the first mobile unit to relay the PTT message to the one or more second mobile units using the communications mechanism different than the WAN when the one or second mobile units are not connected to the WAN.

8. The method of claim 1, wherein the server instructs the first mobile unit to relay the PTT message to the one or more second mobile units using the communications mechanism different than the WAN in accordance with potential congestion in the WAN, potential congestion in a local area network (LAN) used by the one or more second mobile units to communicate with the first mobile unit, or a combination thereof.

9. A method comprising:

receiving, by a first mobile unit, a first message from a server of a telecommunications platform over a wide area network (WAN), wherein the telecommunications platform provides push to talk (PTT) services, wherein the first message is a PTT voice message or a PTT control message for a group call session; and

relaying, by the first mobile unit, the first message to a second mobile unit over a communications mechanism different than the WAN, wherein the second mobile unit is a participant of the group call session, wherein the communications mechanism comprises a local access network.

10. The method of claim 9, wherein the communications mechanism comprises a direct mode of communications.

11. The method of claim 10, wherein relaying, by the first mobile unit, the first message to the second mobile unit comprises forwarding, by the first mobile unit, the first message to a third mobile unit, wherein the third mobile unit is capable of a direct mode of communications with the second mobile unit.

12. The method of claim 9 further comprising:

receiving, by the first mobile unit, a second message from the second mobile unit over the communications mechanism different than the WAN, wherein the second message is a voice message for the group call session; and

forwarding, by the first mobile unit, the second message to the server of the telecommunications platform over the WAN.

13. The method of claim 9, wherein relaying, by the first mobile unit, the first message to a second mobile unit comprises multicasting the first message to the second mobile unit.

14. The method of claim 13, wherein multicasting the first message to the second mobile unit comprises forwarding, by the first mobile unit, the first message to a multicast router connected to the second mobile unit over a local area network (LAN).

15. The method of claim 9, wherein relaying, by the first mobile unit, the first message to a second mobile unit comprises unicasting the first message to the second mobile unit.

16. The method of claim 9 further comprising:

duplicating, by the first mobile unit, the first message to provide a duplicated first message; and

transmitting, by the first mobile unit, the duplicated first message to a fourth mobile unit over a communications mechanism different than the WAN, wherein the fourth mobile unit is also a participant in the group call session.

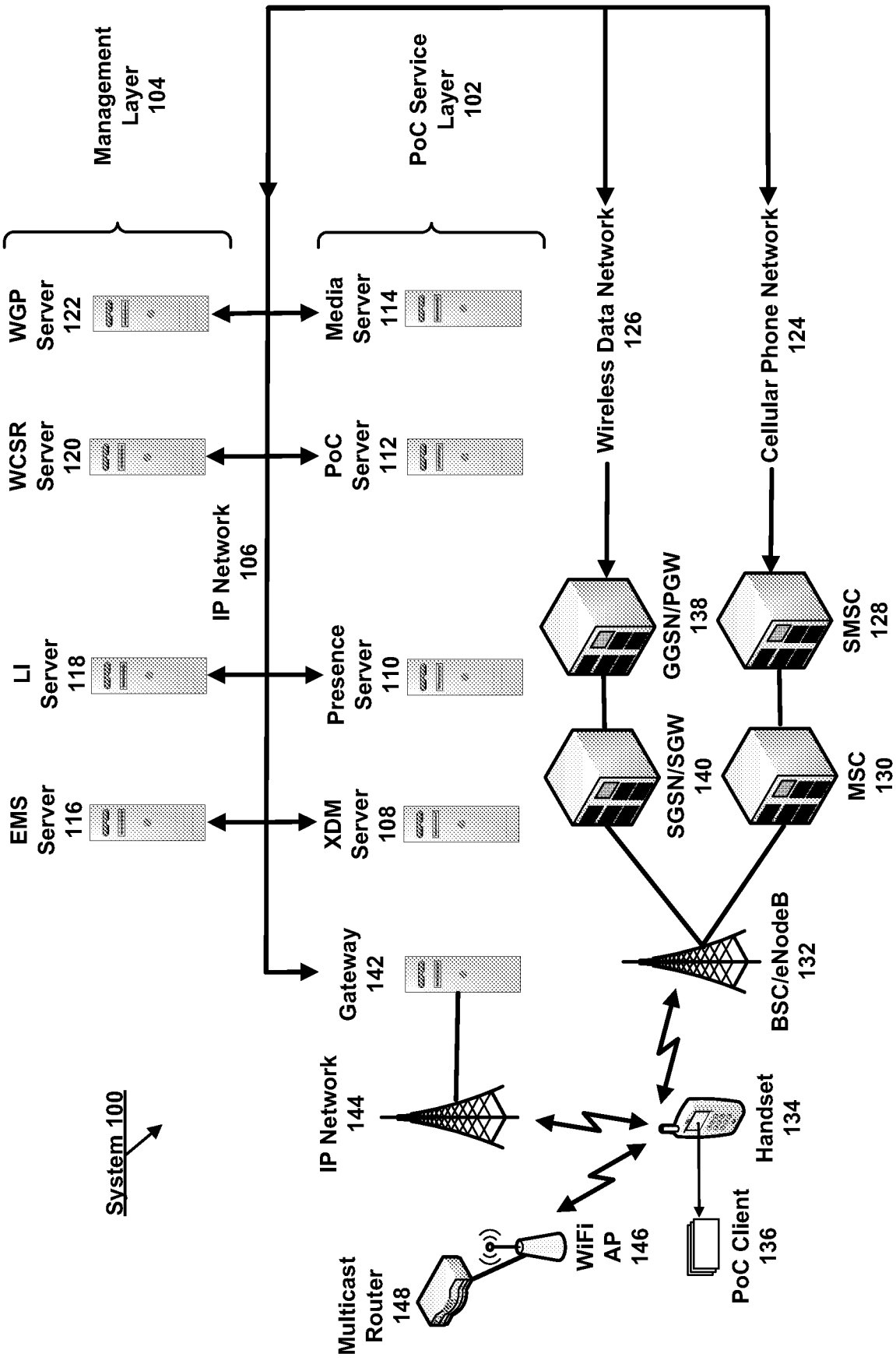

Management Layer 104
PoC Service Layer 102
WGP Server 122
WCSR Server 120
LI Server 118
EMS Server 116
IP Network 106
Media Server 114
PoC Server 112
Presence Server 110
XDM Server 108
Gateway 142
Wireless Data Network 126
Cellular Phone Network 124
GGSN/PGW 138
SGSN/SGW 140
SMSC 128
MSC 130
BSC/eNodeB 132
IP Network 144
Handset 134
WiFi AP 146
PoC Client 136
Multicast Router 148
System 100

FIG. 1

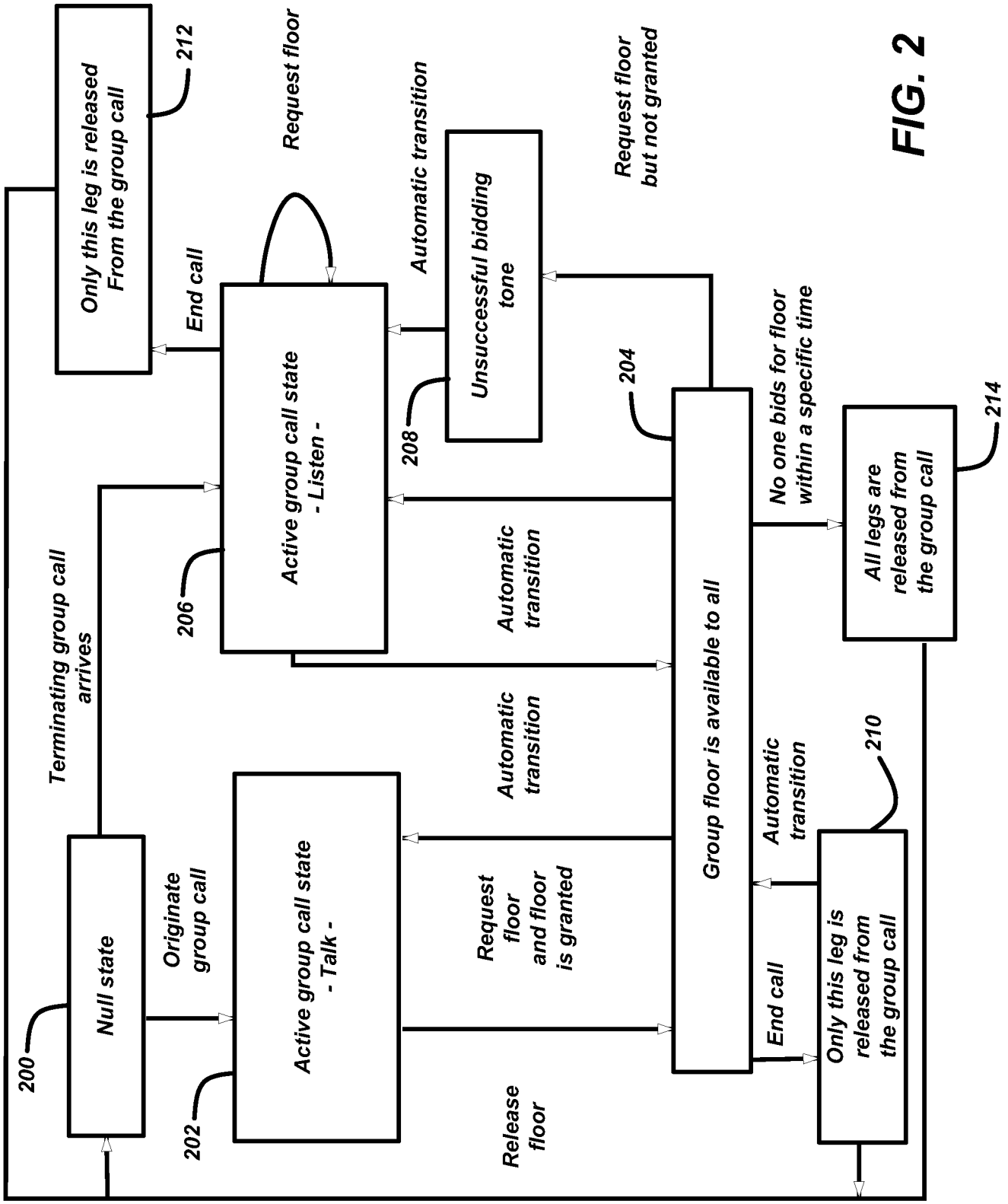

Null state
200
Originate group call
Terminating group call arrives
Active group call state - Talk -
202
Request floor and floor is granted
Release floor
Automatic transition
Group floor is available to all
204
Request floor but not granted
Unsuccessful bidding tone
208
Automatic transition
Active group call state - Listen -
206
Request floor
End call
Only this leg is released From the group call
212
No one bids for floor within a specific time
Automatic transition
End call
Only this leg is released from the group call
210
All legs are released from the group call
214

FIG. 2

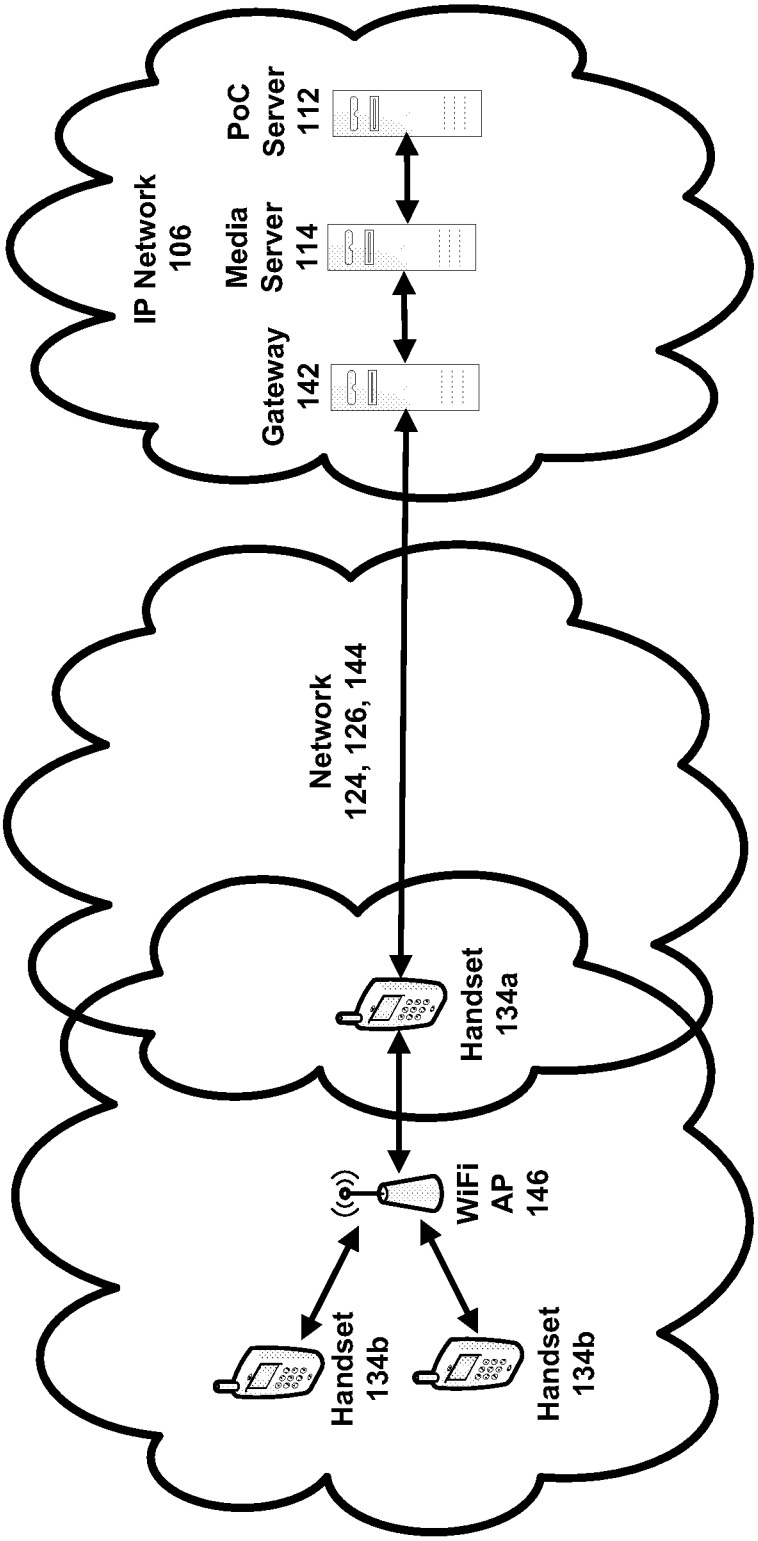

IP Network
106
PoC
Server
112
Media
Server
114
Gateway
142
Network
124, 126, 144
Handset
134a
WiFi
AP
146
Handset
134b
Handset
134b

FIG. 3

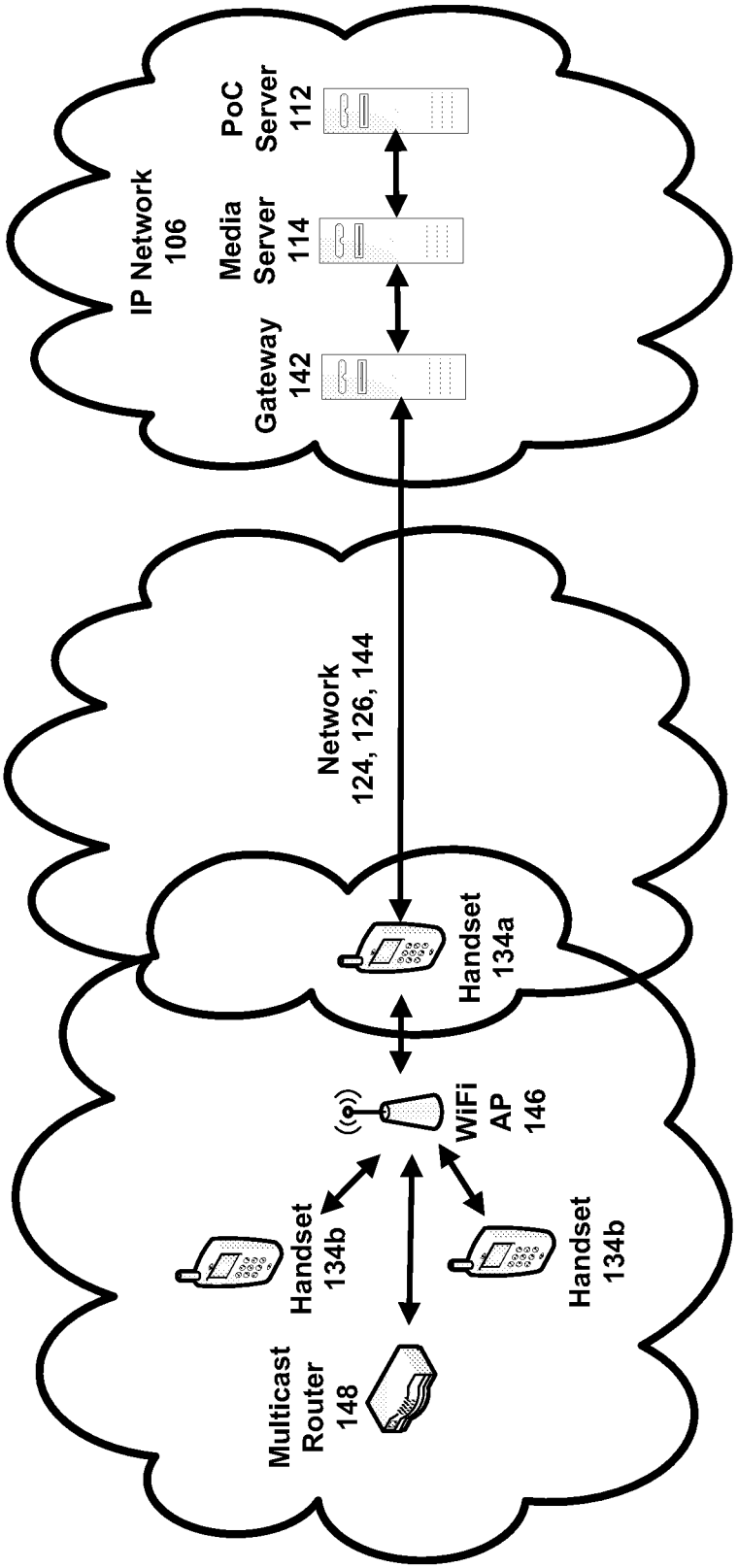

IP Network
106
PoC
Server
112
Media
Server
114
Gateway
142
Network
124, 126, 144
Handset
134a
WiFi
AP
146
Handset
134b
Handset
134b
Multicast
Router
148

FIG. 4

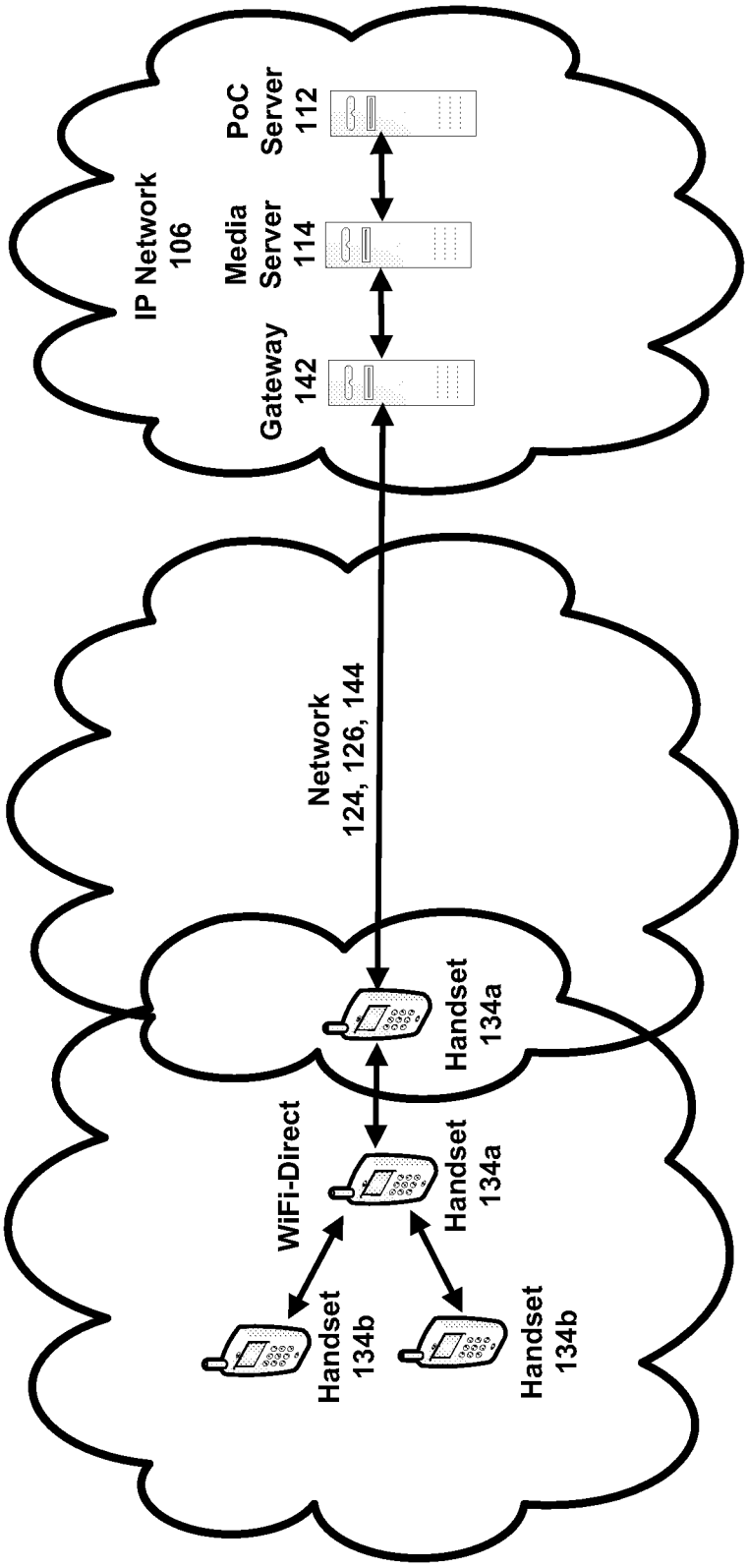
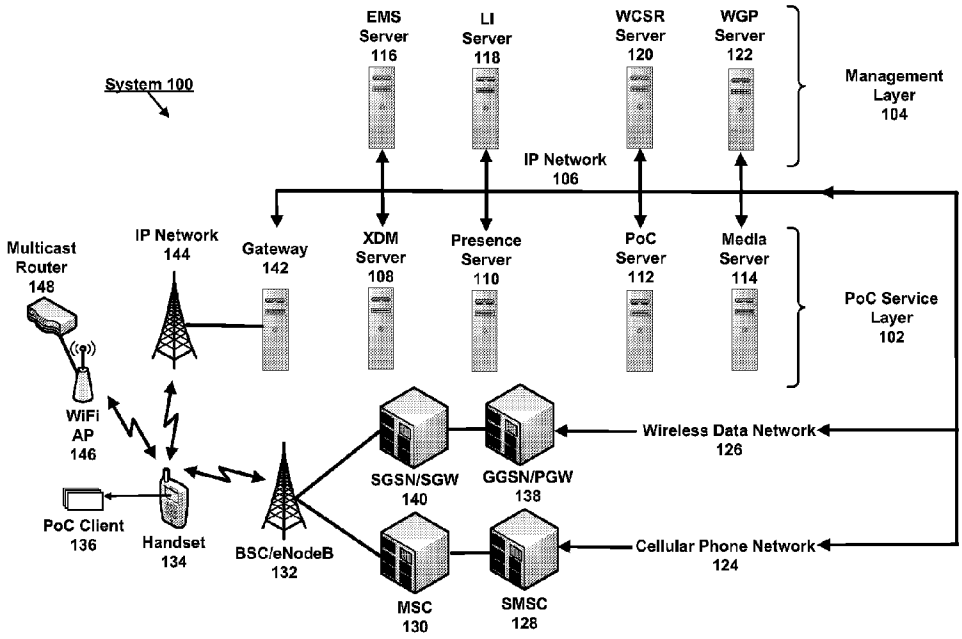

IP Network
106
PoC
Server
112
Media
Server
114
Gateway
142
Network
124, 126, 144
Handset
134a
WiFi-Direct
Handset
134a
Handset
134b
Handset
134b

FIG. 5


System 100
EMS Server 116
LI Server 118
WCSR Server 120
WGP Server 122
Management Layer 104
IP Network 106
Multicast Router 148
IP Network 144
Gateway 142
XDM Server 108
Presence Server 110
PoC Server 112
Media Server 114
PoC Service Layer 102
WiFi AP 146
Wireless Data Network 126
SGSN/SGW 140
GGSN/PGW 138
PoC Client 136
Handset 134
BSC/eNodeB 132
Cellular Phone Network 124
MSC 130
SMSC 128