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(54) Title: OPTIMIZED METHODS FOR LARGE GROUP CALLING USING UNICAST AND MULTICAST TRANSPORT BEARERS FOR PUSH-TO-TALK-OVER-CELLULAR (PoC)

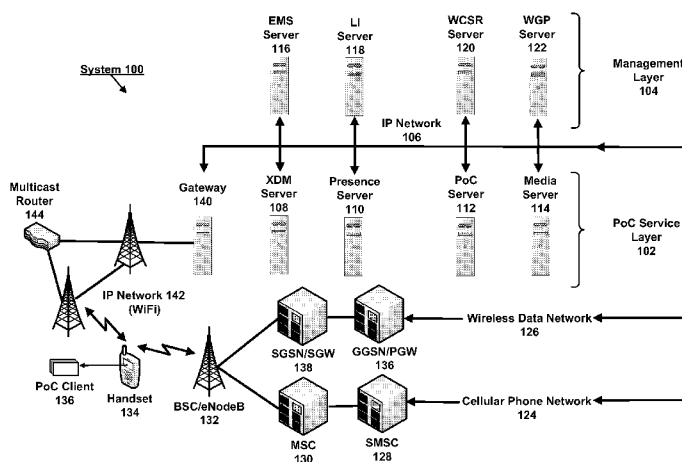


FIG. 1

(57) Abstract: A system and method for optimizing large group calling using unicast and multicast transport bearers for Push-to-talk-over-Cellular (PoC). One or more servers interface to a wireless communications network to perform advanced voice services for mobile units therein, including the PoC call session. The servers and mobile units communicate with each other using control messages, and the servers switch voice messages between the mobile units. At least one of the servers manages the PoC call session by acting as an arbitrator, and controls the sending of the control messages and the voice messages to and from the mobile units. The server performs unicast and multicast delivery of the control messages and the voice messages to and from the mobile units, thereby enabling large group calling involving a large number of participants with optimized use of network and server resources.

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Section 365 of P.C.T. International Application Serial Number PCT/US04/23038 (154.7-WO-U1), which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Numbers 60/488,638 (154.7-US-P1), 60/492,650 (154.8-US-P1) and 60/576,094 (154.14-US-P1) and which application is a continuation-in-part
5 and claims the benefit under 35 U.S.C. Sections 119, 120 and/or 365 of P.C.T. International Application Serial Number PCT/US03/16386 (154.4-WO-U1);

U.S. Utility Application Serial Number 11/126,587, filed May 11, 2005, by Ravi Ayyasamy and Krishnakant M. Patel, entitled “ARCHITECTURE, CLIENT SPECIFICATION AND APPLICATION PROGRAMMING INTERFACE (API) FOR
10 SUPPORTING ADVANCED VOICE SERVICES (AVS) INCLUDING PUSH TO TALK ON WIRELESS HANDSETS AND NETWORKS,” attorney docket number 154.9-US-U1, now U.S. Patent No. 7,738,892, issued June 15, 2010, which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Numbers 60/569,953 (154.9-US-P1) and 60/579,309 (154.15-US-P1), and which
15 application is a continuation-in-part and claims the benefit under 35 U.S.C. Sections 119, 120 and/or 365 of U.S. Utility Application Serial Number 10/515,556 (154.4-US-WO) and P.C.T. International Application Serial Number PCT/US04/23038 (154.7-WO-U1);

U.S. Utility Application Serial Number 11/129,268, filed May 13, 2005, by Krishnakant M. Patel, Gorachand Kundu, Ravi Ayyasamy and Basem Ardah, entitled
20 “ROAMING GATEWAY FOR SUPPORT OF ADVANCED VOICE SERVICES WHILE ROAMING IN WIRELESS COMMUNICATIONS SYSTEMS,” attorney docket number 154.10-US-U1, now U.S. Patent No. 7,403,775, issued July 22, 2008, which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Number 60/571,075 (154.10-US-P1), and which application is a
25 continuation-in-part and claims the benefit under 35 U.S.C. Sections 119, 120 and/or 365 of U.S. Utility Application Serial Number 10/515,556 (154.4-US-WO) and P.C.T. International Application Serial Number PCT/US04/23038 (154.7-WO-U1);

U.S. Utility Application Serial Number 11/134,883, filed May 23, 2005, by Krishnakant Patel, Vyankatesh V. Shanbhag, Ravi Ayyasamy, Stephen R. Horton and Shan-Jen Chiou, entitled “ADVANCED VOICE SERVICES ARCHITECTURE FRAMEWORK,” attorney docket number 154.11-US-U1, now U.S. Patent No. 7,764,950, issued July 27, 2010, which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Numbers 60/573,059 (154.11-US-P1) and 60/576,092 (154.12-US-P1), and which application is a continuation-in-part and claims the benefit under 35 U.S.C. Sections 119, 120 and/or 365 of U.S. Utility Application Serial Number 10/515,556 (154.4-US-WO), P.C.T. International Application Serial Number PCT/US04/23038 (154.7-WO-U1), U.S. Utility Application Serial Number 11/126,587 (154.9-US-U1), and U.S. Utility Application Serial Number 11/129,268 (154.10-US-U1);

U.S. Utility Application Serial Number 11/136,233, filed May 24, 2005, 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,” attorney docket number 154.13-US-U1, now U.S. Patent No. 7,738,896, issued June 15, 2010, which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Number 60/573,780 (154.13-US-P1), and which application is a continuation-in-part and claims the benefit under 35 U.S.C. Sections 119, 120 and/or 365 of U.S. Utility Application Serial Number 10/515,556 (154.4-US-WO), P.C.T. International Application Serial Number PCT/US04/23038 (154.7-WO-U1), U.S. Utility Application Serial Number 11/126,587 (154.9-US-U1), and U.S. Utility Application Serial Number 11/134,883 (154.11-US-U1);

U.S. Utility Application Serial Number 11/158,527, filed June 22, 2005, by F. Craig Farrill, entitled “PRESS-TO-CONNECT FOR WIRELESS COMMUNICATIONS

SYSTEMS,” attorney docket number 154.16-US-U1, now U.S. Patent No. 7,529,557, issued May 5, 2009, which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Number 60/581,954 (154.16-US-P1), and which application is a continuation-in-part and claims the benefit under 35 U.S.C. Sections 119, 5 120 and/or 365 of U.S. Utility Application Serial Number 10/515,556 (154.4-US-WO) and P.C.T. International Application Serial Number PCT/US04/23038 (154.7-WO-U1);

U.S. Utility Application Serial Number 11/183,516, filed July 18, 2005, by Deepankar Biswaas, entitled “VIRTUAL PUSH TO TALK (PTT) AND PUSH TO SHARE (PTS) FOR WIRELESS COMMUNICATIONS SYSTEMS,” attorney docket 10 number 154.17-US-U1, which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Number 60/588,464 (154.17-US-P1);

U.S. Utility Application Serial Number 11/356,775, filed February 17, 2006, by Krishnakant M. Patel, Bruce D. Lawler, Giridhar K. Boray, and Brahmananda R. Vempati, entitled “ENHANCED FEATURES IN AN ADVANCED VOICE SERVICES 15 (AVS) FRAMEWORK FOR WIRELESS COMMUNICATIONS SYSTEMS,” attorney docket number 154.18-US-U1, now U.S. Patent No. 7,813,722, issued October 12, 2010, which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Number 60/654,271(154.18-US-P1);

P.C.T. International Application Serial Number PCT/US2006/011628, filed 20 March 30, 2006, by Krishnakant M. Patel, Gorachand Kundu, Sameer Dharangaonkar, Giridhar K. Boray, and Deepankar Biswas, entitled “TECHNIQUE FOR IMPLEMENTING ADVANCED VOICE SERVICES USING AN UNSTRUCTURED SUPPLEMENTARY SERVICE DATA (USSD) INTERFACE,” attorney docket number 154.19-WO-U1, which application claims the benefit under 35 U.S.C. Section 119(e) of 25 U.S. Provisional Application Serial Number 60/666,424 (154.19-US-P1);

U.S. Utility Application Serial Number 11/462,332, filed August 3, 2006, 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," attorney docket number 154.20-US-U1, now U.S. Patent No. 7,689,238, issued March 30, 2010, which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional
5 Application Serial Number 60/705,115 (154.20-US-P1);

U.S. Utility Application Serial Number 11/463,186, filed August 8, 2006, by Ravi Ayyasamy and Krishnakant M. Patel, entitled "ADVANCED VOICE SERVICES CLIENT FOR BREW PLATFORM," attorney docket number 154.21-US-U1, now U.S. Patent No. 8,036,692, issued October 11, 2011, which application claims the benefit
10 under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Number 60/706,265 (154.21-US-P1);

U.S. Utility Application Serial Number 11/567,098, filed December 5, 2006, by Ravi Ayyasamy, Bruce D. Lawler, Krishnakant M. Patel, Vyankatesh V. Shanbhag, Brahmananda R. Vempati, and Ravi Shankar Kumar, entitled "INSTANT MESSAGING
15 INTERWORKING IN AN ADVANCED VOICE SERVICES (AVS) FRAMEWORK FOR WIRELESS COMMUNICATIONS SYSTEMS," attorney docket number 154.23-US-U1, which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Number 60/742,250 (154.23-US-P1);

U.S. Utility Application Serial Number 11/740,805, filed April 26, 2007, by
20 Krishnakant M. Patel, Giridhar K. Boray, Ravi Ayyasamy, and Gorachand Kundu, entitled "ADVANCED FEATURES ON A REAL-TIME EXCHANGE SYSTEM," attorney docket number 154.26-US-U1, now U.S. Patent No. 7,853,279, issued December 14, 2010, which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Number 60/795,090 (154.26-US-P1);

25 U.S. Utility Application Serial Number 11/891,127, filed August 9, 2007, by Krishnakant M. Patel, Deepankar Biswas, Sameer P. Dharangaonkar and Terakanambi Nanjanayaka Raja, entitled "EMERGENCY GROUP CALLING ACROSS MULTIPLE

WIRELESS NETWORKS,” attorney docket number 154.27-US-U1, which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Number 60/836,521 (154.27-US-P1);

5 U.S. Utility Application Serial Number 12/259,102, filed on October 27, 2008, by Krishnakant M. Patel, Gorachand Kundu, and Ravi Ayyasamy, entitled “CONNECTED PORTFOLIO SERVICES FOR A WIRELESS COMMUNICATIONS NETWORK,” attorneys’ docket number 154.32-US-U1, which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Numbers 60/982,650 (154.32-US-P1) and 61/023,042 (154.32-US-P2);

10 U.S. Utility Application Serial Number 12/359,861, filed on January 26, 2009, 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,” attorneys’ docket number 154.33-US-U1, now
15 U.S. Patent No. 8,676,189, issued March 18, 2014, which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Number 61/023,332 (154.33-US-P1);

20 U.S. Utility Application Serial Number 12/582,601, filed October 20, 2009, 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,” attorney docket number 154.36-US-U1, which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Number 61/106,689 (154.36-US-P1);

25 U.S. Utility Application Serial Number 12/781,566, filed on May 17, 2010, 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,” attorneys’ docket number 154.38-US-I1, now U.S. Patent No. 8,670,760, issued March 11, 2014, which application is a continuation-in-part and claims the benefit under 35 U.S.C. Sections 119, 120 and/or 365 of U.S. Utility Application Serial Number 12/582,601 (154.36-US-U1);

5 U.S. Utility Application Serial Number 12/750,175, filed on March 30, 2010, 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
10 SERVICES IN A WIRELESS COMMUNICATIONS NETWORK,” attorneys’ docket number 154.39-US-U1, now U.S. Patent No. 8,498,660, issued July 30, 2013, which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Numbers 61/164,754 (154.39-US-P1) and 61/172,129 (154.39-US-P2);

15 U.S. Utility Application Serial Number 12/961,419, filed December 6, 2010, 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,” attorneys’ docket number 154.40-US-U1, which application claims the
20 benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Number 61/266,896 (154.40-US-P1);

U.S. Utility Application Serial Number 13/039,635, filed on March 3, 2011, by Narasimha Raju Nagubhai, Ravi Shankar Kumar, Krishnakant M. Patel, and Ravi Ayyasamy, entitled “PREPAID BILLING SOLUTIONS FOR PUSH-TO-TALK IN A
25 WIRELESS COMMUNICATIONS NETWORK,” attorneys’ docket number 154.41-US-U1, now U.S. Patent No. 8,369,829, issued February 5, 2013, which application claims

the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Number 61/310,245 (154.41-US-P1);

U.S. Utility Application Serial Number 13/093,542, filed April 25, 2011, by Brahmananda R. Vempati, Krishnakant M. Patel, Pratap Chandana, Anand Narayanan, 5 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,” attorneys’ docket number 154.42-US-U1, now U.S. Patent No. 8,478,261, issued July 2, 2013, which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. 10 Provisional Application Serial Number 61/347,217 (154.42-US-P1);

U.S. Utility Application Serial Number 13/710,683, filed December 11, 2012, 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 15 Narayanan, and Pratap Chandana, entitled “PUSH-TO-TALK-OVER-CELLULAR (PoC),” attorneys’ docket number 154.43-US-U1, which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Number 61/570,694 (154.43-US-P2);

U.S. Utility Application Serial Number 13/917,561, filed June 13, 2013, by 20 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,” attorneys’ docket number 154.47-US-U1, which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Number 61/659,292 (154.47-US-P1); U.S. Provisional Application 25 Serial Number 61/682,524 (154.47-US-P2); and U.S. Provisional Application Serial Number 61/705,748 (154.47-US-P3);

U.S. Utility Application Serial Number 13/757,520, filed February 1, 2013, 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),” attorneys’ docket number 154.48-US-U1, which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Number 61/593,485 (154.48-US-P1);

U.S. Utility Application Serial Number 14/093,240, filed November 29, 2013, by Gorachand Kundu, Krishnakant M. Patel, Harisha Mahabaleshwara Negalaguli, Ramu Kandula, and Ravi Ayyasamy, entitled “METHOD AND FRAMEWORK TO DETECT SERVICE USERS IN INSUFFICIENT WIRELESS RADIO COVERAGE NETWORK AND IMPROVE SERVICE DELIVERY EXPERIENCE BY GUARANTEED PRESENCE,” attorneys’ docket number 154.55-US-U1, which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Number 61/730,856 (154.55-US-P1);

P.C.T. International Application Serial Number PCT/US2014/036414, filed May 1, 2014, by Krishnakant M. Patel, Harisha Mahabaleshwara Negalaguli, Arun Velayudhan, Ramu Kandula, Syed Nazir Khadar, Shiva Koteshwara Kiran Cheedella, and Subramanyam Narasimha Prashanth, entitled “VOICE-OVER-IP (VOIP) DENIAL OF SERVICE (DOS) PROTECTION MECHANISMS FROM ATTACK,” attorneys’ docket number 154.56-WO-U1, which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Number 61/818,109 (154.56-US-P1); and U.S. Provisional Application Serial Number 61/821,975 (154.56-US-P2);

U.S. Utility Application Serial Number 14/286,427, filed May 23, 2014, by Krishnakant M. Patel, Ravi Ayyasamy and Brahmananda R. Vempati, entitled “METHOD TO ACHIEVE A FULLY ACKNOWLEDGED MODE

COMMUNICATION IN PUSH-TO-TALK OVER CELLULAR (PoC),” attorneys’ docket number 154.57-US-U1, which application claims the benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Number 61/826,895 (154.57-US-P1);

5 P.C.T. International Application Serial Number PCT/US2014/047863, filed on July 23, 2014, 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,” attorneys’ docket number 154.58-US-U1, which application claims the
10 benefit under 35 U.S.C. Section 119(e) of U.S. Provisional Application Serial Number 61/857,363 (154.58-US-P1); and U.S. Provisional Application Serial Number 61/944,168 (154.58-US-P2); and

P.C.T. International Application Serial Number PCT/US2014/047886, filed on July 23, 2014, by Gorachand Kundu, Giridhar K. Boray, Brahmananda R. Vempati,
15 Krishnakant M. Patel, Ravi Ayyasamy, Harisha Mahabaleshwara Negalaguli, and Ramu Kandula, entitled “RADIO ACCESS NETWORK (RAN) AWARE SERVICE DELIVERY FOR PUSH-TO-TALK-OVER-CELLULAR (POC) NETWORKS,” attorneys’ docket number 154.61-WO-U1, which application is a continuation-in-part under 35 U.S.C. Section 120 of P.C.T. International Application Serial Number
20 PCT/US2014/047863 (154.58-US-U1);

all of which applications are incorporated by reference herein.

BACKGROUND OF THE INVENTION

1. Field of the Invention.

25 This invention relates in general to advanced voice services in wireless communications networks, and more specifically, to a system and method for optimizing

large group calling using unicast and multicast transport bearers for Push-to-talk-over-Cellular (PoC) networks.

2. Description of Related Art.

5 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), as well as other AVS functions, such as Push-to-Conference (P2C) or Instant Conferencing (IC), Push-to-Message (P2M), etc., are described in the co-pending and commonly-assigned patent
10 applications cross-referenced above and incorporated by reference herein. 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
15 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.

20 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. For example, many existing implementations of PoC do not support large group calling. The present invention, on the other hand, satisfies the need for supporting
25 large group calling, and also defines procedures for practical implementation of PoC in commercial, standards-based, cellular networks.

SUMMARY OF THE INVENTION

To overcome the limitations in the prior art described above, and to overcome other limitations that will become apparent upon reading and understanding the present specification, the present invention discloses a system and method for optimizing large group calling using unicast and multicast transport bearers for Push-to-talk-over-Cellular (PoC).

Specifically, the present invention discloses a system and method for providing advanced voice services in at least one wireless communications network, comprising: one or more servers that interface to the wireless communications network to perform advanced voice services for one or more 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 Push-to-Talk-over-Cellular (PoC) call session; wherein 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, and at least one of the servers switches voice messages for the advanced group services between the mobile units across the wireless communications network; wherein at least one of the servers manages the PoC call session by acting as an arbitrator for the PoC call session and controls the sending of the control messages and the voice messages to and from the mobile units; and wherein at least one of the servers performs unicast and multicast delivery of the control messages and the voice messages to and from the mobile units, thereby enabling large group calling involving a large number of participants with optimized use of network and server resources.

The Push-to-Talk-over-Cellular (PoC) call session allows the participants to take turns talking and transmitting using a floor control mechanism, while remaining ones of the participants receive and only listen. In addition, the Push-to-Talk-over-Cellular (PoC) call session may be a broadcast call with one of the participants talking and transmitting, while remaining ones of the participants only receive and listen. Moreover,

the Push-to-Talk-over-Cellular (PoC) call session may comprise a pre-established PoC call session or an on-demand PoC call session.

The server performs the unicast delivery of the control messages and the voice messages to and from the mobile units by replicating the voice messages received from the participant that is talking for transmission to each of the participants that are listening. The server may perform the unicast delivery of the control messages and the voice messages to and from the mobile units using a staggered large group call delivery method by creating one or more batches of the participants based on specified criteria and by delivering the voice messages to each of the batches separated by a specified interval, so as to avoid congestion in the network. The specified criteria may comprise a location of the participants, wherein the location is a real-time location or a last reported location. The specified criteria may also comprise a corporation identifier. The staggered large group call delivery method may use a message delivery framework, such that the voice messages received from the participant that is talking are recorded into one or more files that are sent periodically to the participants that are listening, wherein the message delivery framework comprises a SIP/MSRP or HTTP based message upload/delivery framework.

The server performs the multicast delivery of the control messages and the voice messages to and from the mobile units by replicating the voice messages received from the participant that is talking for transmission to one or more multicast addresses for the participants that are listening, wherein the server replicates and transmits the voice messages once for each of multicast addresses. The multicast addresses are assigned to each group and published to members of the group, wherein the mobile units report which of the multicast addresses they are using to the server, and the server records which of the multicast addresses are used by the mobile units.

The server may also perform both the unicast and multicast delivery of the control messages and the voice messages to and from the mobile units by replicating the voice

FIG. 5 is a call flow diagram that illustrates a large group call initiation using multicast methods over WiFi.

DETAILED DESCRIPTION OF THE INVENTION

5 In the following description of the preferred embodiment, reference is made to the accompanying drawings which form a part hereof, and in which is shown by way of illustration the specific embodiment in which the invention 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 invention.

10

1 Overview

The present invention discloses 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 that can be easily deployed, thereby enabling carriers to increase their profits, improve customer retention and attract new customers without costly upgrades to their network infrastructure. This system is built on a proven, reliable all-IP (Internet Protocol) platform. The highly scalable platform is 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.

20

1.1 Definitions

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

25

Acronym	Description
ATCA	Advanced Telecommunications Computing Architecture
DnD	Do not Disturb
DNS	Domain Name Server
MBMS/eMBMS	Multimedia Broadcast Multicast Services
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
GTM	Global Traffic Manager
GTP	GPRS Tunneling Protocol
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
SIM	Subscriber Identity Module
SIP	Session Initiation Protocol
SMMP	Short Message peer-to-peer Protocol
SMS	Small Message Service
SRTP	Secure Real-time Transport Protocol
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
VPN	Virtual Private Network

Acronym	Description
SGW	Serving GateWay
XCAP	XML Configuration Access Protocol
XDM	XML Document Management
XML	Extensible Mark-up Language
4G/LTE	4 th 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.
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.

Term	Description
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.

Term	Description
Serving Server	A set of primary and secondary servers.
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 the present invention. This architecture conforms to the Advanced Telecommunications Computing Architecture (ATCA) standard to support the advanced voice services of the present invention. ATCA is an open standards-based, high-availability telecommunications platform architecture.

Preferably, 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
5 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) 136 and Serving GPRS Support Nodes (SGSNs) or Serving Gateways (SGWs) 138, which also communicate with customer handsets 134 via BSCs or eNodeBs 132.

Finally, in one embodiment of the present invention, the PoC Service Layer 102
10 and Management Layer 104 are connected to one or more Gateways 140, which are coupled to one or more external IP networks 142, such as WiFi networks 142, possibly using one or more Multicast Routers 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 140.

15

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.

20

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 136 transfers IP packets between the PoC Client 136
25 and the various servers:

- 5
 - 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.
 - 10 ▪ 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.

15

2.3 WiFi Network

The PoC Service Layer 102 also interacts with the following entities on the WiFi network 142:

- 20 • The Gateway 140 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.
 - 25 ▪ 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.
- 5 ▪ 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

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

- PoC Server 112,
- Media Server 114,
- Presence Server 110,
- 15 • XDM Server 108, and
- Gateway 140.

These elements are described in more detail below.

2.4.1 PoC Server

20 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
25 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.

10

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.

15

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.

20

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

25

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.

5

2.4.5 Gateway

The Gateway 140 implements a interworking solution for the PoC Service to communicate via one or more IP network 142 access points to the PoC Clients 136. Specifically, the Gateway 140 provides PoC Service over an IP network 142 (such as an external WiFi network), as well as the wireless data networks 126, and supports 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 140 also resolves security concerns that arise with such interworking solutions.

10
15

This is 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 140 provides following benefits:

20

- PoC Services becomes available even in those locations where a wireless data network 126 is not available, but where a general purpose IP network 142 is available. This is particularly more useful in enhancing in-building coverage for the PoC Service.

25

- By connecting over the IP network 142, the available IP bandwidth, quality and performance can be more streamlined and controlled since the IP network 142 (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 142, as compared to the wireless data network 126, it is possible to provide additional services (such as sharing large files) which otherwise is inefficient and costly on wireless data networks 126.

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

10 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,
- 15 • 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

20 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-
25 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
5 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
10 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
15 (CSRs) for managing end user provisioning and account maintenance.

Typically, it supports the following operations:

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

25

3 System Functions

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

5 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.

10 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 allow for faster call setup for PoC call sessions.

15 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
20 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
25 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 allows watchers to subscribe to large number of Presentities without putting strain on the network as well as client and server resources.

10 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.

15 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 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.

20 The XDM Server 108 includes a Subscriber Data Manager module that manages the 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 140 performs interworking for the PoC service by communicating with the PoC Clients 136 via one or more IP networks 142 and/or wireless data networks 126.

5 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 140, 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. For example, the PoC Clients 136 may use the Transport Layer Security (TLS)
10 and/or Secure Sockets Layer (SSL) protocols for encrypting information transmitted over the connections between the PoC Client 136 and the Gateway 140.

 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 140. XCAP signaling may be transmitted using a Hypertext Transfer Protocol Secure
15 (HTTPS) protocol, which results from layering the Hypertext Transfer Protocol (HTTP) on top of the SSL/TLS connections, thus adding the security capabilities of SSL/TLS to standard HTTP communications.

 Consequently, the Gateway 140 performs as an encryption/decryption off-loader that provides end-to-end encryption for all traffic transmitted to and from the PoC Client
20 136. Specifically, all of the traffic sent to the PoC Client 136 is encrypted at the Gateway 140 and all the traffic received from the PoC Client 136 is decrypted at the Gateway 140.

 The Gateway 140 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 140 acts as an intelligent traffic distributor
25 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 140 is 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 140, or other Servers, and the PoC Clients 136. Thus, a PoC Client 136 maintains an “always-on” connection with the Gateway 140 by periodically sending “keep-alive” messages over the SSL/TLS connections.

The system also simplifies the use of the Multicast Routers 144.

3.2 Management Layer

10 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.

20

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.

25 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,
- 5 • 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
10 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.
15 The CAT has a Web User Interface for corporate administrators that supports the
following operations:

- Group management,
 - Contact management, and
 - Associations between corporations.
- 20 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,
 - 25 • 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
- 5 • 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),
- 10 • 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,
- 15 • Association Name,
- Association ID,
- Association Mode (e.g., One-way, Two-way), and
- Restricted List.

20 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,
- 25 • 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.

5

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,
- 10 • 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,
15 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.

20 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.

25 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 most important 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-
5 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
10 according to one embodiment of the present invention.

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
15 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
20 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
25 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).

10 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.

20 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.

25 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 5 Large Group Calling

5.1 Overview

 The present invention provides solutions for Large Group Calling. Specifically, the present invention provides delivery methods for Large Group Calling using unicast methods, such as staggered and batched call delivery, call delivery using PoC calling, and
10 call delivery using a messaging framework. The present invention also provides delivery methods for Large Group Calling using multicast methods, such as call delivery using WiFi multicast and LTE eMBMS. In addition, the present invention provides delivery methods for Large Group Calling using a combination approach of unicast and multicast methods, which employs a combination of call delivery methods based on the
15 participants' access network types and distribution. Finally, the present invention describes the usage of an adaptive codec rate for media for large group calls, as well as an overview of broadcast calling.

5.2 Introduction

20 Group calls that involve a large number of participants could burden both network and server resources significantly and that would cause intermittent failures or more serious issues where service could become completely unusable. The large group calls could be regular PoC calls, wherein the participants of the call can take turns talking (transmitting) using the floor control mechanisms, while other participants will only
25 listen. The large group calls could also be broadcast calls, wherein there will be only one transmitting (talking) user and the rest of the members of the group (or list) only are allowed to listen.

In either type of group calling, there will be only one talker at a time and there will be multiple listeners, and hence the PoC Server 112 is required to replicate the voice packets received from the talker leg to one or more listener legs in real-time, so that the PoC Client 136 or other applications in the handsets 134 can receive the packets and play
5 the voice. When a unicast network bearer is used, the voice packets need to be 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.

In the case of broadcast calling, based on the nature of its usage, the requirement
10 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 several 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
15 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 on various factors in the network, such as available spectrum bandwidth, overall load conditions, priority of the user, etc.

In order to provide better overall user experience, a RAN usually follows an
20 Admission Control strategy, wherein the network limits the maximum number of users that can be simultaneously allowed to use the network and/or its interfaces at any point of time. This limits the number of handsets 134 that can receive the voice packets from the PoC Server 112 in real-time, especially when the participants are highly concentrated within a geographical area covered by the same cell, or sector, or access point.

25 The following table provides a summary of the various solutions for Large Group Calling.

Type	Unicast over 4G/LTE	Unicast over WiFi	Multicast over 4G/LTE	Multicast over WiFi	Combinations
Broadcast call	Staggered PoC call delivery by batches, and staggered message delivery by batches	Staggered PoC call delivery by batches, and staggered message delivery by batches	PoC group calling by leveraging the LTE eMBMS framework	PoC group calling using multicast IP transport over WiFi	Hybrid approach – a combination of different methods based on the user’s access network type
Interactive group call	Staggered message delivery by batches	Staggered message delivery by batches			

5.3 Staggered Large Group Call Delivery over Unicast

In a Staggered Large Group Call Delivery solution, the PoC Server 112 creates “batches” of the participants based on certain criteria, such as location or company, and
 5 delivers the voice messages batch-by-batch, wherein the delivery to each batch is separated by some interval, so as to avoid congestion in the network.

The originating PoC Client 136 originates the large group call to the PoC Server 112 using one of the following methods:

- As a PoC call originated to the large group, or
- 10 • As a message sent to the large group.

In response, the PoC Server 112 buffers and/or records the complete group call.

The PoC Server 112 also creates the batches by analyzing the list of recipients (i.e., the members of the group), their available location, and/or their access network type. The batches can be created using any of number of different criteria or any
 15 combination of criteria, such as:

- A company (e.g. corporation id) to which the recipient user belongs,

- The recipient's current location at an available granularity level (e.g., by GPS location, or cell id, or LAC id, or WiFi SSID, etc.),
- The recipient's last reported location at an available granularity level, for the cases where the real-time location of user is not available, or
- 5 • The type of RAN to which the recipient participant is connected, such as 3G/4G/LTE, WiFi, etc.

The PoC Server 112 schedules delivery of the group call via the batches. The PoC Server 112 first attempts to deliver the group call to the participants of the first batch and then, after a specified interval, attempts to deliver the next batch, and so on. The process continues and repeats until delivery of all batches has been attempted.

The PoC Server 112 also performs delivery status tracking and reporting, and delivery retry attempts. The PoC Server 112 tracks the status of each delivery attempt to each of the recipients of the broadcast call and reports that information to administrators and originators on-demand or in real-time. Moreover, it is possible that one or more delivery attempts to some or all of the participants fails, and the PoC Server 112 can optionally retry the delivery attempts for some configured number of retries and/or some configured period of time, before declaring the delivery attempts as failed.

FIG. 3 is a call flow diagram that illustrates a staggered large group call delivery via unicast methods. Handset 134a originates a large group call using normal PoC call origination or using a messaging transport to signal the PoC Server 112. The PoC Server 112, in turn, attempts batch delivery of the large group call origination to handsets 134b, 134c, 134d and 134e, wherein Batch-1 comprises the handsets 134b in UMTS Cell-1 of cellular network 124, Batch-2 comprises the handsets 134c in UMTS Cell-2 of cellular network 124, Batch-1 comprises the handsets 134d in the LTE Cell of wireless data network 126, and Batch-1 comprises the handsets 134e in WiFi network 142.

The following table describes the delivery methods for the various members of the large group call.

Group Members	Locations	Delivery Batch
M1 – Mx	UMTS Cell-1	Batch-1
My – Mn1	UTMS Cell-2	Batch-2
M2 – Mn2	LTE Cell-1	Batch-1
M3 – Mn3	WiFi	Batch-1

The following table describes the maximum RAN usage target at ~50% of capacity.

5

Access network type	Tracked network information	Approximate users per cell, sector, or access point (configurable)
UMTS	Cell id	~25
LTE	Cell id	~125
WiFi	SSID	~500

5.4 Batch Creation

Since each of the networks 124, 126, 142 used by the handsets 134 can vary by their capacity and bandwidth, it would be extremely hard to have a common batch size that will fit into all the cases. On the other hand, it would be inefficient to track each user’s network type and location accurately so as to estimate the capacity and bandwidth of the current network.

In one embodiment, each batch is built once and then reused to avoid repeated computation of the batch for each large group call. Otherwise, the PoC Server 112 would need to compute the batches every time a large group call is initiated.

Whenever the group is created, the PoC Server 112 builds the batch based on the location and network access type information available in the PoC Server 112 database, as last reported by each PoC Client 136. Each PoC Client 136 can report a change of

network access type or location to the PoC Server 112 in order to update the batch information.

5.5 Large Group Call Delivery Using PoC Calling

5 As discussed above, large 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 large 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. Preferably, the PoC Server 112 buffers the voice packets for the large group call received from the originator until the voice packets are delivered to all participants of the group call. Large group call delivery is performed to the terminating PoC Clients 136 and mobiles 134 using normal PoC call termination methods.

5.6 Large Group Call Delivery Using A Messaging Framework

20 Large group call delivery can also be implemented over a messaging framework.

When large 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.

25 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 large 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 Large 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 5.8 Large Group Call Delivery Using Multicast Over WiFi Networks

FIG. 4 is a call flow diagram that illustrates a large group call delivery using multicast methods over a WiFi network 142. Each handset 134 that is group member receives the group call delivery from the PoC Server 112 via a multicast transport using the Gateway 140 and Multicast Router 144, wherein there is one multicast address per
10 pre-defined group. The same multicast group destination is used across all of the networks to which group members may be connected,

FIG. 5 is a call flow diagram that illustrates a large group call origination using multicast methods over a WiFi network 142. Originator A, using handset 134a, initiates the group call through unicast signaling to the PoC Server 112 via the Multicast Router
15 144a and the Gateway 140. The PoC Server 112 sends an incoming call indication to the group members comprising the handsets 134b and 134c, namely for Recipients B and C, using a multicast delivery method via the Gateway 140 and Multicast Router 144b. Since handsets 134b and 134c have already joined the multicast group and are listening for packets at the designated multicast address, they receive the indication. The handset
20 134a of Originator A (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 A (or the current talker) to handset 134b of Recipient B and handset 134c of Recipient C using a multicast delivery method, and the messages are subsequently received by all listeners.

25

5.9 PoC Client Registration With The PoC Server Using WiFi Multicast

The following steps describe the PoC Client 136 registration process with the PoC Server 112, in which the PoC Client 136 publishes its capability and readiness to use a multicast network bearer over a WiFi network 142.

- 5 1. The PoC Client 136 starts normal SIP registration with the PoC Server 112 (SIP Registrar).
2. The PoC Client 136 indicates to the PoC Server 112 during registration that it is multicast capable and also provides the SSID of its WiFi network 142.
- 10 3. The PoC Server 112 performs a configuration lookup to determine whether the reported SSID is multicast capable.
4. The PoC Server 112 identifies the participants which are multicast enabled.
5. The PoC Server 112 marks the appropriate listener legs as multicast
15 enabled.
6. The PoC Server 112 may apply logic to determine whether to use multicast or unicast delivery based on number of PoC Clients 136 that can be served by a multicast-enabled network.
7. The PoC Server 112 provides multicast addresses to PoC Clients during
20 registration.
8. Encryption keys may also be distributed during registration or on-demand.
9. To optimize this communication, a SIP REGISTER session may be reused.
10. The PoC Client 136 starts listening on the multicast IP address, in addition
25 to the IP sessions with the PoC Server 112.

5.10 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:

- 5 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
10 an IP address for the Multicast Router 144.
 4. The PoC Server 112 automatically assigns 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-
15 capable groups, then 10 different ports are allocated).

5.11 Large Group Call Delivery Using LTE eMBMS

A multicast PoC group call may also use LTE eMBMS. Multimedia Broadcast Multicast Services (MBMS) is a point-to-multipoint interface specification for cellular
20 networks, which is 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
25 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 136, SGSNs 138, 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 is intended for “Download and Play” services.

5.12 Security Aspects Of Large 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 large 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.

20

5.13 The Combination Of Multiple Transports

Large 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.).

25

Consequently, the appropriate calling method may be 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
5 intelligently decides 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 large group calls occurring in same area, whenever such information is available, to make best efforts to avoid network congestion.

10 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 determines 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
15 networks of the participants, then group calling is established using normal PoC calling methods.
- The PoC Server 112 categorizes 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
20 PoC calling methods can be used for those participants. Otherwise, a delivery method that avoids network congestion is employed and the chosen calling method is based on the participant's access network type:
 - For participants concentrated in a UMTS cell, staggered, batched, message or PoC call based group calling methods are employed.
 - 25 ▪ For participants concentrated in an LTE Cell that supports multicast, an eMBMS based calling method is employed.

- 5
- For participants concentrated in a WiFi SSID that supports multicast, a WiFi multicast calling method is employed.
 - For participants concentrated in a WiFi SSID that does not support multicast, a staggered, batched PoC calling/message based group calling method is employed.
 - For participants that are distributed across various locations and network access types, a unicast based regular PoC calling method is employed.
- 10
- 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 a staggered method of call delivery using either PoC calling or message based methods for all users on UMTS.
- 15
- 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
- 20
- PoC Server 112 in developing such network capability learning by reporting such information to the PoC Server 112.

5.14 Use Of Adaptive Codec Rate In Large Group Calls

25 In one embodiment of the present invention, media transfer rates can be adapted for large group calls. When a large number of users are concentrated on the same network access points, such as 3G/4G/LTE cells or WiFi network access points, the available

bandwidth and air time to transmit/receive becomes a limiting factor. By intelligently adapting the codec to a lower rate used for media (audio, video, etc.), it is possible to serve more users from the same cells, sectors or access points, which otherwise may not be possible.

5 There are two methods of rate adaptation is possible for large group calls:

1) A PoC Server 112 trans-rating based approach:

- The talker leg of the group call sends media data using a pre-configured or negotiated rate, preferably the best rate possible, and the PoC Server 112 trans-rates (i.e., changes the codec rates) based on the codec rate required for the other participants.
- Based on the participants' access network types, a network and/or location appropriate codec rate is chosen. For example, if there is a large concentration of users in the same UMTS/3G/4G/LTE cell, the codec rate may be downgraded, so that all potential participants can listen to the voice at a reasonably acceptable quality. In another example, if there is another set of participants in a WiFi network or LTE network that supports multicast, then a codec rate for the best quality available may be used.
- The codec rate to be used for a call can be provided at the beginning of the call, such as by means of an MBTCP Connect message in the case of pre-established call terminations.
- It may also be possible to change the codec rate dynamically from the PoC Server 112, based on quality feedback received from the participating PoC Clients 136. The quality feedback may be made possible via RTCP SR/RR reporting mechanisms.

2) A codec rate fixed at the beginning of the call:

- 5
- When a large group call is originated, the PoC Server 112 analyzes the list of participants and identifies the most common codec rate that will work seamlessly for all participants for the large group call. For example, the PoC Server 112 might decide to use a common codec rate for a subset of users concentrated in the same UMTS cell. The selected codec rate needs to be communicated to the participants at the time of call establishment, for example, using an MBCP Connect message for both the originating and terminating legs.
- 10 3) Trans-rating applied for the first set of volleys only, where a second and/or subsequent set of volleys use a fixed codec rate:
- This mechanism is similar to mechanism 2) above, with the addition of allowing trans-rating for a first volley of the group call.
 - In order to minimize the call setup time and processing delay and overhead involved in codec rate changes, it may not be possible to decide on and communicate a common codec rate that will work for all users at the time of call setup. Thus, a hybrid mechanism in which the first volley is based on a default codec rate, which is pre-negotiated or pre-configured, and the PoC Server 112 trans-rates the codec rate to a lower common codec rate for the second and/or subsequent volleys.
 - The codec rate used for second and/or subsequent volleys is communicated to the PoC Clients 136 at call setup time or during first volley (e.g., by means of an MBCP Connect or MBCP Taken message). The PoC Clients 136 that are transmitting the second and/or subsequent volleys use the common codec rate provided
- 15
- 20
- 25

and the PoC Server 112 is not required to trans-rating of the codec for the second and/or subsequent volleys.

5.15 Broadcast Calling Overview

5 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 be able to receive the broadcast call message or voice completely and clearly, with minimal or no voice/packet loss.

10 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 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.

15 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
20 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,
25 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.

5.16 Broadcast Group Management

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

5 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:
 - 10 ▪ The broadcast group is special type of group, which are maintained by administrators (e.g. using a CAT) with full authority. The broadcast group member list is also manipulated by certain privileged users such as supervisors, as determined by administrators.
 - 15 ▪ The visibility of the complete list of broadcast group members is 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.
 - 20 ▪ 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.

25 For staggered large group call delivery, there is a need for tools to support broadcast call originations:

- An originating PoC Client 136 records the broadcast message.

- Any options for the user to review, record, etc., are provided before the request is established with the PoC Server 112.
- The originating PoC Client 136 sends the broadcast message to the PoC Server 112 as a PoC call originated to the broadcast group (preferred), or
5 as a message sent to the broadcast group.
- Preferably, the PoC Server 112 buffers or records the complete broadcast call.

6 Conclusion

10 The foregoing description of the preferred embodiment 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
15 appended hereto.

WHAT IS CLAIMED IS:

1. A system for providing advanced voice services in at least one wireless communications network, comprising:

one or more servers that interface to the wireless communications network to perform advanced voice services for one or more 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 Push-to-Talk-over-Cellular (PoC) call session;

wherein 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, and at least one of the servers switches voice messages for the advanced group services between the mobile units across the wireless communications network;

wherein at least one of the servers manages the PoC call session by acting as an arbitrator for the PoC call session and controls the sending of the control messages and the voice messages to and from the mobile units; and

wherein at least one of the servers performs unicast and multicast delivery of the control messages and the voice messages to and from the mobile units, thereby enabling large group calling involving a large number of participants with optimized use of network and server resources.

2. The system of claim 1, wherein the Push-to-Talk-over-Cellular (PoC) call session allows the participants to take turns talking and transmitting using a floor control mechanism, while remaining ones of the participants receive and only listen.

3. The system of claim 1, wherein the Push-to-Talk-over-Cellular (PoC) call session is a broadcast call with one of the participants talking and transmitting, while remaining ones of the participants only receive and listen.

4. The system of claim 1, wherein the at least one of the servers performs the unicast delivery of the control messages and the voice messages to and from the mobile units

by replicating the voice messages received from the participant that is talking for transmission to each of the participants that are listening.

5. The system of claim 4, wherein the at least one of the servers performs the unicast delivery of the control messages and the voice messages to and from the mobile units using a staggered large group call delivery method by creating one or more batches of the participants based on specified criteria and by delivering the voice messages to each of the batches separated by a specified interval, so as to avoid congestion in the network.

6. The system of claim 5, wherein the specified criteria comprises a location of the participants.

7. The system of claim 6, wherein the location is a real-time location or a last reported location.

8. The system of claim 5, wherein the specified criteria comprises a corporation identifier.

9. The system of claim 5, wherein the Push-to-Talk-over-Cellular (PoC) call session comprises a pre-established PoC call session or an on-demand PoC call session.

10. The system of claim 5, wherein the staggered large group call delivery method uses a message delivery framework, such that the voice messages received from the participant that is talking are recorded into one or more files that are sent periodically to the participants that are listening.

11. The system of claim 10, wherein the message delivery framework comprises a SIP/MSRP based message upload/delivery framework.

12. The system of claim 10, wherein the message delivery framework comprises an HTTP based message upload/delivery framework.

13. The system of claim 4, wherein the at least one of the servers performs the multicast delivery of the control messages and the voice messages to and from the mobile units by replicating the voice messages received from the participant that is talking for transmission to one or more multicast addresses for the participants that are listening.

14. The system of claim 13, wherein the multicast addresses are assigned to each group and published to members of the group.

15. The system of claim 13, wherein the at least one of the servers records which of the multicast addresses are used by the mobile units.

16. The system of claim 15, wherein the mobile units report which of the multicast addresses they are using to the at least one of the servers.

17. The system of claim 13, wherein the at least one of the servers replicates and transmits the voice messages once for each of multicast addresses.

18. The system of claim 13, wherein the voice and control messages sent by multicast delivery are encrypted, and decryption keys are made available only to participants.

19. The system of claim 18, wherein the decryption keys are made available before the large group call.

20. The system of claim 1, wherein the at least one of the servers performs both the unicast and multicast delivery of the control messages and the voice messages to and from the mobile units by replicating the voice messages received from the participant that is talking for transmission to each of the participants that are listening in unicast mode and to one or more multicast addresses for each of the participants that are listening in multicast mode.

21. The system of claim 20, wherein a number of online and available members of the group is used as a criteria to decide whether to employ the unicast or multicast delivery for each of the participants.

22. The system of claim 20, wherein the at least one of the servers performs the unicast or multicast delivery based on a network access type for each of the participants.

23. The system of claim 20, wherein the mobile units report a status for the unicast or multicast delivery to the at least one of the servers.

24. The system of claim 1, wherein a codec data rate used for the voice messages is dynamically determined based on congestion in the network.

25. The system of claim 24, wherein the congestion in the network is estimated based on a number of the mobile units of the group concentrated within the network or a subdivision of the network.

26. A method of providing advanced voice services in at least one wireless communications network, comprising:

interfacing one or more servers to the wireless communications network to perform advanced voice services for one or more 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 Push-to-Talk-over-Cellular (PoC) call session;

wherein 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, and at least one of the servers switches voice messages for the advanced group services between the mobile units across the wireless communications network;

wherein at least one of the servers manages the PoC call session by acting as an arbitrator for the PoC call session and controls the sending of the control messages and the voice messages to and from the mobile units; and

wherein at least one of the servers performs unicast and multicast delivery of the

control messages and the voice messages to and from the mobile units, thereby enabling large group calling involving a large number of participants with optimized use of network and server resources.

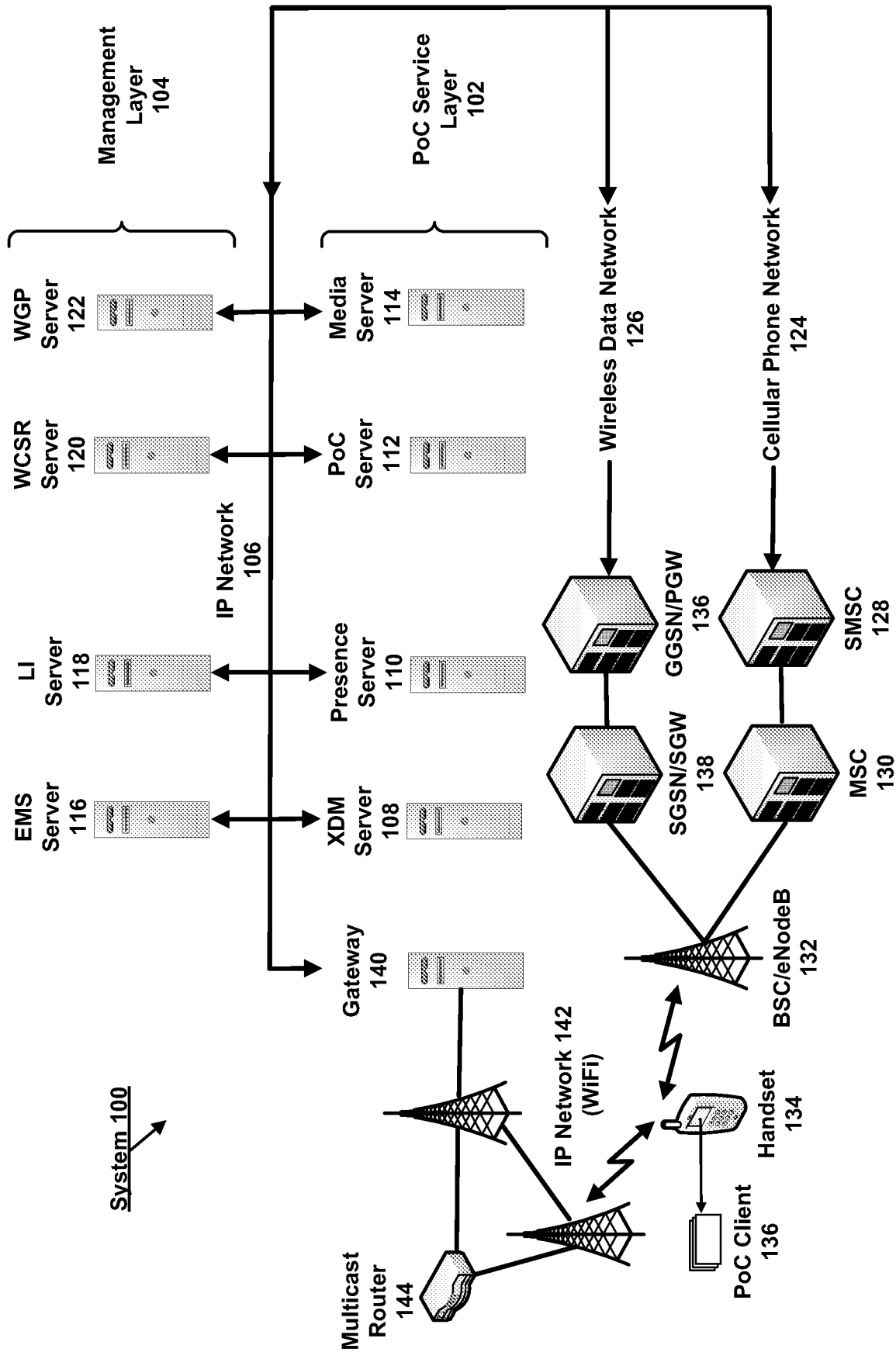


FIG. 1

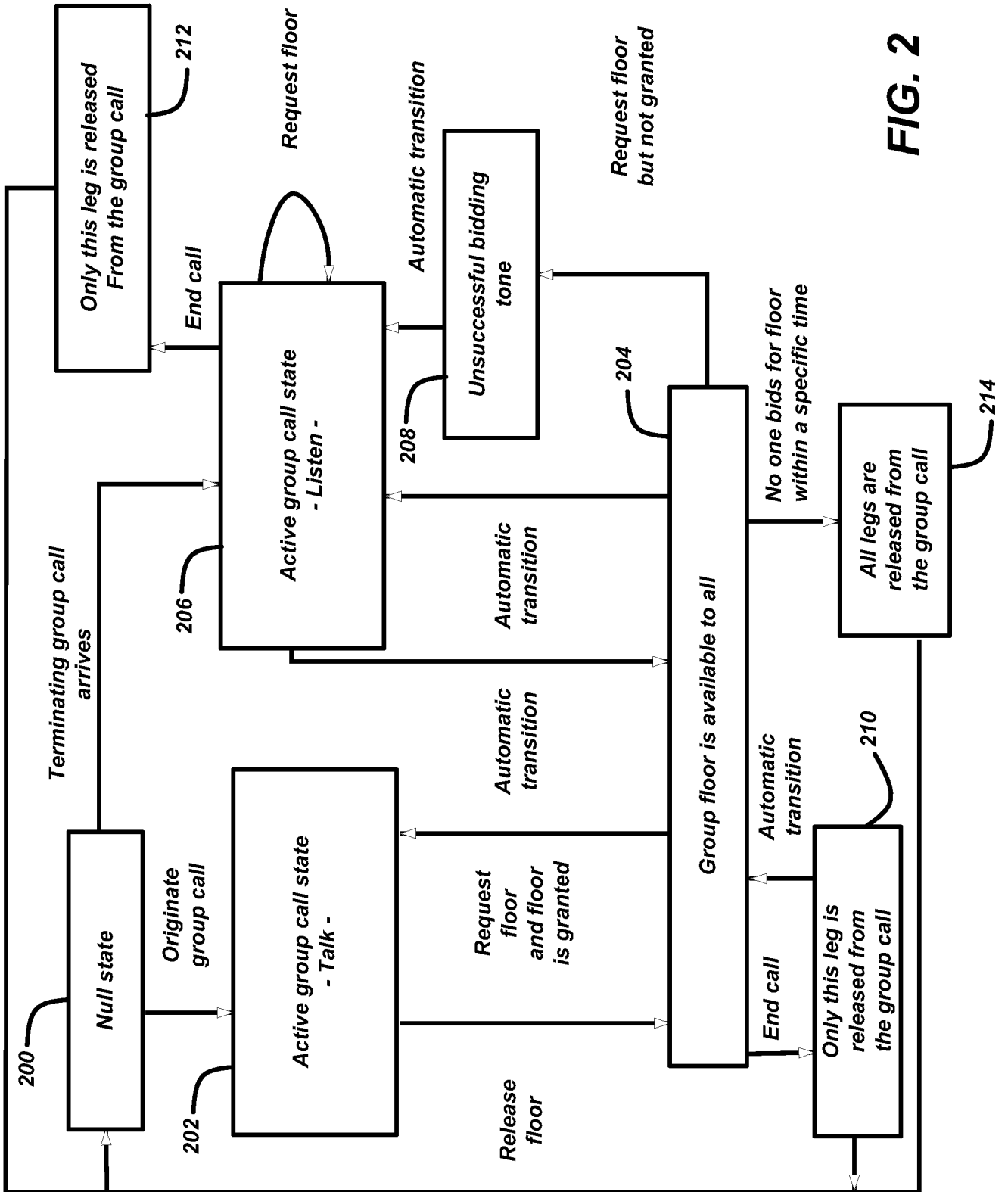


FIG. 2

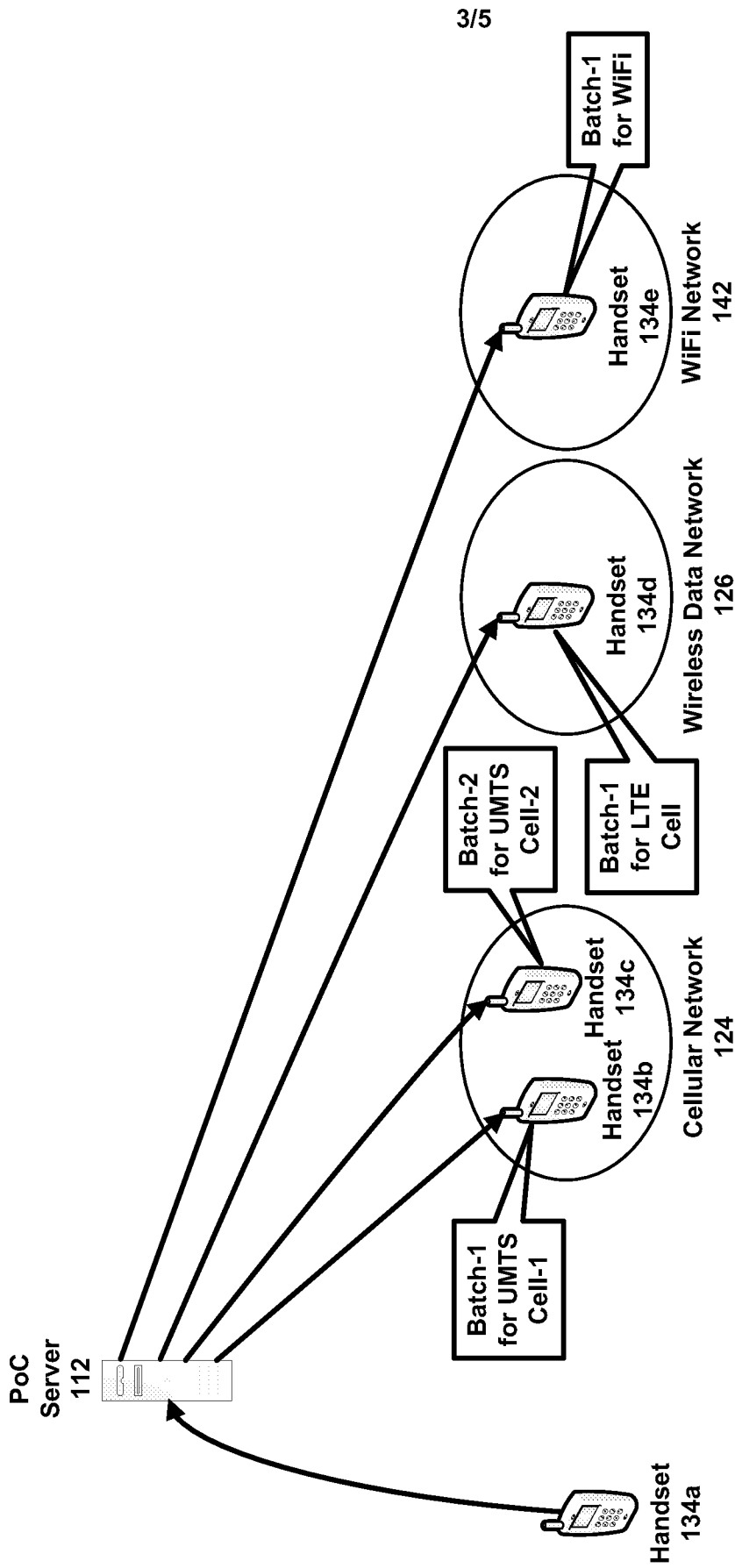


FIG. 3

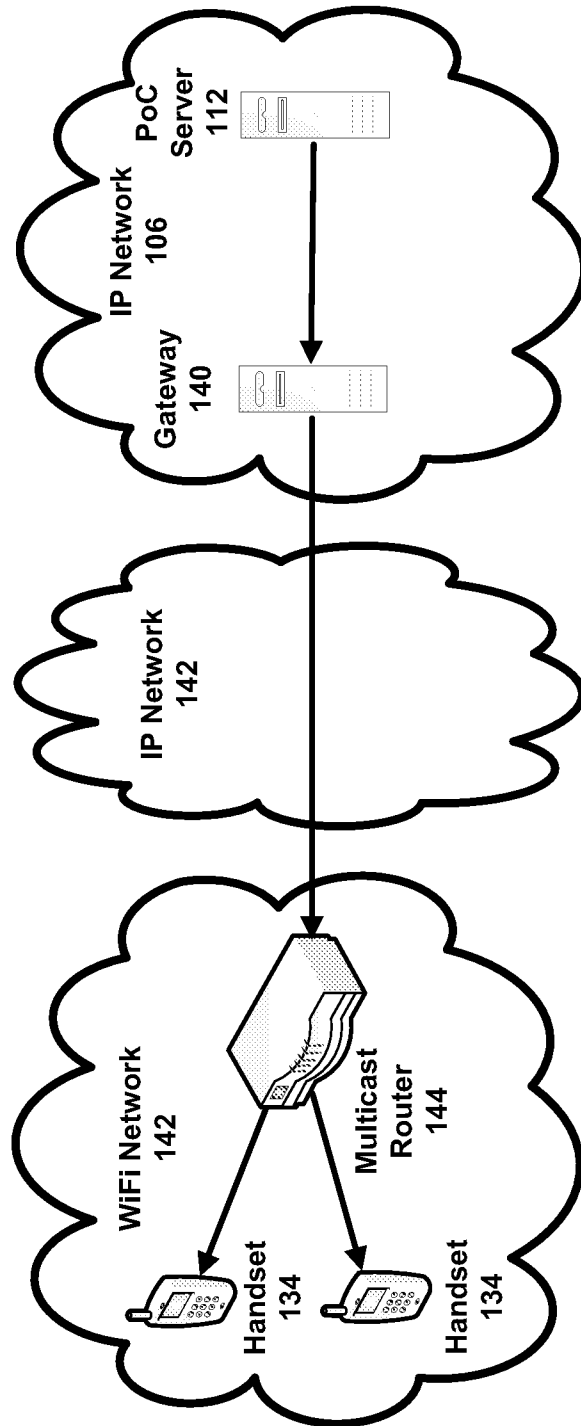


FIG. 4

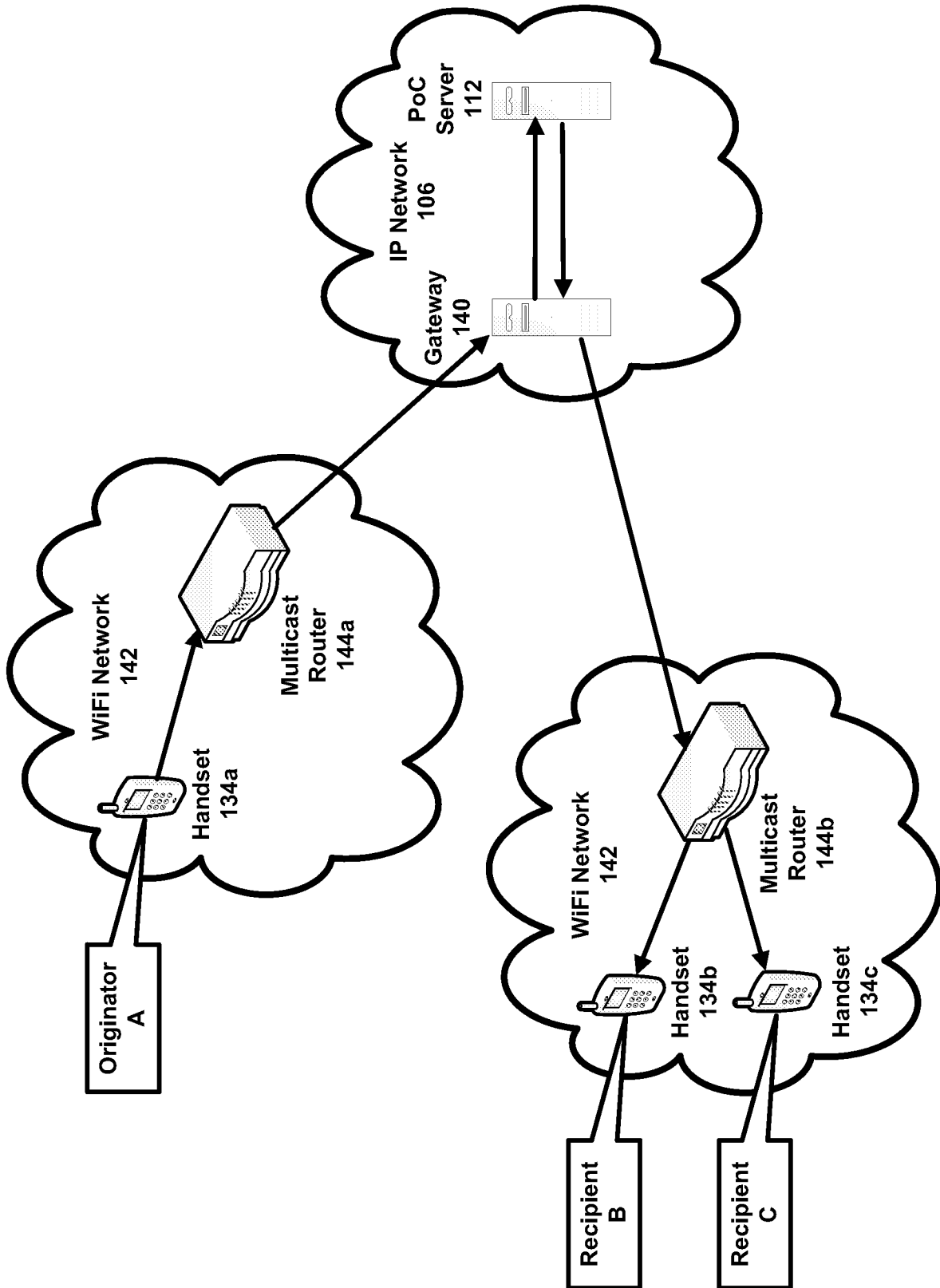


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US15/10617

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - H04W 28/02 (2015.01)

CPC - G06F 9/505

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) Classifications: H04W 4/10; H04W 4/06; H04W 28/02 (2015.01)

CPC Classifications: G06F 9/505; G06Q 30/0601; G06Q 30/08

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatSeer (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, INPADOC Data); Google/ GooglePatents; IEEE; ProQuest; Espacenet.

Keywords: network; Push-to-talk; participants; unicast; multicast; encrypt; decrypt.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2013/0196706 A1 (KODIAK NETWORKS, INC.) 01 August 2013; Abstract; paragraphs [0035], [0048], [0056], [0088].	1, 3, 4 and 26
Y		2 and 5-25
Y	US 2006/0142036 A1 (LIM, G) 29 June 2006; Abstract; paragraph [0027].	2
Y	US 5991279 A (HAUGLI, H et al.) 23 November 1999; Abstract; Column 3, lines 16-21; Column 4, lines 12-13, lines 25-27; Column 7, lines 32-37.	5-12
Y	US 2010/0056109 A1 (WILSON, C et al.) 04 March 2010; Abstract; paragraph [0014].	10-12
Y	US 2010/0272105 A1 (LI, M et al.) 28 October 2010; Abstract; paragraphs [0010], [0037].	13-23
Y	US 7181014 B1 (SRIVASTAVA, S) 20 February 2007; Abstract; Column 6, lines 59-62; Column 8, lines 25-27.	18 and 19
Y	US 2011/0170410 A1 (ZHAO, X et al.) 14 July 2011; Abstract; paragraphs [0027], [0030].	24 and 25
A	US 2011/0217949 A1 (NAGUBHAI, N et al.) 08 September 2011; whole document.	1-26
A	US 2013/0007814 A1 (CHERIAN, G et al.) 03 January 2013; whole document.	1-26

 Further documents are listed in the continuation of Box C. See patent family annex.

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

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Date of mailing of the international search report

16 APR 2015

Name and mailing address of the ISA/

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