(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
4 December 2014 (04.12.2014)

WIPO | PCT

(10) International Publication Number
WO 2014/193933 A1

(51) International Patent Classification:
H04W 16/10 (2009.01) *H04W 16/14* (2009.01)

(21) International Application Number:
PCT/US2014/039757

(22) International Filing Date:
28 May 2014 (28.05.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/828,238 29 May 2013 (29.05.2013) US

(71) Applicant: **RIVADA NETWORKS LLC** [US/US]; Suite 300, 1755 Telstar Drive, Colorado Springs, Colorado 80920 (US).

(72) Inventors: **SMITH, Clint**; 12 Brandywine Drive, Warwick, New York 10990 (US). **DEVISETTI, Nageswara Rao Deekshitha**; c/o Radisys India Pvt Ltd., 6th Fl Electra Wing B Exora Business Park, Sarjapur, Maratahalli Outer Ring Road, Bangalore 560103 (IN). **SMITH, Samuel**; c/o Rivada Networks, LLC, 1755 Telstar Drive, Suite 300, Colorado Springs, Colorado 80920 (US).

(74) Agents: **MAZAHERY, Benjamin** et al.; The Marbury Law Group PLLC, 11800 Sunrise Valley Drive, 15th Floor, Reston, Virginia 20191 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ,

[Continued on next page]

(54) Title: METHODS AND SYSTEMS FOR DYNAMIC SPECTRUM ARBITRAGE WITH HOME eNodeBs

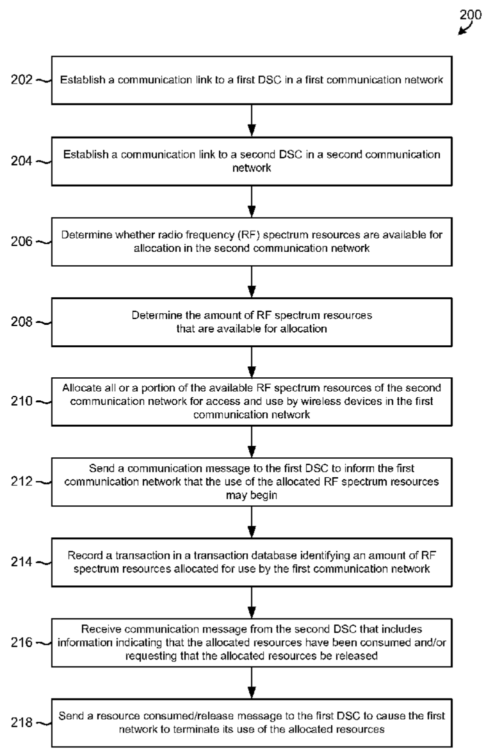


FIG. 2A

(57) Abstract: A dynamic spectrum arbitrage (DSA) system includes a plurality of femtocells, a home eNodeB gateway (HGW) coupled to each of the plurality of femtocells, a dynamic spectrum controller (DSC) coupled to the HGW, and a dynamic spectrum policy controller (DPC) coupled to the DSC and a plurality of other DSCs. Each of the femtocells may be configured to monitor network conditions, generate congestion reports based on a result of the monitoring, and send the generated congestion reports to the HGW. The HGW may be configured to receive congestion reports from many different femtocells, generate congestion state information based on the received congestion reports, and send the congestion state information to the DSC. The DSC may be configured to receiving the congestion state information from one or more HGWs, and use the received congestion state information to perform intelligent DSA operations (e.g., allocating resources, requesting handins, performing backoff operations, etc.).

WO 2014/193933 A1

UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

TITLE

Methods and Systems for Dynamic Spectrum Arbitrage with Home eNodeBs

RELATED APPLICATIONS

[0001] This application claims the benefit of priority to U.S. Provisional Application No. 61/828,238, entitled 'Methods and Systems for Dynamic Spectrum Arbitrage with Home eNodeBs' filed May 29, 2013, the entire contents of which are hereby incorporated by reference.

BACKGROUND

[0002] Over the past several years, internet-enabled smart phones, tablets and gaming consoles have become essential personal accessories, connecting users to friends, work, leisure activities and entertainment. Users now have more choices and expect to have access to content, data and communications at any time, in any place. As more users utilize these services, telecommunication networks must meet these increases in user demand, and support the array of new services and provide fast, reliable communications. Therefore, improved methods and solutions for dynamically allocating underutilized telecommunication resources (e.g., RF spectrum, etc.) of a first telecommunication network for access and use by wireless devices that subscribe to other networks will be beneficial to the telecommunication networks, service providers, and to the consumers of telecommunication services.

SUMMARY

[0003] The various embodiments include a dynamic spectrum arbitrage (DSA) system that includes a plurality of femtocells in a first telecommunication network, a home eNodeB gateway (HGW) having a HGW processor that is coupled to each of the plurality of femtocells via first communication links, a dynamic spectrum controller (DSC) having a DSC processor that is coupled to the HGW via a second communication link, and a

dynamic spectrum policy controller (DPC) having a DPC processor that coupled to the DSC via a third communication link. In an embodiment, the first communication links may be defined over a S1 interface, the second communication link may be defined over a Xe interface, and the third communication link may be defined over a Xd interface.

[0004] In a further embodiment, the plurality of femtocells may include a home eNodeB (HeNB) that includes a HeNB processor. The HeNB processor may be configured with processor-executable instructions to perform operations that include monitoring network conditions, generating congestion reports based on a result of the monitoring, and sending the generated congestion reports to the HGW via the first communication links. In a further embodiment, the HeNB processor may be configured with processor-executable instructions to perform operations so that monitoring network conditions includes monitoring one of a network congestion, a resource usage, and a resource availability. In a further embodiment, the HeNB processor may be configured with processor-executable instructions to perform operations that further include determining that the HeNB has been moved, determining whether there is are suitable serving HGWs in the first telecommunication network, establishing a communication link to one of the identified serving HGWs, and terminating one of the first communication links to the HGW.

[0005] In a further embodiment, the HGW processor may be configured with processor-executable instructions to perform operations including receiving congestion reports from the plurality of femtocells via the first communication links, generating congestion state information based on the received congestion reports, and sending the generated congestion state information to the DSC via the second communication link.

[0006] In a further embodiment, the DSC processor may be configured with processor-executable instructions to perform operations including receiving the congestion state information from the HGW via the second communication link, and using the received congestion state information to determine whether there are excess network resources available in the first telecommunication network for allocation and use by a second telecommunication network.

[0007] In a further embodiment, the DSC processor may be configured with processor-executable instructions to perform operations including receiving the congestion state information from the HGW via the second communication link, and using the received congestion state information to determine whether to perform handover operations to transfer selected wireless devices to a non-congested target eNodeB.

[0008] In a further embodiment, the DSC processor may be configured with processor-executable instructions to perform operations further including communicating with the DPC via the third communication link to cause the DPC to instruct a second DSC in a second telecommunication network to restrict further handovers to one or more of the plurality of femtocells in the first telecommunication network.

[0009] In a further embodiment, the DPC processor may be configured with processor-executable instructions to perform operations further including receiving a request for radio frequency (RF) spectrum resources, determining server an amount of RF spectrum resources available for allocation within the first telecommunication network, and dynamically allocating a portion of available RF spectrum resources of the first telecommunication network for access and use by multiple cell sites in a second communication network.

[0010] Further embodiments include a femtocell that includes a processor configured with processor-executable instructions to perform operations that include monitoring network conditions, generating congestion reports based on a result of the monitoring, and sending the generated congestion reports to a home eNodeB gateway (HGW) via a communication link defined over a S1 interface. In an embodiment, the femtocell processor may be configured with processor-executable instructions to perform operations such that monitoring network conditions includes monitoring one of a network congestion, a resource usage, and a resource availability. In a further embodiment, the femtocell processor may be configured with processor-executable instructions to perform operations further including determining that the femtocell has been moved, determining whether there is a suitable serving HGW available, establishing a second communication link to an identified serving HGW in response to determining that there is a suitable serving HGW available, and terminating the communication link to the HGW in response to establishing the second communication link to the serving HGW.

[0011] Further embodiments include home eNodeB gateway (HGW) that includes a processor configured with processor-executable instructions to perform operations that include establishing first communication links to a plurality of femtocells in a first telecommunication network, establishing a second communication link to a dynamic spectrum controller (DSC) in the first telecommunication network, receiving congestion reports from the plurality of femtocells via the first communication links, generating congestion state information based on the received congestion reports, and sending the generated congestion state information to the DSC via the second communication link.

[0012] Further embodiments may include computing devices having a processor (or processing core) configured with processor-executable instructions to perform various operations corresponding to the operations/methods discussed above.

[0013] Further embodiments may include computing devices that include various means for performing functions corresponding to the operations/methods discussed above.

[0014] Further embodiments may include a non-transitory processor-readable storage medium having stored thereon processor-executable instructions configured to cause a processor/processing core to perform various operations corresponding to the operations/methods operations discussed above.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The accompanying drawings, which are incorporated herein and constitute part of this specification, illustrate exemplary embodiments of the invention, and, together with the general description given above and the detailed description given below, serve to explain features of the invention.

[0016] FIGs. 1A through 1F are system block diagrams illustrating various logical and functions components and communication links in communication systems that may be used to implement the various embodiments.

[0017] FIG. 2A is a process flow diagram illustrating a dynamic spectrum arbitrage (DSA) method of allocating resources from the perspective of a dynamic spectrum policy controller (DPC) in accordance with an embodiment.

[0018] FIG. 2B is a message flow diagram illustrating message communications between components of a DSA communication system when allocating resources in accordance with an embodiment.

[0019] FIGs. 3 through 7 are process flow diagrams illustrating an embodiment DSA method of allocating and accessing resources in a communication system that includes a DPC, two dynamic spectrum controllers (DSCs), and a wireless device.

[0020] FIGs. 8A through 8C are message flow diagrams illustrating an embodiment dynamic spectrum arbitrage application part (DSAAP) registration method.

[0021] FIGs. 9A and 9B are message flow diagrams illustrating an embodiment DSAAP advertizing method.

[0022] FIGs. 10A and 10B are message flow diagrams illustrating an embodiment DSAAP method for communicating a list of available resources.

[0023] FIGs. 11A and 11B are message flow diagrams illustrating an embodiment DSAAP bidding method.

[0024] FIGs. 12A through 12D are message flow diagrams illustrating an embodiment DSAAP notification method for informing participating networks of the results of the bidding operations.

[0025] FIGs. 13A and 13B are message flow diagrams illustrating an embodiment DSAAP purchase method for immediately (or near immediately) purchasing a resource.

[0026] FIGs. 14A and 14B are message flow diagrams illustrating an embodiment DSAAP allocation method for allocating resources in a lessor network for access and use by components in a lessee network.

[0027] FIGs. 15A and 15B are message flow diagrams illustrating an embodiment DSAAP backoff method of selectively handing over a wireless device from a lessor network back to the lessee's network (i.e. its home PLMN).

[0028] FIG. 16A is a message flow diagram illustrating an embodiment DSC initiated DSAAP de-registration method for terminating DSA operations.

[0029] FIG. 16B is a message flow diagram illustrating an embodiment DPC initiated DSAAP de-registration method for terminating DSA operations.

[0030] FIG. 17A is a message flow diagram illustrating a DSC initiated DSAAP error indication method for reporting errors.

[0031] FIG. 17B is a message flow diagram illustrating a DPC initiated DSAAP error indication method for reporting errors.

[0032] FIG. 18 is a component block diagram illustrating various communication links in an embodiment DSA system that includes femtocells.

[0033] FIG. 19 is a table diagram illustrating the relationships between a source component and a target component for X2-based handover (HO) support in accordance with an embodiment.

[0034] FIGs 20A through 22 are block diagrams illustrating protocol stacks for user plane and control plane communications between various components in accordance with various embodiments.

[0035] FIG. 23 is a process flow diagram illustrating an embodiment home eNodeB (HeNB) method of dynamically determining a most suitable serving home eNodeB gateway (HGW).

[0036] FIG. 24 is a process flow diagram illustrating a home eNodeB (HeNB) method of generating congestion reports in accordance with an embodiment.

[0037] FIG. 25 is a process flow diagram illustrating a home eNodeB gateway (HGW) method of generating congestion state information based on information received from many femtocells and in accordance with an embodiment.

[0038] FIG. 26 is a process flow diagram illustrating a dynamic spectrum controller (DSC) method of managing congestion in a telecommunication network in accordance with an embodiment.

[0039] FIG. 27 is a component block diagram of an example wireless device suitable for use with the various embodiments.

[0040] FIG. 28 is a component block diagram of a server suitable for use with an embodiment.

DETAILED DESCRIPTION

[0041] The various embodiments will be described in detail with reference to the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts. References made to particular examples and implementations are for illustrative purposes, and are not intended to limit the scope of the invention or the claims.

[0042] As used herein, the terms 'wireless device,' 'wireless device' and 'user equipment (UE)' may be used interchangeably and refer to any one of various cellular telephones, personal data assistants (PDA's), palm-top computers, laptop computers with wireless modems, wireless electronic mail receivers (e.g., the Blackberry® and Treo® devices), multimedia Internet enabled cellular telephones (e.g., the iPhone®), and similar personal electronic devices. A wireless device may include a programmable processor and memory. In a preferred embodiment, the wireless device is a cellular handheld device (e.g., a wireless device), which can communicate via a cellular telephone communications network.

[0043] As used in this application, the terms 'component,' 'module,' 'engine,' 'manager' are intended to include a computer-related entity, such as, but not limited to, hardware, firmware, a combination of hardware and software, software, or software in execution, which are configured to perform particular operations or functions. For example, a component may be, but is not limited to, a process running on a processor, a processor, an object, an executable, a thread of execution, a program, a computer, a server, network hardware, etc. By way of illustration, both an application running on a computing device and the computing device may be referred to as a component. One or more components may reside within a process and/or thread of execution and a component may be localized on one processor or core and/or distributed between two or more processors or cores. In addition, these components may execute from various non-transitory computer readable media having various instructions and/or data structures stored thereon.

[0044] A number of different cellular and mobile communication services and standards are available or contemplated in the future, all of which may implement and benefit from the various embodiments. Such services and standards include, e.g., third generation partnership project (3GPP), long term evolution (LTE) systems, third generation wireless mobile communication technology (3G), fourth generation wireless mobile communication technology (4G), global system for mobile communications (GSM), universal mobile telecommunications system (UMTS), 3GSM, general packet radio service (GPRS), code division multiple access (CDMA) systems (e.g., cdmaOne, CDMA2000TM), enhanced data rates for GSM evolution (EDGE), advanced mobile phone system (AMPS), digital AMPS (IS-136/TDMA), evolution-data optimized (EV-DO), digital enhanced cordless telecommunications (DECT), Worldwide Interoperability for Microwave Access (WiMAX), wireless local area network (WLAN), public switched telephone network (PSTN), Wi-Fi Protected Access I & II (WPA, WPA2), Bluetooth®, integrated digital enhanced network (iden), land mobile radio (LMR), and evolved universal terrestrial radio access network (E-UTRAN). Each of these technologies involves, for example, the transmission and reception of voice, data, signaling and/or content messages. It should be understood that any references to terminology and/or technical details related to an individual telecommunication standard or technology are for illustrative purposes only, and are not intended to limit the scope of the claims to a particular communication system or technology unless specifically recited in the claim language.

[0045] The various embodiments include a dynamic spectrum arbitrage (DSA) system configured to dynamically manage the availability, allocation, access, and use of telecommunication resources, such as radio frequency (RF) spectrum and RF spectrum resources, between two or more telecommunication networks. In the various embodiments, the DSA system may be configured to better support small cell architectures, such as femtocell architectures.

[0046] Generally, a femtocell is a small, low power, and/or portable device (e.g., a base station) that may be configured to provide telecommunication services to wireless devices in relatively small area (e.g., cell size of 1-50 meters). A telecommunication network may deploy many such femtocells to quickly reduce coverage gaps and/or to extend services to additional users or areas. Yet, a large number of femtocells are typically required or used to provide users with adequate service, and performing DSA operations often requires sending and receiving large amount of information to and from each femtocell. Further, a degree of executive control is required to manage and coordinate the communications and interactions between the DSA components and the different femtocells when allocating resources between networks. For these and other reasons, using existing femtocell solutions may have a significant negative impact on the performance of the DSA system. Therefore, existing femtocell solutions are not suitable for use in DSA systems.

[0047] To overcome the limitations of existing solutions, the various embodiments provide methods, and computing devices configured to implement the methods, of intelligently and efficiently communicating information between components in a dynamic spectrum arbitrage (DSA) system and femtocells. That is, the various embodiments include components configured to manage and coordinate the communications and interactions between femtocells and other DSA components to allow for the inclusion and use of femtocells as part of a comprehensive DSA solution.

[0048] An embodiment DSA system may include a dynamic spectrum policy controller (DPC) component and a dynamic spectrum controller (DSC) component. The DPC component may be configured to manage the DSA operations and interactions between two or more networks (e.g., between a lessor network and a lessee network) by communicating with a DSC component in each of the participating networks. Each of these DSC components may include a wired or wireless communication link to a home eNodeB gateway (HGW), to an eNodeB, and various other components. The home eNodeB gateway may be configured to facilitate the communications between many femocells and the DSC component, so that the DSC communicates with these cells in the same manner as it would communicate with a single component (i.e., a single eNodeB). This allows the DSA system to efficiently communicate large volumes of information with many different femtocells without negatively impacting the operations or performance of the DSA system.

[0049] In an embodiment, the DSA system may include a femotcell in the form of a home eNodeB (HeNB). The HeNB may be configured to perform any of all of the operations performed by the embodiment eNodeBs discussed in this application. For example, a HeNB may be equipped with a DSC application protocol and congestion monitoring (DAPCM) module. The DAPCM module may be configured to monitor various network conditions (e.g., network congestion, resource usage, resource availability, etc.), generate reports based on the monitoring, and send the generated reports to a DSC component via the HGW. The DSC may be configured to receive and use such information to make better or more informed resource requests and/or to better identify the resources that could be made available for allocation.

[0050] In various embodiments, the operations, communications, and interactions between the DSA components may be facilitated or accomplished via a dynamic spectrum arbitrage application part (DSAAP) protocol or component.

[0051] The DSAAP component may be configured to allow, facilitate, support, or augment communications between various DSA components so as to improve the efficiency and speed of the DSA system and telecommunication networks.

[0052] The DSAAP component may be configured to allow many femtocells to communicate with a DSC component (e.g., via the Xe interface), with other eNodeBs (e.g., via an X2 interface), and with various other components (e.g., via the S1 interface). The DSAAP component may be configured to allow a DSC to communicate with many different femtocells as if they were a single eNodeB (e.g., via the Xe interface) and/or so as to improve the efficiency and speed of the DSA system.

[0053] In various embodiments, all or portions of the DSAAP component may be included in a DPC component, a DSC component, an eNodeB component, an MME component, a HGW component, in an independent DSA component, or any combination thereof. The DSAAP component may be implemented in hardware, software, or a combination of hardware and software.

[0054] In an embodiment, the DSAAP component may be configured to implement a DSAAP protocol, which may be defined over the Xe, Xd, and/or X2 reference points. In various embodiments, the Xe reference points between a HGW and DSC and/or between a DSC and eNodeB may use the DSAAP protocol, TR-069 protocol, and/or TR-192 data model extensions to support listing available resources at the eNodeB and notifying the eNodeB of bid/buy confirmations. The Xd reference point between DSC and DPC may use the DSAAP protocol for dynamic spectrum and resource arbitrage operations. The X2 interface/reference point between the eNodeBs may also use the DSAAP protocol to communicate information.

[0055] The DSAAP component(s) may allow the various DSA components (e.g., DSC, DPC, eNodeB, etc.) to communicate using the DSAAP protocol and to perform various DSA and DSAAP methods. In an embodiment, these methods may be performed in a DSA system that includes a first DSC server and a HGW server in a first telecommunication network (e.g., a lessee network), a second DSC server and HGW in a second telecommunication network (e.g., a lessor network), and a DPC server that is outside of the first and second telecommunication networks.

[0056] The first DSC may include first DSC processor that is coupled to the DPC via a first communication link (i.e., a wired or wireless link), and the second DSC may include a second DSC processor coupled to the DPC via a second communication link. In addition, the first and second DSCs may be coupled to the first and second HGWs via third and fourth communication links. The first and second communication links may be defined over the Xd interface, and the third and fourth communication links may be defined over the Xe interface. The HGWs may be configured to communicate with many different HeNB via the S1 interface.

[0057] The second HeNB may be configured to monitor network conditions (e.g., network congestion, resource usage, resource availability, etc.), generate reports based on a result of the monitoring, and send the generated reports to the second DSC via the second HGW. This may be accomplished by using the DSAAP protocol (i.e., by sending/receiving DSAAP communication messages and/or performing any of methods discussed in this application). The second DSC may be configured to receive and use this information to keep track of congestion states of the eNodeBs and HeNBs in its network, select target nodes for handovers, and/or manage traffic on the eNodeBs/HeNBs by offloading wireless devices. The HGW may be configured to present information from many different HeNBs to the second DSC as if they were from a single eNodeB. As such, the HGW may act as gateway between the DSC and the HeNBs, which allows the system to add or remove HeNBs without significant network planning and without further modifying the DSC or other components in the network.

[0058] The various embodiments may be implemented within a variety of communication systems, examples of which are illustrated in FIGs. 1A-1F. With reference to FIG. 1A, wireless devices 102 may be configured to transmit and receive voice, data, and control signals to and from a base station 111, which may be a base transceiver station (BTS), NodeB, eNodeB, etc. The base station 111 may communicate with an access gateway 113, which may include one or more of a controller, a gateway, a serving gateway (SGW), a packet data network gateway (PGW), an evolved packet data gateway (ePDG), a packet data serving node (PDSN), a serving GPRS support node (SGSN), or any similar component or combinations of the features/functions provided thereof. Since these structures are well known and/or discussed in detail further below, certain details have been omitted from FIG. 1A in order to focus the descriptions on the most relevant features.

[0059] The access gateway 113 may be any logical and/or functional component that serves as the primary point of entry and exit of wireless device traffic and/or connects the wireless devices 102 to their immediate service provider and/or packet data networks (PDNs). The access gateway 113 may forward the voice, data, and control signals to other network components as user data packets, provide connectivity to external packet data networks, manage and store contexts (e.g. network internal routing information, etc.), and act as an anchor between different technologies (e.g., 3GPP and non-3GPP systems). The access gateway 113 may coordinate the transmission and reception of data to and from the Internet 105, as well as the transmission and reception of voice, data and control information to and from an external service network 104, the Internet 105, other base stations 111, and to wireless devices 102.

[0060] In various embodiments, the base stations 111 and/or access gateway 113 may be coupled (e.g., via wired or wireless communication links) to a dynamic spectrum arbitrage (DSA) system configured to dynamically manage the availability, allocation, access, and use of various network resources (e.g., RF spectrum, RF spectrum resources, etc.). The DSA system is discussed in detail further below.

[0061] FIG. 1B illustrates that wireless devices 102 may be configured to send and receive voice, data and control signals to and from the service network 104 (and ultimately the Internet 105) using a variety of communication systems/technologies (e.g., GPRS, UMTS, LTE, cdmaOne, CDMA2000TM), any or all of which may be supported by, or used to implement, the various embodiments.

[0062] In the example illustrated in FIG. 1B, long term evolution (LTE) and/or evolved universal terrestrial radio access network (E-UTRAN) data transmitted from a wireless device 102 is received by an eNodeB 116, and sent to a serving gateway (SGW) 118 located within the core network 120. The eNodeB 116 may send signaling/control information (e.g., information pertaining to call setup, security, authentication, etc.) to a mobility management entity (MME) 130. The MME 130 may request user/subscription information from a home subscriber server (HSS) 132, communicate with other MME components, perform various administrative tasks (e.g., user authentication, enforcement of roaming restrictions, etc.), select a SGW 118, and send authorization and administrative information to the eNodeB 116 and/or SGW 118. Upon receiving the authorization information from the MME 130 (e.g., an authentication complete indication, an identifier of a selected SGW 118, etc.), the eNodeB 116 may send data received from the wireless device 102 to a selected SGW 118. The SGW 118 may store information about the received data (e.g., parameters of the IP bearer service, network internal routing information, etc.) and forward user data packets to a policy control enforcement function (PCEF) and/or packet data network gateway (PGW) 128.

[0063] FIG. 1B further illustrates that general packet radio service (GPRS) data transmitted from the wireless devices 102 may be received by a base transceiver station (BTS) 106 and sent to a base station controller (BSC) and/or packet control unit (PCU) component (BSC/PCU) 108. Code division multiple access (CDMA) data transmitted from a wireless device 102 may be received by a base transceiver station 106 and sent to a base station controller (BSC) and/or packet control function (PCF) component (BSC/PCF) 110. Universal mobile telecommunications system (UMTS) data transmitted from a wireless device 102 may be received by a NodeB 112 and sent to a radio network controller (RNC) 114.

[0064] The BSC/PCU 108, BSC/PCF 110, and RNC 114 components may process the GPRS, CDMA, and UMTS data, respectively, and send the processed data to a component within the core network 120. More specifically, the BSC/PCU 108 and RNC 114 units may send the processed data to a serving GPRS support node (SGSN) 122, and the BSC/PCF 110 may send the processed data to a packet data serving node (PDSN) and/or high rate packet data serving gateway (HSGW) component (PDSN/HSGW) 126. The PDSN/HSGW 126 may act as a connection point between the radio access network and the IP based PCEF/PGW 128. The SGSN 122 may be responsible for routing the data within a particular geographical service area, and send signaling (control plane) information (e.g., information pertaining to call setup, security, authentication, etc.) to an MME 130. The MME 130 may request user and subscription information from a home subscriber server (HSS) 132, perform various administrative tasks (e.g., user authentication, enforcement of roaming restrictions, etc.), select a SGW 118, and send administrative and/or authorization information to the SGSN 122.

[0065] The SGSN 122 may send the GPRS/UMTS data to a selected SGW 118 in response to receiving authorization information from the MME 130. The SGW 118 may store information about the data (e.g., parameters of the IP bearer service, network internal routing information, etc.) and forward user data packets to the PCEF/PGW 128. The PCEF/PGW 128 may send signaling information (control plane) to a policy control rules function (PCRF) 134. The PCRF 134 may access subscriber databases, create a set of policy rules and performs other specialized functions (e.g., interacts with online/offline charging systems, application functions, etc.). The PCRF 134 may then send the policy rules to the PCEF/PGW 128 for enforcement. The PCEF/PGW 128 may implement the policy rules to control the bandwidth, the quality of service (QoS), the characteristics of the data, and the services being communicated between the service network 104 and the end users.

[0066] In the various embodiments, any or all of the components discussed above (e.g., components 102-134) may be coupled to, or included in, a DSA system configured to dynamically manage the availability, allocation, access, and use of telecommunication resources.

[0067] FIG. 1C illustrates various logical components and communication links in an embodiment system 100 that includes an DSA system 142 and a evolved universal terrestrial radio access network (E-UTRAN) 140. In the example illustrated in FIG. 1C, the DSA system 142 includes a dynamic spectrum controller (DSC) 144 component and a dynamic spectrum policy controller (DPC) 146 component. The E-UTRAN 140 includes a plurality of interconnected eNodeBs 116 coupled to the core network 120 (e.g., via a connection to an MME, SGW, etc.).

[0068] In various embodiments, the DSC 144 may be included in or coupled to the E-UTRAN 140, either as part of its core network 120 or outside of the core network 120. In an embodiment, the DSC 144 may be coupled directly (e.g., via wired or wireless communication links) to one or more eNodeBs 116.

[0069] The eNodeBs 116 may be configured to communicate with the DSC 144 via the Xe interface/reference point. In various embodiments, the Xe reference point between DSC and eNodeB 116 may use the DSAAP protocol, TR-069 protocol, and/or TR-192 data model extensions to support listing available resources at the eNodeB 116 and notifying the eNodeB 116 of bid/buy confirmations. The DSC 144 may be configured to communicate with the DPC 146 via the Xd interface/reference point. The Xd reference point between DSC and DPC may use the DSAAP protocol for dynamic spectrum and resource arbitrage operations. The eNodeBs 116 may be interconnected, and configured to communicate via an X2 interface/reference point, which may also use the DSAAP protocol to communicate information. The eNodeBs 116 may be configured to communicate with components in the core network 120 via the S1 interface. For example, the eNodeBs 116 may be connected to an MME 130 via the S1-MME interface and to a SGW 118 via the S1-U interface. The S1 interface may support a many-to-many relation between the MMEs 130, SGWs 118, and eNodeBs 116. In embodiment, the DPC and/or DSC component may also be configured to communicate with a HSS 132 component.

[0070] The eNodeBs 116 may be configured to provide user plane (e.g., PDCP, RLC, MAC, PHY) and control plane (RRC) protocol terminations towards the wireless device 102. That is, the eNodeBs 116 may act as a bridge (e.g., layer 2 bridge) between the wireless devices 102 and the core network 120 by serving as the termination point of all radio protocols towards the wireless devices 102, and relaying voice (e.g., VoIP, etc.), data, and control signals to network components in the core network 120. The eNodeBs 116 may also be configured to perform various radio resource management operations, such as controlling the usage of radio interfaces, allocating resources based on requests, prioritizing and scheduling traffic according to various quality of service (QoS) requirements, monitoring the usage of network resources, etc. In addition, the eNodeBs 116 may be configured to collect radio signal level measurements, analyze the collected radio signal level measurements, and handover wireless devices 102 (or connections to the mobile devices) to another base station (e.g., a second eNodeB) based on the results of the analysis.

[0071] The DSC 144 and DPC 146 may be functional components configured to manage the dynamic spectrum arbitrage process for sharing radio frequency and other network resources between different E-UTRANs 140. For example, the DPC 146 component may be configured to manage the DSA operations and interactions between multiple E-UTRAN networks by communicating with DSCs 144 in the E-UTRAN network.

[0072] FIG. 1D illustrates various logical components and communication links in an embodiment system 101 configured to support smaller-cell architectures. In the example illustrated in FIG. 1D, the DSA system 142 and E-UTRAN 140 include all the components discussed above with reference to FIG. 1C. In addition, the E-UTRAN 140 is upgraded to include a femtocell home eNodeB (HeNB) gateway (HGW 145) 145 that is coupled to a plurality of interconnected HeNBs 117, to the core network 120 (e.g., via a connection to an MME, SGW, etc.), and to the DSC 144. The HeNBs 117 may be interconnected via the X2 interface, and coupled to the HGW 145 via the S1 interface. FIG. 1D also illustrates that a HeNB 117a operating in a local IP access (LIPA) mode may communicate with the core network 120 via the S5 interface.

[0073] The system 101 may be configured so that the S1 interface is used to communicate information between the HGW 145 and the core network 120, between the HeNB 117 and the HGW 145, between the HeNB 117 and the core network 120, and/or between the eNodeB 116 and the core network 120. The system 101 may be configured such that the S1-U interface from the HeNB 117 terminates at the HGW 145. The system 101 may also be configured so that there is a direct logical user plane connection or communication link between HeNB 177 and the SGW 118. The HGW 145 may be configured to serve as a concentrator for the control plane communications, such as via the S1-MME interface.

[0074] The HGW 145 may be configured to allow the system 101 to support any or all small-cell or femtocell architectures. This may be accomplished by using the S1 interface between the HeNBs 117 and the core network 120 to support a large number of HeNBs 117 in a scalable manner.

[0075] In an embodiment, the system 101 may be configured such that the HGW 145 appears as an eNodeB 116 to the MME 130. The system 101 may also be configured such that HGW 145 appears to the HeNB 117 as an MME 130. In an embodiment, the S1 interface between the HeNB 117 and the core network 120 may be the same regardless whether the HeNB 117 is connected to the core network 120 via the HGW 145.

[0076] In an embodiment, the HGW 145 may be configured to establish a connection to a component in the core network 120 so that inbound and outbound mobility to cells served by the HGW 145 do not necessarily require inter-MME handovers. In an embodiment, the system 101 may be configured so that one HeNB 117 serves one cell.

[0077] The DSC 144 may be configured to interface with HGW 145, as opposed to interfacing with large numbers/volumes of HeNB 117. The DSC 144 may also be configured to interface with the DPC 146 via the Xd interface, such as for bid management and inter-DSC communications.

[0078] The HeNB 117 may be configured to support the same functions as those supported by an eNodeB 116 and/or so that the operations between a HeNB 117 and the core network 120 are the same as those between the eNodeBs 116 and the components in the core network 120.

[0079] In an embodiment, the DSC 144 may be configured to receive congestion state information from eNodeBs 116 in its network, and send the congestion state information to the DPC 146 component. The DSC 144 may also be configured to receive congestion state information from HeNBs 117 in its network via the HGW 145 component, and send the congestion state information to the DPC 146 component. The congestion state information may identify a current congestion state (e.g., Normal, Minor, Major, Critical, etc.) of an eNodeB, a plurality of eNodeBs, and/or other network components. Each congestion state may be associated with a congestion level. For example, a "Normal" congestion state may indicate that a network component (e.g., eNodeB, etc.) is operating under normal load (e.g., user traffic is within the normal operating rages, etc.). A "Minor" congestion state may indicate that the network component is experiencing congestion and/or operating under an above-average load. A "Major" congestion state may indicate that the network component is experiencing significant congestion and/or operating under heavy load. A "Critical" congestion state may indicate that the network component is experiencing severe congestion, experiencing an emergency situation, or operating under an extremely heavy load.

[0080] In the various embodiments, the DSC 144 and/or DPC 146 components may be configured to use the congestion state information to intelligently allocate resources, manage user traffic of the eNodeBs, select target eNodeBs for handovers, determine the quality of service (QoS) levels that are to be given to wireless devices 102 attached to the eNodeBs 116 and/or HeNBs 117, and/or perform other similar operations to intelligently manage the allocation and use of resources by the various networks.

[0081] In an embodiment, a dynamic spectrum arbitrage (DSA) system may include a plurality of femtocells (e.g., HeNBs 117) in a first telecommunication network, a home eNodeB gateway (HGW) 145 that includes a HGW processor coupled to each of the plurality of femtocells via first communication links, a dynamic spectrum controller (DSC) 144 that includes a DSC processor coupled to the HGW 145 via a second communication link, and a dynamic spectrum policy controller (DPC) 146 that includes a DPC processor coupled to the DSC 144 via a third communication link. The first communication links may be defined over a S1 interface, the second communication link may be defined over a Xe interface, and the third communication link may be defined over a Xd interface.

[0082] The plurality of femtocells may include a home eNodeB (HeNB) 117, and an HeNB may be a femtocell (e.g., a small, portable, or low-power device). Each femtocell or HeNB may include a processor that is configured to monitor network conditions, generate congestion reports based on a result of the monitoring, and send the generated congestion reports to the HGW HGW via the first communication links (via the S1 interface). The congestion reports may include congestion state information that identifies a current congestion state (e.g., Normal, Minor, Major, Critical, etc.) of a femtocell or HeNB 117.

[0083] In various embodiments, a femtocell or HeNB processor may be configured to determine whether the femtocell/HeNB has been moved, determine whether there is are suitable serving HGWs 145 in the first telecommunication network in response to determining that the femtocell or HeNB has been moved, establish a communication link to one of the identified serving HGWs 145, and terminate one of the first communication links to the HGW 145 (i.e., the communication link between the femtocell that moved and the old HGW 145). In an embodiment, the femtocell or HeNB processor may perform these operations so that it is connected to, communicates with, or sends congestion reports and information to one serving HGW 145 at a time.

[0084] The serving HGW 145 may include a HGW processor that is configured to receive the congestion reports from many femtocells/HeNBs 117 via the first communication links, analyze the information included in the congestion reports, compile the reports, generate congestion state information based on the received congestion reports, and send the generated congestion state information to the DSC 144 via the second communication link (e.g., via the Xe interface). The HGW processor may be configured to generate the congestion state information that the plurality of femtocells appear as a single eNodeB 116 to the DSC 144 component.

[0085] The DSC 144 may include a DSC processor configured to receive the congestion state information from the HGW 145 via the second communication link (and many other

HGWs 145 and eNodeBs 116), and use the received congestion state information to determine whether there are excess network resources available in the first telecommunication network for allocation and use by a second telecommunication network. The DSC processor may also use the received congestion state information to determine whether to perform handover operations to transfer selected wireless devices 102 to a non-congested target eNodeB 116 or HGW 145. The DSC processor may communicate with the DPC 146 via the third communication link (e.g., via the Xd interface) to cause the DPC 144 to instruct a second DSC in a second telecommunication network to restrict further handovers to one or more of the plurality of femtocells (or to the HGW 145 managing the plurality of femtocells) in the first telecommunication network.

[0086] Each of the femtocells (e.g., HeNBs 117) may include a transmitter and a femtocell processor that is configured to monitor network conditions (e.g., network congestion, congestion state, resource usage, resource availability, etc.), generate congestion reports based on a result of the monitoring, and send the generated congestion reports to the HGW 145 via a communication link defined over a S1 interface. The femtocell processor may also be configured to determine that the femtocell has been moved, determine whether there is a suitable serving HGW available, establish a second communication link to an identified serving HGW in response to determining that there is a suitable serving HGW available, and terminate the communication link to the HGW in response to establishing the second communication link to the serving HGW.

[0087] In an embodiment, the HGW may include a HGW processor configured to establish communication links to a plurality of femtocells in a first telecommunication network (e.g., via the S1 interface), establish a second communication link to the DSC 144 in the first telecommunication network, receive the congestion reports from the plurality of femtocells, generate congestion state information based on the received congestion reports, and send the generated congestion state information to the DSC via the second communication link.

[0088] In embodiment, the HGW processor may be configured to perform load balancing operations to manage the user traffic, such as by intelligently transferring devices between the femtocells to balance the total load across a plurality of femtocells. In an embodiment, the HGW processor may be configured to degrade a local quality of service (QoS) of one or more wireless devices 102 in response to determining that the usage of network resources by a femtocell or in an area exceeds a usage threshold value. The HGW processor may degrade the local QoS of the wireless devices 102 based on priorities associated with tiers into which the wireless devices are grouped. The HGW processor may continue monitoring network resource usage by the femtocells to determine whether the usage of network resources at a femtocell exceeds a second threshold value, and hand off one or more wirelss devices to a second femtocell (or to another HGW or eNodeB) when it is determined that the usage of network resources exceeds the second threshold.

[0089] FIG. 1E illustrates various logical and functional components that may be included in a communication system 105 that suitable for use in performing DSA operations in accordance with various embodiments. In the example illustrated in FIG. 1E, the communication system 105 includes an eNodeB 116, a DSC 144, a DPC 146, an MME 130, a SGW 118, and a PGW 128.

[0090] The eNodeB 116 may include a DSC application protocol and congestion monitoring module 150, an inter-cell radio resource management (RRM) module 151, a radio bearer (RB) control module 152, a connection mobility control module 153, a radio admission control module 154, an eNodeB measurement configuration and provision module 155, and a dynamic resource allocation module 156. Each of these modules 150-156 may be implemented in hardware, in software, or in a combination of hardware and software.

[0091] In addition, the eNodeB 116 may include various protocol layers, including a radio resource control (RRC) layer 157, a packet data convergence protocol (PDCP) layer 158, a radio link control (RLC) layer 159, a medium access control (MAC) layer 160, and a physical (PHY) layer 161. In each of these protocol layers, various hardware and/or software components may implement functionality that is commensurate with responsibilities assigned to that layer. For example, data streams may be received in the physical layer 161, which may include a radio receiver, buffers, and processing components that perform the operations of demodulating, recognizing symbols within the radio frequency (RF) signal, and performing other operations for extracting raw data from the received RF signal.

[0092] The DSC 144 may include an eNodeB geographic boundary management module 162, an eNodeB resource and congestion management module 163, a stream control transmission protocol (SCTP) module 164, a Layer-2 (L2) buffer module 165, and a Layer-1 (L1) buffer module 166. The DPC 146 may include an eNodeB resource bid management module 167, an inter-DSC communication module 168, SCTP/DIAMETER module 169, an L2 buffer module 170, and a L1 buffer module 171. The MME 130 may include a non-access stratum (NAS) security module 172, and idle state mobility handling module 173, and an evolved packet system (EPS) bearer control module 174. The SGW 118 may include a mobility anchoring module 176. The PGW 128 may include a UE IP address allocation module 178 and a packet filtering module 179. Each of these modules 162-179 may be implemented in hardware, in software, or in a combination of hardware and software.

[0093] The eNodeB 116 may be configured to communicate with the SGW 118 and/or MME 130 via the S1 interface/protocol. The eNodeB 116 may also be configured to communicate with the DSC 144 via the Xe interface/protocol. The DSC 144 may be configured to communicate with the DPC 146 via the Xd interface/protocol.

[0094] The eNodeB 116 may be configured to perform various operations (e.g., via modules/layers 150-161) to provide various functions, including functions for radio resource management, such as radio bearer control, radio admission control, connection mobility control, dynamic allocation of resources to wireless devices 102 in both uplink and downlink (scheduling), etc. These functions may also include IP header compression and encryption of user data stream, selection of an MME at UE (or wireless device) attachment when no routing to an MME 130 can be determined from the information provided by the UE, routing of user plane data towards SGW 118, scheduling and transmission of paging messages (originated from the MME), scheduling and transmission of broadcast information (originated from the MME), measurement and measurement reporting configuration for mobility and scheduling, scheduling and transmission of public warning system (e.g., earthquake and tsunami warning system, commercial mobile alert service, etc.) messages (originated from the MME), closed subscriber group (CSG) handling, and transport level packet marking in the uplink. In an embodiment, the eNodeB 116 may be a donor eNodeB (DeNB) that is configured to perform various operations to provide additional functions, such as an S1/X2 proxy functionality, S11 termination, and/or SGW/PGW functionality for supporting relay nodes (RNs).

[0095] The MME 130 may be configured to perform various operations (e.g., via modules 172-175) to provide various functions, including non-access stratum (NAS) signaling, NAS signaling security, access stratum (AS) security control, inter-CN node signaling for mobility between 3GPP access networks, idle mode UE reach-ability (including control and execution of paging retransmission), tracking area list management (e.g., for a wireless device in idle and active mode), PGW and SGW selection, MME selection for handovers with MME change, SGSN selection for handovers to 2G or 3G 3GPP access networks, roaming, authentication, bearer management functions including dedicated bearer establishment, support for public warning system (e.g., earthquake and tsunami warning system, commercial mobile alert service, etc.) message transmission, and performing paging optimization. The MME module may also communicate various device state and attach/detach status information to the DSC. In an embodiment, the

MME 130 may be configured to not filter paging massages based on the CSG IDs towards macro eNodeBs.

[0096] The SGW 118 may be configured to perform various operations (e.g., via module 176) to provide various functions, including mobility anchoring (e.g., for inter-3GPP mobility), serving as a local mobility anchor point for inter-eNodeB handovers, E-UTRAN idle mode downlink packet buffering, initiation of network triggered service request procedures, lawful interception, packet routing and forwarding, transport level packet marking in the uplink (UL) and the downlink (DL), accounting on user and QoS class identifier (QCI) granularity for inter-operator charging, uplink (UL) and the downlink (DL) charging (e.g., per device, PDN, and/or QCI), etc.

[0097] The PGW 128 may be configured to perform various operations (e.g., via modules 178-179) to provide various functions, including per-user based packet filtering (by e.g. deep packet inspection), lawful interception, UE IP address allocation, transport level packet marking in the uplink and the downlink, UL and DL service level charging, gating and rate enforcement, DL rate enforcement based on APN-aggregate maximum bit rate (AMBR), etc.

[0098] The DSC 144 may be configured to perform various operations (e.g., via modules 162-166) to provide various functions, including managing resource arbitration operations within a network (e.g., PLMN), tracking network resource listings, tracking current bids in progress, tracking executed bids, and tracking bid specific closed subscriber group (CSG) identifiers (CSG-IDs) for mobility management of lessee wireless devices 102 in lessor networks. The DSC 144 may be configured to handover wireless devices 102 from lessee network to lessor network (i.e., perform handins), and handover wireless devices 102 from lessor network back to lessee network (i.e., perform backoff).

[0099] The DSC 144 may also be configured to track congestion states of eNodeBs, select target eNodeBs for handovers, and manage traffic on lessor eNodeBs. The DSC 144 may be configured to offload users based on configured policies (e.g. offload lower priority users, offload higher priority users, offload users with specific QoS, etc.) from lessee networks to other less loaded eNodeBs 116 within a lessor network. The DSC 144 may also perform backoff operations to handover a wireless device 102 from lessor network back to the lessee network. The DSC 144 may also be configured to monitor, manage, and/or maintain historic congestion information that is collected or received from one or more eNodeBs in the system.

[0100] The DPC 146 may be configured to perform various operations (e.g., via modules 167-171) to provide various functions, including functioning as a resource arbitrage broker between the DSCs 144 of lessor and lessee networks (e.g., PLMNs), listing resources from various lessor networks for auction, and managing the auction process. The DPC 146 may be configured to send notifications of outbid, bid win, bid cancel and bid withdrawal and bid expiry to DSCs 144, install bid specific charging rules in the online and/or offline charging systems of lessee and lessor networks, and coordinate resource usage between DSCs 144 by acting as gateway between lessee and lessor DSCs 144.

[0101] FIG. 1F illustrates network components and information flows in an example communication system 107 that includes two E-UTRANs 140a, 140b interconnected by a DPC 146 configured to manage DSA operations and interactions. In the example illustrated in FIG. 1F, each E-UTRAN 140a, 140b includes an eNodeB 116a, 116b that is outside of its core network 120a, 120b, and a DSC 144a, 144b that is inside of the core network 120a, 120b.

[0102] The DSCs 144a, 144b may be configured to communicate with the DPC 146 via Xd interface. The DSCs 144a, 144b may also be connected, directly or indirectly, to various network components in their respective core networks 120a, 120b, such as a PCRF 134, HSS 132 and a PCEF/PGW 128 (not illustrated in FIG. 1F). In an embodiment, one or more of the DSCs 144a, 144b may be connected directly to one or more of the eNodeBs 116a, 116b.

[0103] In addition to the above-mentioned connections and communication links, the system 107 may include additional connections/links to accommodate data flows and communications between components in different E-UTRANs (e.g., E-UTRANS 140a and 140b). For example, the system 107 may include a connection/communication link between an eNodeB 116b in the second E-UTRAN 140b to an SGW 118 in the first E-UTRAN 140a. As another example, the system 107 may include a connection/communication link between a SGW 118 in the second E-UTRAN 140b to a PGW 128 in the first E-UTRAN 140a. To focus the discussion of the relevant embodiments, these additional components, connections, and communication links are not illustrated in FIG. 1F.

[0104] As is discussed in detail further below, the DSCs 144a, 144b may be configured to send information regarding the availability of spectrum resources (e.g., information received from an eNodeB, PCRF, PCEF, PGW, etc.) to the DPC 146. This information may include data relating to current and expected future usage and/or capacity of each network or sub-network. The DPC 146 may be configured to receive and use such information to intelligently allocate, transfer, manage, coordinate, or lease the available resources of the first E-UTRAN 140a to the second E-UTRAN 140b, and vice versa.

[0105] For example, the DPC 146 may be configured to coordinate the allocation of spectrum resources to the second E-UTRAN 140b (i.e., lessee network) from the E-UTRAN 140a (i.e., lessor network) as part of the dynamic spectrum arbitrage operations. Such operations may allow a wireless device 102 that is wirelessly connected to the eNodeB 116b in the second E-UTRAN 140b via a communication link 143 to be handed off to an eNodeB 116a in the first E-UTRAN 140a so that it may use the allocated spectrum resources of the first E-UTRAN 140a. As part of this handoff procedure, the wireless device 102 may establish a new connection 141 to the eNodeB 116a in the first

E-UTRAN 140a, terminate the wireless connection 143 to the original eNodeB 116b, and use the allocated resources of the first E-UTRAN 140a as if they are included in the second E-UTRAN 140b. The DSA operations may be performed so that the first DSC 144a is a lessor DSC for a first resource/period of time, and a lessee DSC for a second resource or another period of time.

[0106] In an embodiment, the DSA and/or handoff operations may be performed so that the wireless device 102 maintains a data connection to (or a data connection that is managed by) the original network after it is handed off. For example, DSA and/or handoff operations may be performed so that the wireless device 102 maintains a dataflow connection to a PGW 128 in the second E-UTRAN 140b after being handed off to the eNodeB 116a in the first E-UTRAN 140a.

[0107] FIG. 2A illustrates an example DSA method 200 of allocating resources in accordance with an embodiment. Method 200 may be performed by a processing core in a DPC 146 component (e.g., server computing device, etc.).

[0108] In block 202, the DPC 146 may establish a first communication link to a first DSC 144a in a first communication network (e.g., E-UTRAN, etc.). In block 204, the DPC 146 may establish a second communication link to a second DSC 144b in a second communication network. In block 206, the DPC 146 may determine whether radio frequency (RF) spectrum resources are available for allocation within the second communication network. This may be accomplished by using the DSAAP protocol to communicate with a DSC 144 in the second communication network via the second communication link, which may be a wired or wireless communication link. In block 208, the DPC 146 may determine the amount of RF spectrum resources that are available for allocation. In block 210, the DPC 146 may perform various operations to allocate all or a portion of the available RF resources of the second communication network for access and use by wireless devices 102 in the first communication network.

[0109] In block 212, the DPC 146 may send a communication message to the first DSC 144a (e.g., by using the DSAAP protocol) to inform the first communication network that the use of the allocated RF spectrum resources may begin. In block 214, the DPC 146 may record a transaction in a transaction database identifying an amount of RF spectrum resources allocated for use by the first communication network.

[0110] In block 216, the DPC 146 may receive a communication message from the second DSC 144b that includes information indicating that the allocated resources have been consumed and/or requesting that the allocated resources be released. In block 218, the DPC 146 may send a resource consumed/release message to the first DSC 144a to cause the first network to terminate its use of the allocated resources.

[0111] FIG. 2B illustrates example information flows between a DPC 146 and a plurality of DSCs 144a-d when performing another embodiment DSA method 250 to allocate resources. In the description below, the DSA method 250 is discussed from the perspective of the DPC 146 component, and may be performed by a processing core in the DPC 146. However, it should be understood that the DSA method 250 may be performed by processing cores in a DPC 146 component, processing cores in DSC 144a-d components, or a combination thereof. In addition, it should be understood that all the interactions and communications between the DPC 146 and the other components may be accomplished by DSAAP components and/or using the DSAAP protocol. As such, all such interactions and communications may be included in the DSAAP protocol.

[0112] In operation 252, a processing core in a DPC 146 component may receive a "request for resources" communication message from a first DSC 144a component in a first network (e.g., E-UTRAN, etc.). It should be understood that the "request for resources" communication message and all other communication messages discussed in this application may be DSAAP messages.

[0113] The "request for resources" communication message may include information suitable for informing the DPC 146 that the first network is interested in purchasing, leasing, accessing, and/or using resources from other networks. The "request for resources" communication message may also include information suitable for identifying the types and/or amounts of resources (e.g., RF spectrum resources, etc.) that are requested by the first network, the types and capabilities of the wireless devices 102 to which the requested resources will be allocated, and other similar information.

[0114] In operations 254, 256, and 258 the DPC 146 may generate and send a "resource inquiry" communication message to each of a second DSC 144b component in a second network, a third DSC 144c component in a third network, and a fourth DSC 144d component in a fourth network, respectively. The DPC 146 may be configured to generate the "resource inquiry" communication messages to include various component, device, and resource requirements, criteria, and information. For example, the DPC 146 may generate a "resource inquiry" communication message to include information identifying the types, capabilities, and geographic criteria of user wireless devices 102 in the first network (and other networks) to which resources are to be allocated. The geographic criteria may include a geographic location, a geographic polygon, and/or license area for a user wireless device 102 to which resources will be allocated.

[0115] In operations 260 and 262, the DPC 146 may receive "resource inquiry response" communication messages from the second and third DSCs 144b, 144c. These "resource inquiry response" communication messages may include information identifying the availability of excess resources that comply with the requirements/criteria included in the resource inquiry messages. In operation 264, the DPC 146 may receive another "resource inquiry response" communication message from the fourth DSC 144d. This "resource inquiry response" communication messages may include information indicating that the fourth network does not include resources that meet the requested requirements/criteria.

[0116] In an embodiment, as part of operations 260-264, the DPC 146 may update a database record to identify the second and third networks as having resources available for allocation and/or to identify the fourth network as not including such resources.

[0117] In operation 266, the DPC 146 may generate and send a "resource availability" communication message to a plurality of DSCs in a plurality of networks, including the first DSC 144a in the first network. The DPC 146 may be configured to generate the "resource availability" communication message to include information that is suitable for informing the networks that resources are available for allocation. In an embodiment, the DPC 146 may be configured to inform the networks that resources are available for allocation by broadcasting a communication signal that includes information suitable for informing the networks that resources are available for allocation via auction and/or an auction start time for the auction.

[0118] In operation 268, the DPC 146 may receive a "resource reservation request" communication message from the first DSC 144a. The received "resource reservation request" communication message may include information suitable for informing the DPC 146 that the first network intends to participate in the auction and/or bid on at least a portion of the available resources.

[0119] In operations 270 and 272, the DPC 146 may send the "resource reservation request" communication message to the second and third DSCs 144b, 144c, respectively. The "resource reservation request" communication message may include information suitable for causing the second and third DSCs 144b, 144c to reserve all or a portion of their available resources for allocation and use by other networks.

[0120] In operations 274 and 276, the DPC 146 may receive a "resource reservation response" communication message from each of the second and third DSCs 144b, 144c. The "resource reservation response" messages may include information suitable for informing the DPC 146 that the requested resources that have been reserved and/or information suitable for identifying the reserved resources.

[0121] Optionally, in operation block 278, the DPC 146 may pool the reserved resources for allocation and use by wireless devices 102 in other networks (e.g., the first network). For example, the DPC 146 may combine a block of spectrum reserved in the second network with a block of spectrum reserved in the third network. As another example, the DPC 146 may pool the resources available in the first and fourth channels of a block of spectrum reserved in the second network.

[0122] In operation 280, the DPC 146 may receive "resource bid" communication messages from a plurality of networks, including from the first DSC 144a in the first network. Each "resource bid" communication message may include a bid or offer for accessing, using, leasing, and/or purchasing a resource, as well as other related bid information (e.g., price, requested allocation/access methods, etc.). As part of operation 280, the DPC 146 may determine whether the received resource bids comply with the policies and rules of the DSA system and/or with requirements set forth by the networks offering the resources for allocation (e.g., meet the minimum asking price, etc.).

[0123] In operation 282, the DPC 146 may accept the bid/offer from the first network in response to determining that the resource bid received from the first network complies with the policies/rules of the DSA system and with requirements set forth by the resource offering network (e.g., offers a monetary amount for the use of all or a portion of the resources in the pool of available resources that is greater than or equal to a minimum amount specified by the second network). Also in operation 282, the DPC 146 may generate and send a "bid acceptance" communication message to the first DSC 144a.

[0124] In operation 284, the DPC 146 may allocate the resources of the second network for access and used by wireless devices 102 in the first network by sending an "assign resources request" communication message to the second DSC 144b. That is, in operation 284, the DPC may determine that the portion of the resources (e.g., in the pool of available resources) won by the first DSC 144a are fully available via the second network, and in response, only send the assign resources request message to the second network.

[0125] In operation 286, the DPC 146 may receive a "resources allocated" communication message from the second DSC 144b. In operation 288, the DPC 146 may send the "resources allocated" communication message to the first DSC 144a to inform the first network that the resources have been allocated for access and used by its wireless devices 102 and/or that the use of the allocated resources may begin. In operation block 290, the DPC 146 may record a transaction in a transaction database identifying these resources as being allocated for access and use by the first network.

[0126] In operation 292, the DPC 146 may receive a "release resources" communication message from the second DSC 144b that includes information indicating that the allocated resources have been consumed and/or information suitable for requesting that the allocated resources be released. In operation 294, the DPC 146 may send a resource consumed/release message to the first DSC 144a to cause the first network to terminate its use of the allocated resources.

[0127] FIGs. 3-7 illustrate an embodiment DSA method 300 for allocating and accessing resources in a communication system that includes a DPC 146 component, two DSC 144a, 144b components, and wireless devices 102. All or portions of DSA method 300 may be performed by processing cores in a DPC 146, DSCs 144a-b, and/or wireless device 102. In the various embodiments, any of all of the interactions and communications between the components 146, 144a, 144b, and 102 may be accomplished or facilitated by DSAAP components and/or using the DSAAP protocol. As such, all such interactions and communications may be included in the DSAAP protocol.

[0128] With reference to FIG. 3, in block 302, a first DSC 144a in a first network may monitor user traffic (e.g., call and data traffic, etc.) as compared to the total spectrum resources available to the first network. In block 304, the first DSC 144a may generate a resource status report based on a result of its monitoring, record/store the resource status report in memory, and send a resource status report to the DPC 146 via a resources status report communication message. In determination block 306, the first DSC 144a may determine, based on the received resource status reports, whether additional resources are required (and/or whether there is a high probability that additional resources will be required in the near future) to provide adequate service to the existing wireless devices 102 in the first network. In response to determining that additional resources are required (i.e., determination block 306 = "Yes"), in block 308, the first DSC 144a may send a "request for resources" communication message to the DPC 146. In response to determining that additional resources are not required (i.e., determination block 306 = "No"), the first DSC 144a may continue monitoring user traffic and/or perform other DSC operations in block 302.

[0129] In block 310, a second DSC 144b in a second network may monitor user traffic as compared to the total spectrum resources available to the second network, generate resource status reports, and/or perform any or all of the DSC operations discussed in this application. In determination block 312, the second DSC 144b may determine whether there is an excess amount of resources available in the second network. In response to determining that there are no excess resources available in the second network (i.e., determination block 312 = "No"), in block 310, the second DSC 144b may continue monitoring user traffic and/or performing other DSC operations.

[0130] In response to determining that there is an excess amount of resources available in the second network (i.e., determination block 312 = "Yes"), in block 314, the second DSC 144b may mark, designate, or allocate all or portions of its excess resources for access and use by other networks (e.g., the first network, etc.). In block 316, the second DSC 144b may generate a resource allocation report, and send the generated resource allocation report to the DPC 146 (e.g., via a resource communication message). The DSC 144b may be configured to generate the resource allocation report to include information identifying the resources (or portions or amounts of resources) that are available for allocation and/or that have been marked, designated, or allocated by the second network.

[0131] In block 320, the DPC 146 may receive various resource status and allocation reports from DSCs 144 in many different networks, including the first and second DSCs 144a, 144b in the first and second networks. These reports may include information identifying various characteristics, criteria, requirements, and conditions of the networks and their components, such as the ratio of the detected user traffic to the total available spectrum resources, the amount of resources that are required by a network, the amount of resources that are available for allocation in a network, the types and capabilities of the wireless devices 102 that will use the allocated resources, system requirements that must be met before the wireless devices 102 access the allocated resources, network rules and policies with respect to access and use of resources, and other similar information.

[0132] In block 322, the DPC 146 may store the received reports (e.g., resource status reports, resource allocation reports, etc.) in memory (e.g., a non-volatile memory). In block 324, the DPC 146 may receive a request for resources from DSCs 144 in different networks, including the first DSC 144a in the first network. In block 326, the DPC 146 may use the received/stored information (e.g., information received in requests for resources, resource allocation reports, resource status reports, etc.) to identify and select the most suitable/best available network from which the first network may lease or purchase additional resources. In the example illustrated in FIG. 3, the DPC 146 identifies and selects the second network as the most suitable network to provide resources to the first network.

[0133] In block 328, the DPC 146 may send a resource inquiry communication message to the second DSC 1144b. In block 330, the second DSC 1144b may receive the resource inquiry communication message. In block 332, the second DSC 1144b may determine the availability, amounts, and/or quantity of the excess resources that are marked, designated, or allocated by the second network. In block 334, the second DSC 1144b may generate and send a "resource inquiry response" communication message to the DPC 146. The second DSC 1144b may generate resource inquiry response to include information suitable for use in identifying the availability and quantity of the resources that are marked, designated, or allocated for access and use by other networks (e.g., the first network). In block 336, the DPC 146 may receive the "resources inquiry response" communication message from the second DSC 1144b, and in response, perform the operations of determination block 400 illustrated in FIG. 4.

[0134] With reference to FIG. 4, in determination block 400, the DPC 146 may determine whether resources are available based on the data (e.g., resources inquiry response message) received from the second DSC 144b in the second network. For example, the DPC 146 may determine that the identified resources are not available in response to determining that all or a portion of the resources were purchased or won by other bidders before they were reserved.

[0135] In response to determining that the resources are not available (i.e., determination block 400 = "No"), in block 402, the DPC 146 may send a "no resources available" communication message to the first DSC 144a in the first network. In block 404, the first DSC 144a may receive the "no resources available" communication message. In block 406, the first DSC 144a may search (e.g., via the DPC 146) for other available resources, request resources from a different network, request different resources, terminate connections or communication sessions with users to free-up resources, or perform other similar operations to manage network traffic and congestion in the first network.

[0136] In response to determining that the resources are available (i.e., determination block 400 = "Yes"), in block 408, the DPC 146 may send a "resources available" communication message to the first DSC 144a. The resources available message may include information that may be used by the first DSC 144a to determine the quality and quantity of resources in the second network that may be used by wireless devices 102 in the first network.

[0137] In block 410, the first DSC 144a may receive the resources available communication message sent from the DPC 146. In block 412, the first DSC 144a may determine the amount/quantity of resources that the first network requires and/or will attempt to acquire, and send this and other resource information to the DPC 146 in a "request resources" communication message.

[0138] In block 414, the DPC 146 may receive the "request resources" message from the first DSC 144a. In block 416, the DPC 146 may use information included in received message to generate and send a "reserve resources request" communication message to the second DSC 144b in the second network.

[0139] In block 418, the second DSC 144b may receive the "reserve resource request" message from the DPC 146. In block 420, the second DSC 144b may use the information included in the received "reserve resources request" message to reserve the requested quantity of allocated resources for access and use by components in other networks. In block 422, the second DSC 144b may send a "resource reserved" communication message to the DPC 146 to confirm that the requested quantity of resources has been reserved and/or to identify the reserved resources.

[0140] In block 424, the DPC 146 may receive the "resource reserved" communication message from the second DSC 144b. In block 426, the DPC 146 may offer the reserved resources for auction and/or begin accepting resource bids on the reserved resources.

[0141] FIG. 5 illustrates a bidding procedure of the DSA method 300 that may be performed after the DPC 146 offers the reserved resources for auction and/or begins accepting resource bids on the reserved resources (e.g., after performing the operations of block 426 illustrated in FIG. 4).

[0142] With reference to FIG. 5, in block 500, the first DSC 144a in the first network may negotiate access to the reserved resources of second network by sending a resource bid (e.g., via a communication message) to the DPC 146. In block 502, the DPC 146 may receive the resource bid from the first DSC 144a.

[0143] In determination block 504, the DPC 146 may determine whether the received resource bid is to be accepted, which may be accomplished by determining whether the resource bid complies with the policies and rules of the DSA system and the requirements of the second network (e.g., is greater than a minimum amount, etc.). In response to determining that the resource bid received from the first DSC 144a is to be accepted (i.e., determination block 504 = "Yes"), in block 506, the DPC 146 may send an "accept bid" communication message to the first DSC 144a. In block 508, the first DSC 144a may receive the "accept bid" message and wait to receive resource access instructions. In block 510, the DPC 146 may send an "assign resources" communication message to the second DSC 144b in the second network.

[0144] In block 512, the second DSC 144b may receive the "assign resources" communication message from the DPC 146. In block 514, the second DSC 144b may use the information included in the received "assign resources" message to assign all or portions of its reserved resources for access and use by components in the first network. In block 516, the second DSC 144b may generate a "resources access" communication message that includes information (e.g., access parameters, etc.) that may be used by a wireless device 102 (i.e., in the first network) to access the assigned resources, and the send the "resources access" message to the DPC 146. In block 518, the second DSC 144b may perform various operations to prepare for establishing a communication session/link to wireless device 102 in the first network, such as by configuring or preparing to receive a voice or data call.

[0145] In block 522, the DPC 146 may receive the "resources access" communication message from the second DSC 144b, and relay the resources access message to the first DSC 144a. In block 524, the first DSC 144a may receive the "resources access" message from the DPC 146. The received "resource access" message may include access parameters that may be used by the wireless devices 102 to access the allocated resources of the second network. In block 526, the first DSC 144a may send access parameters to wireless devices 102 that have communication sessions with the first network and/or to the wireless devices 102 that the first network has designated/marked for migration to other networks.

[0146] In block 528, the wireless devices 102 may receive the access parameters of second network from the first DSC 144a. In blocks 530 and 520, the wireless devices 102 and/or second DSC 142b may perform various operations to establish a communication session/link between the wireless devices 102 and the second network. The second DSC 144b may then perform the operations of block 700 illustrated in FIG. 7 and discussed further below.

[0147] As mentioned above, in determination block 504, the DPC 146 may determine whether the resource bid received from the first DSC 144a is to be accepted. In response to determining that the resource bid received from the first DSC 144a is not to be accepted (i.e., determination block 504 = "No"), the DPC 146 may perform the operations of block 600 illustrated in FIG. 6.

[0148] With reference to FIG. 6, in block 600, the DPC 146 may send a "rejected bid" communication message to the first DSC 144a. In block 602, the first DSC 144a may receive the "rejected bid" message from the DPC 146. In determination block 604, the first DSC 144a may determine whether the first network will/should rebid for the resources. In response to determining that the first network will/should rebid for the resources (i.e., determination block 604 = "Yes"), in block 606, the first DSC 144a may send a new resource bid (e.g., in a resource bid communication message) to the DPC 146.

[0149] In block 608, the DPC 146 may receive the new resource bid (or rebid) from the first DSC 144a. In determination block 610, the DPC 146 may determine whether to accept the new resource bid, such as by determining whether the new resource bid complies with the policies and rules of the DSA system and the requirements of the second network. In response to determining that the new resource bid is to be accepted (i.e., determination block 610 = "Yes"), the DPC 146 may perform the operations of block 506 illustrated in FIG. 5. In response to determining that the new resource bid is to not be accepted (i.e., determination block 610 = "No"), the DPC 146 may perform the operations of block 600.

[0150] In response to determining that the first network should rebid for the resources (i.e., determination block 604 = "No"), in block 612, the first DSC 144a may send a "cancel resource request" communication message to the DPC 146. In block 614, the DPC 146 may receive the "cancel resource request" message from the first DSC 144a. In block 616, the DPC 146 may send a "release of resources" communication message to the second DSC 144b.

[0151] In block 618, the second DSC 144b may receive the "release of resources" message from the DPC 146. In block 620, the second DSC 144b may release the reserved resources so that they may be used by other networks. The second DSC 144b may then report the status of the allocated resources to DPC 146, which may be accomplished by performing the operations of block 316, which is illustrated in FIG. 3 and discussed above.

[0152] FIG. 7 illustrates settlement procedure of the DSA method 300 that may be performed after second network provides access to the secondary user wireless devices 102 in the first network (i.e., after performing the operations of block 520 illustrated in FIG. 5).

[0153] In block 700, the second DSC 144b may send invoices and payment instructions relating to the use of allocated resources by the first network to the DPC 146. In block 704, the DPC 146 may relay the received invoice and payment instructions to the first DSC 144a. In block 706, the first DSC 144a may receive the invoices and payment instructions, and settle the charges with the second network in block 718.

[0154] Optionally or alternatively, in block 708, the second DSC 144b may send usage parameters and payment instructions to the DPC 146. In block 710, the DPC 146 may receive the usage parameters and payment instructions from the second DSC 144b. In block 712, the DPC 146 may create an invoice for the access and use of the resources. In block 714, the DPC 146 may send the invoice to the first DSC 144a in the first network. In block 716, the first DSC 144a may receive the invoice and payment instructions, and perform various operations to settle the charges with second network in block 718.

[0155] In the various embodiments, the DPC 146 and DSC 144 components may be configured to communicate via an interface, which may be implemented in, or provided via, a dynamic spectrum arbitrage application part (DSAAP) protocol/module/component that is defined over the Xe and/or Xd reference points. The DSAAP may allow, facilitate, support, or augment communications between the DPC 146 and DSC 144 so as to improve the efficiency and speed of the DSA system and telecommunication network. In various embodiments, all or portions of the DSAAP module/component may be included in a DPC 146 component, a DSC 144 component, in a component that is independent of the DPC 146 and DSC 144 components, or any combination thereof. The DSAAP module/component may allow these and other DSA components to communicate information using the DSAAP protocol.

[0156] For example, the DSAAP may allow the DPC 146 and DSC 144 components to communicate specific information and/or perform operations that together provide various functions, including a DSC registration function, resource availability advertisement function, bidding and allocation of resources functions, handing off lessee users to lessor network function, backoff from lessor networks function, error handling function (e.g., reporting of general error situations for which function specific error messages are not defined, etc.), DSC de-registration function, error indication function, DSC bidding success and failure indication functions, and DSC resource allocation withdrawal function. In various embodiments, these functions may be provided, implemented, or accomplished by configuring the DPC 146 and/or DSC 144 components to perform one or a combination of the DSAAP methods discussed below with reference to FIGs. 8A-17B. Using the DSAAP protocol and performing the DSAAP methods may include communicating via one or more DSAAP messages.

[0157] In various embodiments, the DSAAP messages used to communicate information between the DSC 144 and DPC 146 may include a DSC REGISTER REQUEST message, DSC REGISTER ACCEPT message, DSC REGISTER REJECT message, DSC DE-REGISTER message, DSC RESOURCE REGISTER REQUEST message, DSC RESOURCE REGISTER ACCEPT message, DSC RESOURCE REGISTER REJECT message, AVAILABLE BIDS REQUEST message, AVAILABLE BIDS RESPONSE message, AVAILABLE BIDS REJECT message, DSC BID REQUEST message, DSC BID ACCEPT message, DSC BID REJECT message, DSC BID OUTBID message, DSC BID WON message, DSC BID LOST message, DSC BID CANCELLED message, DSC BUY REQUEST message, DSC BUY ACCEPT message, DSC BUY REJECT message, DSC RESOURCES ALLOCATED message, DSC RESOURCES WITHDRAWN message, and/or DSC BACKOFF COMMAND message. Each of these messages may include, or may be associated with, criticality information, presence information, range information, and assigned criticality information. These messages and their contents are discussed in detail further below.

[0158] In various embodiments, the DSAAP methods may be performed in a DSA system that includes a first DSC server in a first telecommunication network (e.g., a lessee network), a second DSC server in second telecommunication network (e.g., a lessor network), and a DPC server that is outside of the first and second telecommunication networks. The first DSC may include first DSC processor coupled to the DPC via a first communication link, and the second DSC may include a second DSC processor coupled to the DPC via a second communication link. The second DSC may be coupled to an eNodeB in the second telecommunication network via third communication link. The first and second communication links may be defined over the Xd interface, and the third communication link is defined over the Xe interface.

[0159] FIGs. 8A through 8C illustrate an embodiment DSAAP registration method 800 for registering a DSC 144 component with a DPC 146 so as to allow the DPC 146 to provide various services to the DSC 144 (e.g., advertizing a lessor DSC's 144 resources for bidding, allowing a lessee DSC 144 to bid for resources provided by other networks, etc.). In the examples illustrated in FIGs. 8A through 8C, the DSAAP registration method 800 is performed by processing cores in a DPC 146 component and a DSC 144 component, each of which may include all or portions of a DSAAP module/component. The operations DSAAP registration method 800 may be performed after, or in response to the DSC 144 or DPC 146 detecting that, an XE signaling transport or communication link has been established.

[0160] In operation 802 illustrated in FIGs. 8A through 8C, the DSC 144 may initiate DSAAP registration method 800 by generating and sending a DSC REGISTER REQUEST message to the DPC 146. In an embodiment, the DSC 144 may be configured to generate and/or send the DSC REGISTER REQUEST message in response to determining that it requires services from the DPC 146. For example, the DSC 144 may be configured to generate the DSC REGISTER REQUEST message in response to determining that its corresponding network (i.e., the network represented by the DSC) includes excess resources that may be allocated to other networks. As another example, the DSC 144 may be configured to generate the DSC REGISTER REQUEST message in response to determining that its newtork requires additional resources to provide adequate service to its existing wireless devices 102 in view of the current or expected future user traffic, network congestion, etc.

[0161] In various embodiments, the DSC 144 may be configured to generate the DSC REGISTER REQUEST message to include any or all of a message type information element (IE), a message ID IE, a DSC identity IE, a DSC Internet protocol (IP) address IE, a DSC type IE, a DSC PLMN-ID IE, PLMN type IE, and DSC resource update timer IE. The DSC PLMN-ID IE may include a PLMN ID that is suitable for use in identifying the network (e.g., E-UTRAN) that is associated with, or represented by, the DSC 144.

The PLMN type IE may include information that is suitable for use in determining the type of network (e.g., public safety, commercial, etc.) that is represented by the DSC 144. The DSC IP address IE may include the IP address of a DSC 144 that is responsible for managing, maintaining, or providing the XE interface of the DSAAP.

[0162] In operation block 804 illustrated in FIGs. 8A and 8B, the DPC 146 may perform various registration operations (i.e., authenticating the DSC, storing DSC identifier information in memory, etc.) to register the DSC 144 with the DPC 146. In an embodiment, as part of these registration operations, the DPC 146 may overwrite/override an existing registration with a new registration, such as in response to receiving a duplicate DSC REGISTER REQUEST message (i.e. for an already registered DSC identified by the same unique DSC identity).

[0163] In operation block 806 illustrated in FIG. 8A, the DPC 146 may determine that the registration operations were successful. In operation 808, the DPC 146 may generate and send a DSC REGISTER ACCEPT message to the DSC 144 to indicate the acceptance and registration of the DSC 144. In various embodiments, the DPC 146 may generate the DSC REGISTER ACCEPT message to include any or all of a message type information element (IE), a message ID IE, a DPC ID IE, a XEh signaling transport network layer (TNL) address IE, and a tunneling information IE. The XEh signaling TNL address IE may include an address value that is suitable for use in establishing to transport layer session. The tunneling information IE may include information that may used to encapsulate a different payload protocol, establish a secured communication through an untrusted or unverified network, carry a payload over an incompatible delivery-network, and/or to perform other similar tunneling operations.

[0164] To support XEh connectivity via/to the DPC 146, in operation block 810, the DSC 144 may use the address value included in the XEh signaling TNL address IE of the DSC REGISTER ACCEPT message establish a transport layer session. In an embodiment, the DSC 144 may be configured to establish the transport layer session in response to determining that the DSC REGISTER ACCEPT message includes an address value in the XEh signaling TNL address information element. In an embodiment, the DSC 144 may be configured to determine that the XEh connectivity via/to the DPC 146 is not supported or not required in response to determining that the XEh signaling TNL address information element is not present, null, empty, or not valid.

[0165] With reference to FIG. 8B, in operation block 812, the DPC 146 may determine that the registration operations performed as part of operation 804 failed. The DPC 146 may determine that registration failed in response to detecting any of a variety of conditions/events, including the failure to authenticate or authorize the DSC, network or component overload, DSC parameter mismatch, etc. In operation 814, the DPC 146 may generate and send a DSC REGISTER REJECT message to the DSC 144 to inform the DSC 144 that the registration failed and/or that the DPC 146 cannot register the DSC 144. In various embodiments, the DPC 146 may generate the DSC REGISTER REJECT message to include any or all of a message type information element (IE), a message ID IE, a cause IE, a criticality diagnostics IE, and a backoff timer IE. The cause IE may include information suitable for identifying a specific reason for the failure (e.g., overloaded, etc.) or for indicating that the reason for the failure is not known or is unspecified.

[0166] In operation block 816, the DSC 144 may perform various registration failure-response operations based on the information included in the received REGISTER REJECT message. For example, the DSC 144 may wait for a duration indicated in the backoff timer IE of the received REGISTER REJECT message before reattempting registration with that same DPC 146 in response to determining that the value of the cause IE in the received REGISTER REJECT message is set to "overload."

[0167] With reference to FIG. 8C, in operation block 852, the DSC 144 may start a register response timer in response to sending a DSC REGISTER REQUEST message to the DPC 146 (e.g., as part of operation 802). In operation block 854, the DSC 144 may determine that the register response timer expired before the DSC 144 received a DSC REGISTER RESPONSE message. In operation 856, the DSC 144 may resend the DSC REGISTER REQUEST message to the DPC 146 in response to determining that the timer expired before it received a corresponding DSC REGISTER RESPONSE message. In operation block 858, the DSC 144 may restart or reset the register response timer. In operation 860, the DPC may send a DSC REGISTER RESPONSE message to the DSC 144. In operation block 862, the DSC 144 may stop the register response timer in response to receiving the DSC REGISTER RESPONSE message.

[0168] FIGs. 9A and 9B illustrate a DSAAP advertizing method 900 for advertizing resources that are available for bidding/buying so as to allow the DPC 146 to store, organize, and/or make those resources available for bidding/allocation via a financial brokerage platform. In the examples illustrated in FIGs. 9A and 9B, the DSAAP advertizing method 900 is performed by processing cores in a DPC 146 component and a DSC 144 component, each of which may include all or portions of a DSAAP module/component.

[0169] In operation block 902 illustrated in FIGs. 9A and 9B, the DSC 144 may determine that there are resources available for allocation within cells serviced by that DSC 144. In operation block 904, the DSC 144 may generate and send a DSC RESOURCE REGISTER REQUEST message to the DPC 146. In various embodiments, the DSC 144 may generate the DSC RESOURCE REGISTER REQUEST message to include any or all of a message type information element (IE), a message ID IE, a DSC identity IE, a DSC type IE, a PLMN-ID list IE, resource availability IE, resource availability start time IE, a data bandwidth IE, a list of grids IE, a bid or buy IE, a minimum bid amount IE, resource availability end time IE, a time of the day IE, a time duration IE, megabits per second (MBPS) IE, and a cell identity IE.

[0170] The DSC identity IE may include information that may be used by the DPC 146 to determine the identity of DSC 144. For example, the DSC identity IE may include a

DSC pool ID, DSC instance information, and a PLMN ID of the network that the DSC is managing or representing. The DSC pool ID may be a unique identifier of a pool of available resources and/or may be the same as or similar to MME pool IDs and MME IDs in 3GPP EPC architecture.

[0171] The message ID IE may include a message identifier for the specific DSC RESOURCE REGISTER REQUEST message sent from the DSC 144. The DSC 144 and DPC 146 may be configured to use the message ID IE as a sequence number to identify and correlate DSC RESOURCE REGISTER REQUEST, DSC RESOURCE REGISTER ACCEPT and/or DSC RESOURCE REGISTER REJECT messages.

[0172] The resource availability IE may include information suitable for use by the DPC 146 in determining the PLMN ID of the network that is advertising resources for allocation and use by other networks. The DPC 146 may be configured to receive, store, and/or maintain resource availability IEs for multiple DSCs and/or for multiple different networks (i.e. different PLMN IDs). As such, each resource availability IE may include information suitable for identifying one or more of the networks that are advertising resources.

[0173] The time of the day IE may include information suitable for use by the DPC 146 in determining the time of the day that the DSC 144 transmitted the DSC RESOURCE REGISTER REQUEST message. The time duration IE may include information that is suitable for use in determining a time period during which the resources are to be made available for bidding or buying.

[0174] The data bandwidth IE may include information suitable for use in determining the available bandwidth (e.g., in MBPS) for the time duration specified in the optional time duration IE. The DPC 146 may determine that the bandwidth specified in the MBPS IE is to be made available until that bandwidth is consumed by the winning bidder or buyer in response to determining that the time duration IE is not included in the received DSC

RESOURCE REGISTER REQUEST message (or in response to determining that the time duration IE does not include a valid value).

[0175] The list of grids IE may include information suitable for use in determining grid identifiers for the locations of the network bandwidth that is to be made available for bidding or buying. The cell identity IE may include information suitable for use in determining the individual cells within each grid (identified by grid ID and cell ID) that have available resources offered for bidding or buying as part of the offer in the DSC RESOURCE REGISTER REQUEST message. The minimum bid amount IE may include a monetary amount in a denomination or currency, such as in United States Dollars (USD).

[0176] In operation block 906 illustrated in FIG 9A, the DPC 146 may accept the DSC's 144 resources for bidding. In operation 908, the DPC 146 may generate and send a DSC RESOURCE REGISTER RESPONSE or DSC RESOURCE REGISTER ACCEPT message to the DSC 144 to acknowledge that the resources were accepted. In various embodiments, the DPC 146 may generate the DSC RESOURCE REGISTER message to include any or all of a message type information element (IE), a bid ID IE, and a message ID IE. The message ID IE may include the same message identifier value that is included in the received DSC RESOURCE REGISTER REQUEST message. The DPC 146 and/or DSC may be configured to use the value of the message ID IE to identify and correlate the DSC RESOURCE REGISTER REQUEST and DSC RESOURCE REGISTER ACCEPT messages. In operation block 910, the DPC 146 may store, organize, and/or make the network resources available for bidding or buying via the financial brokerage platform.

[0177] In operation 912 illustrated in FIG. 9B, the DPC 146 may reject the DSC RESOURCE REGISTER REQUEST message and/or reject for bidding the resources identified in the received DSC RESOURCE REGISTER REQUEST message. The DPC 146 may reject the message/resources for a variety of reasons and/or in response to detecting any of a variety of events or conditions. For example, the DPC 146 may reject the resources in response to determining that the DPC 146 is not accepting resources from any operator, is not accepting resources for the specific operator identified in the received message, is not accepting the resources identified in the message, that the DPC is overloaded, that there is insufficient memory to store and service the resources available for bidding, etc. The DPC 146 may also reject the resource available message in response to determining that an administrator of the DPC 146 has disabled further bidding from the specific PLMN ID included in the DSC RESOURCE REGISTER REQUEST message, from all the networks (e.g., all the PLMN IDs), etc.

[0178] In operation 914 illustrated in FIG. 9B, the DPC 146 may generate and send a DSC RESOURCE REGISTER REJECT message to the DSC 144. In various embodiments, the DPC 146 may generate the DSC RESOURCE REGISTER REJECT message to include any or all of a message type information element (IE), a message ID IE, a cause IE, and a criticality diagnostics IE. The DPC 146 may also generate the DSC RESOURCE REGISTER REJECT message to include a message ID IE that includes a value that is the same as the message identifier included in the DSC RESOURCE REGISTER REQUEST message received from DSC 144. The DPC 146 and/or DSC 144 may be configured to use the value of the message ID IE to identify and correlate the DSC RESOURCE REGISTER REQUEST and DSC RESOURCE REGISTER REJECT messages.

[0179] In operation block 916, the DSC 144 may perform various resource registration failure response operations based on information included in the received DSC RESOURCE REGISTER REJECT message. For example, the DSC 144 may use the information included in the DSC RESOURCE REGISTER REJECT message to determine whether to reattempt resource registration with the DPC 146, attempt to register the resources with another DPC, reattempt the registration with different resources, or perform any of the other DSC operations discussed in this application.

[0180] FIGs. 10A and 10B illustrate a DSAAP method 1000 for communicating a list of available resources in accordance with an embodiment. DSAAP method 1000 may be performed to inform lessee networks of the resource bids or resources that are available for bidding/buying. In the examples illustrated in FIGs. 10A and 10B, the DSAAP method 1000 is performed by processing cores in a DPC 146 component and a DSC 144 component, each of which may include all or portions of a DSAAP module/component. In an embodiment, a lessee DSC 144 may be configured to perform DSAAP method 1000 to retrieve/receive a list of available resources prior to that DSC 144 bidding on, or requesting to lease or purchase, resources from the DPC 146.

[0181] In operation 1002 illustrated in FIGs. 10A and 10B, a lessee DSC 144 may generate and send an AVAILABLE BIDS REQUEST message to the DPC 146 to request information on the resource bids that are available for allocation from lessor network(s) for bidding or buying. In various embodiments, the lessee DSC 144 may generate the AVAILABLE BIDS REQUEST message to include any or all of a sequence number information element (IE), a message type IE, a PLMN list IE that includes one or more PLMN ID IEs, a grid ID list IE that includes one or more Grid ID IEs.

[0182] In an embodiment, the lessee DSC 144 may be configured to request specific resources from a specific network by generating the AVAILABLE BIDS REQUEST message to include the PLMN ID of the desired network, which may be included in the PLMN ID IE of the PLMN list IE in the AVAILABLE BIDS REQUEST message.

[0183] In an embodiment, the lessee DSC 144 may be configured to request resources from any available network by not populating the PLMN list IE in the generated AVAILABLE BIDS REQUEST message and/or by generating the AVAILABLE BIDS REQUEST message to not include a PLMN list IE and/or PLMN ID value.

[0184] In an embodiment, the lessee DSC 144 may be configured to request resources from a specific grid within a lessor network by generating the AVAILABLE BIDS

REQUEST message to include the grid IDs of the desired grids, which may be included in the grid ID IE of the grid ID list IE in the AVAILABLE BIDS REQUEST message.

[0185] In an embodiment, the lessee DSC 144 may be configured to request resources from any or all grids within a specified PLMN ID in PLMN ID IE grid by not populating the grid ID list IE in the generated AVAILABLE BIDS REQUEST message and/or by generating the AVAILABLE BIDS REQUEST message to not include a grid ID.

[0186] In operation block 1004 illustrated in FIGs. 10A and 10B, the DPC 146 may determine whether the PLMN ID(s) and grid ID(s) included in the received AVAILABLE BIDS REQUEST message are valid. If the PLMN ID(s) and grid ID(s) are incorrect, in operation block 1005, the DPC 146 may determine a reason code for the error/incorrect values. In operation block 1006, the DPC 146 may determine whether there are resources/bids available for each grid identified in the received AVAILABLE BIDS REQUEST message or for all the available grids (e.g., when the grid ID list IE in the received AVAILABLE BIDS REQUEST message not include valid values).

[0187] In operation 1008 illustrated in FIG. 10A, the DPC 146 may generate and send an AVAILABLE BIDS RESPONSE message to the DSC 144. The DPC 146 may be configured to generate the AVAILABLE BIDS RESPONSE message to include any or all of a message type information element (IE), a message ID IE, a DSC identity IE, a PLMN-ID grid cell bid info list IE, a sequence number IE, a PLMN list IE that includes one or more PLMN ID IEs, and a grid list IE. In an embodiment, the PLMN list IE and grid list IE may be included in the PLMN-ID grid cell bid info list IE. In an embodiment, the grid list IE may include one or more cell ID list IEs that include one or more cell ID IEs.

[0188] In various embodiments, the DPC 146 may generate the AVAILABLE BIDS RESPONSE message to also include any or all of an absolute radio-frequency channel number (ARFCN) IE, a channel bandwidth IE, a megabit or megabyte IE for identifying total available bandwidth, a MBPS IE for identifying the peak data rate for the resource, a resource available time IE, a resource expiration time IE, a bid/buy IE, a bid/buy expiry time IE, a minimum bid amount IE, and a buy price IE. The DPC 146 may generate the AVAILABLE BIDS RESPONSE message to include such information for each PMLN, each resource, each grid, and/or each cell identified in the message.

[0189] In an embodiment, the DPC 146 may be configured to generate the AVAILABLE BIDS RESPONSE message to include the list of PLMN ID, lists of grid ID(s) within each PLMN, and the available resources/bids within each grid in response to determining that there are bids for resources available for auction.

[0190] In an embodiment, the DPC 146 may be configured to generate the AVAILABLE BIDS RESPONSE message to include the message type and sequence number IEs (or valid values for these IEs) in response to determining that there no resources/bids for resources available for auction by that DPC 146 for the relevant networks/PLMN IDs. In an embodiment, the DPC 146 may be configured to generate the AVAILABLE BIDS RESPONSE message to include a sequence number IE having the same value as in the sequence number IE included in the received AVAILABLE BIDS REQUEST message. In an embodiment, the DSC 144 may be configured to use the sequence number IEs in these request and response messages to correlate the messages.

[0191] In an embodiment, the DPC 146 may be configured to generate the AVAILABLE BIDS RESPONSE message to include a PLMN list IE that includes a PLMN ID and grid ID list IE. The grid ID list IE may include a list of cells available for auction within the grid. The cell ID list IE may include a cell ID, and for each cell, the ARFCN, channel bandwidth, total available bandwidth, peak data rate allowed, the time of day (e.g., in UTC) when the resources are available and when they expire/end, whether it's a bid or buy type auction, minimum bid amount or buy price, bid expiry time (e.g., in UTC), and other similar information.

[0192] In operation block 1010, the DSC 144 may use the information included in the AVAILABLE BIDS RESPONSE message to identify the resources that are available for bidding, determine whether the DSC 144 will submit a bid for the available resources, determine the resources for which the DSC 144 will submit bids, and/or perform other similar operations.

[0193] With reference to FIG. 10B, in operation 1012, the DPC 146 may reject the AVAILABLE BIDS REQUEST message received from lessee DSC 144 by generating and sending a AVAILABLE BIDS REJECT message to the DSC 144. The DPC 146 may be configured to reject the AVAILABLE BIDS REQUEST message in response to determining (e.g., as part of operation 1004 or 1006) that one or more of the PLMN IDs supplied in the request message is not from any of the known networks, that one or more of the Grid IDs supplied in the request message is not valid with respect to the supplied PLMN ID, and/or that there are no resources/bids available in the relevant grids.

[0194] In an embodiment, the DPC 146 may be configured to generate the AVAILABLE BIDS REJECT message to include a message type information element (IE), a message ID IE, a cause IE, a criticality diagnostics IE, and a sequence number IE. The cause IE may include a reason code (e.g., Invalid PLMN ID, Invalid Grid ID, etc.) for the rejection of the available bids request, which may be determined in operation block 1005. The sequence number IE may include the same sequence number value that was included in the AVAILABLE BIDS REQUEST message received from lessee DSC 144. As such, the DPC 146 and/or DSC 144 may be configured to use sequence number IEs in the request and response messages to correlate those messages.

[0195] In operation block 1014, the DSC 144 may use the information included in the received AVAILABLE BIDS REJECT message to perform various failure-response operations. For example, the DSC 144 may determine whether to send another AVAILABLE BIDS REQUEST message to the DPC 146, determine whether to send another AVAILABLE BIDS REQUEST message to a different DPC, etc.

[0196] FIGs. 11A and 11B illustrate a DSAAP bidding method 1100 of bidding for DSC resources, which allows different lessee networks to bid for resources that are available from lessor networks. In the examples illustrated in FIGs. 11A and 11B, the DSAAP method 1100 is performed by processing cores in a DPC 146 component and a DSC 144 component, each of which may include all or portions of a DSAAP module/component.

[0197] In an embodiment, the DSC 144 and/or DPC 146 may be configured to perform DSAAP method 1100 after the DSC 144 retrieves the list of resources that are available for bidding (e.g., after performing DSAAP method 1000). In various embodiments, the DSC 144 and/or DPC 146 may be configured to perform DSAAP method 1100 continuously or repeatedly until the expiration of a bidding time. In an embodiment, the DPC 146 may be configured to select a winning bid (i.e., bid highest bid value) at the expiry of a bidding time.

[0198] In operation 1102 of method 1100 illustrated in FIGs. 11A and 11B, the lessee DSC 144 may generate and send a DSC BID REQUEST message to the DPC 146 to bid for one or more of the resource that are determined to be available from a lessor network, (i.e., one or more of resources included the list of resources obtained via the performance of method 1000). The lessee DSC 144 may be configured to generate the DSC BID REQUEST message to include any or all of a message type information element (IE), a message ID IE, a DSC identity IE, a DSC type IE, bid ID IE, a PLMN ID IE, and a bid amount IE. The bid ID IE may include information suitable for identifying a specific resource for which the lessee DSC 144 places a bid. The PLMN ID IE may include information suitable for use in identifying the PLMN ID of the network associated with the resources identified in the bid ID IE. The bid amount IE may include a monetary amount in a currency (e.g., USD), or the bid value.

[0199] In an embodiment, the lessee DSC 144 may be configured to generate the DSC BID REQUEST message to include a bid amount IE value that is greater than a minimum bid amount specified in a bid listing for the specific resource/bid ID. In an embodiment, the lessee DSC 144 may be configured to obtain the minimum bid amount and/or bid listing from the received AVAILABLE BIDS RESPONSE message (e.g., the message sent as part of operation 1008 illustrated in FIG. 10A).

[0200] In operation block 1104 illustrated in FIG. 11A, the DPC 146 may use the information included in the received DSC BID REQUEST message to determine whether the bid (resource bid) is valid and is to be accepted, such as by determining whether the bid complies with the policies and rules of the DSA system and the requirements of the lessor network. In operation 1106, the DPC 146 may generate and send DSC BID ACCEPT message to the DSC in response to determining that the bid is valid and/or is to be accepted. The DPC 146 may be configured to generate the DSC BID ACCEPT message to include any or all of a message type information element (IE), a message ID IE, a bid ID IE, and other information suitable for informing the DSC 144 that the bid has been determined to be valid and/or has been accepted.

[0201] It should be noted that, in the example discussed above, the DSC BID ACCEPT message informs the DSC 144 that the bid is valid/accepted, not that lessee DSC 144 has won the bid. The winning lessee DSC may be informed via DSC BID WON message when the DPC 146 determines that the bid time has expired and that lessee DSC is the highest bidder at the time of bid expiry. Similarly, the DPC 146 may inform lessee DSC(s) who participated in the bidding process but submitted losing bids that they did not submit a winning bid via a DSC BID LOST message. The DSC BID WON message and DSC BID LOST message are discussed in more detail further below.

[0202] With reference to FIG. 11B, in operation block 1108, the DPC 146 may use the information included in the received DSC BID REQUEST message to determine that the bid is not valid and is not to be accepted. For example, the DPC 146 may use the received information to determine that the bid does not comply with the policies/rules of the DSA system and/or does not comply with the requirements of the lessor network (e.g., does not meet the minimum asking price, etc.). As further examples, the DPC 146 may be configured to determine that the bid is not valid or is not to be accepted in response to determining that the bid amount specific in bid amount IE in the BID REQUEST message is not higher than the minimum bid, that the bid amount is not the highest among currently offered bids, that the bid id included in the bid ID IE is invalid, or that the bid/resource is no longer available for bidding (e.g., due to expiry, end of auction, bid withdrawn or invalid bid id).

[0203] In operation 1110, the DPC 146 may generate and send a DSC BID REJECT message to the DSC 144. The DPC 146 may be configured to generate the DSC BID REJECT message to include any or all of a message type information element (IE), a message ID IE, a bid ID IE, a cause IE, and a criticality diagnostics IE. The bid ID IE in the DSC BID REJECT message may include the same value as the bid identifier included in the received DSC BID REQUEST message. The cause IE may include a reason code identifying a reason for the rejection of the bid (e.g., minimum bid not met, outbid, bid not found, etc.). In operation block 1112, the DSC 144 may use information included in the received DSC BID REJECT message to perform various bid request failure-response operations, such as operations to determine whether to rebid for the resources, to generate a new DSC BID REQUEST message that includes a valid bid ID, etc.

[0204] FIGs. 12A through 12D illustrate a DSAAP notification method 1200 of informing participating networks of the results of the bidding operations. That is, DSAAP notification method 1200 may be performed to inform DSCs 144 of a result of an auction (e.g., that they submitted a winning bid, that they have been outbid, that they submitted a losing bid, that the auction was cancelled, etc.). In the examples illustrated in FIGs. 12A-12D, the DSAAP notification method 1200 is performed by processing cores in a DPC 146 component and a DSC 144 component, each of which may include all or portions of a DSAAP module/component.

[0205] DSAAP notification method 1200 may be performed after the DPC 146 notifies the DSC 144 that the bid has been accepted (e.g., after operation 1106 illustrated in FIG. 11). The DSAAP notification method 1200 also may be performed after the expiry of a bidding time and/or in response to the DPC 146 detecting an event or condition (e.g., new bid received, outbid, etc.).

[0206] In operation block 1202 illustrated in FIG. 12A, the DPC 146 may determine that the bid amount specific in bid amount IE in the last, latest, or most current BID REQUEST message accepted from the DSC 144 is not the highest among the current bids. In operation 1204, the DPC 146 may generate and send a DSC BID OUTBID message to the DSC 144 to inform the lessee DSC 144 that its earlier bid was outbid by a higher bid from another lessee DSC and/or that their earlier bid is no longer valid. In various embodiments, the DPC 146 may generate the DSC BID OUTBID message to include any or all of a message type information element (IE), a message ID IE, a cause IE, a bid info IE, a criticality diagnostics IE, a DSC ID IE and a BID ID IE.

[0207] The DSC ID IE may include information that is suitable for use in identifying the specific lessee DSC 144. The BID ID IE may include a bid ID suitable for use in identifying the submitted bid that has been outbid. In operation block 1206, the lessee DSC 144 may perform various bid-outbid failure-response operations, such as by determining whether to submit a higher bid for the resources to that DPC 146, to submit a bid to a different DPC 146, to drop existing calls to free bandwidth, etc.

[0208] With reference to FIG. 12B, in operation block 1210, the DPC 146 may determine that the bidding time has expired and that the bid amount specific in bid amount IE in the last, latest, or most current BID REQUEST message accepted from the DSC 144 is the highest among the current bids. In operation 1212, the DPC 146 may generate and send a DSC BID WON message to the DSC 144 to inform the lessee DSC 144 that their earlier bid is the winning bid. In various embodiments, the DPC 146 may generate the DSC BID WON message to include any or all of a message type information element (IE), a message ID IE, a bid ID IE, a bid info IE, a DSC ID IE, and original bid details such as bandwidth, MBPS, duration and the winning bid amount, etc. The DSC ID IE may include information that is suitable for use in identifying the specific lessee DSC 144.

The bid ID IE may include a bid identifier suitable for identifying the bid that won the resource auction/bidding operations.

[0209] In operation block 1214, the winning lessee DSC 144 may wait to receive DSC RESOURCES ALLOCATED message from the DPC 146 before scheduling its network equipment and device (e.g., wireless devices) to start using the resources and/or for the resources to be made available for use (i.e. scheduling for the time of day when the resources will be ready for use by the winning lessee network). In operation block 1216, the DPC 146 may close the auction, such as by rejecting further bids from other networks for the resources won by the bid submitted by lessee DSC 144.

[0210] With reference to FIG. 12C, in operation block 1220, the DPC 146 may determine that the bidding time has expired and that the bid amount specific in bid amount IE in the last, latest, or most current BID REQUEST message accepted from the DSC 144 is not the highest among the current bids. In operation 1222, the DPC 146 may generate and send a DSC BID LOST message to the DSC 144 to inform the lessee DSC 144 that its earlier bid has not won the bid and the auction/bid is closed due to another lessee DSC winning the auction. In various embodiments, the DPC 146 may generate the DSC BID LOST message to include any or all of a message type information element (IE), a message ID IE, a bid ID IE, and a DSC ID IE. The DSC ID IE may include information that is suitable for use in identifying the specific lessee DSC 144 that submitted the losing bid and/or to which the DSC BID LOST message is sent. The bid ID IE may include a bid identifier suitable for use in identifying the submitted bid.

[0211] In operation block 1224, the lessee DSC 144 may perform various failure response operations, such as determining whether to submit a bid to for other available resources, whether to drop existing calls to free up resources, etc. In operation block 1226, the DPC 146 may close the auction and/or allow the losing lessee DSCs to bid for other available resources.

[0212] With reference to FIG. 12D, in operation block 1230, the DPC 146 may determine that the auction for a network resource that the DSC 144 previously submitted a bid has been cancelled. For example, the DPC 146 may determine that the auction has been withdrawn by lessor network operator or that the auction has been cancelled by DPC operator for administrative reasons. In operation 1232, the DPC 146 may generate and send a DSC BID CANCELLED message to the DSC 144 to inform the lessee DSC 144 that the auction has been cancelled. In various embodiments, the DPC 146 may generate the DSC BID CANCELLED message to include any or all of a message type information element (IE), a message ID IE, a bid ID IE, a DSC ID IE, and a cause IE. The DSC ID IE may include information that is suitable for use in identifying the specific lessee DSC 144. The bid ID IE may include a bid identifier suitable for use in identifying the resource/bid for which the auction has been cancelled. The cause IE may include a reason code for the bid's cancellation (e.g., auction withdrawn, auction cancelled, etc.). In operation block 1234, the lessee DSC 144 may perform various failure-response operations, such as by determining whether to submit a bid to a different DPC 146, to drop calls, etc.

[0213] FIGs. 13A and 13B illustrate a DSAAP purchase method 1300 of allowing a lessee network to make an immediate (or near immediate) purchase and/or claim of use for a resource that is made available for allocation by a lessor network. In the examples illustrated in FIGs. 13A and 13B, the DSAAP purchasing method 1300 is performed by processing cores in a DPC 146 component and a DSC 144 component, each of which may include all or portions of a DSAAP module/component. In an embodiment, the DSC 144 and DPC 146 may be configured to perform DSAAP method 1300 after the DSC 144 retrieves/receives a list of resources that are available for purchase (e.g., after performing DSAAP method 1000 discussed above with reference to FIG. 10).

[0214] In operation block 1302 illustrated in FIGs. 13A and 13B, the lessee DSC 144 may identify and select a specific resource for immediate purchase from the list of resources (e.g., list of resources obtained from performing DSAAP method 1000 discussed above).

In various the embodiments, the lessee DSC 144 may select a resource that is scheduled for bidding, that is currently being auctioned, that is only made available for immediate purchase, etc. In operation 1304, the DSC 144 may generate and send DSC BUY REQUEST message to the DPC 146 to request to buy the identified/selected resources from a lessor network.

[0215] In various embodiments, the DSC 144 may generate the DSC BUY REQUEST message to include any or all of a message type information element (IE), a message ID IE, a DSC identity IE, a DSC type IE, a bid ID IE, a buy amount IE, and a PLMN ID IE. The PLMN ID IE may include information suitable for use in identifying the PLMN ID of the network associated with the bid, which may identified via the bid ID IE. The buy amount IE may include the amount (e.g., in USD) of the bid (i.e., bid value) submitted by the lessee DSC 144.

[0216] In an embodiment, the DSC 144 may be configured to generate the DSC BUY REQUEST message to include a buy amount value that is equal to an amount identified via a buy amount IE in a listing for the bid ID included in a received AVAILABLE BIDS RESPONSE message (which is discussed above with reference to FIG. 10).

[0217] In operation block 1306 illustrated in FIG. 13A, the DPC 146 may use the information included in the received DSC BUY REQUEST message to identify the requested resource, the network associated with the request resource, whether the requested resource is currently being auctioned, whether the requested resource has been made available for immediate purchase, a minimum purchase amount requested for the immediate purchase of that resource, and/or whether the buy amount included in the received DSC BUY REQUEST message is equal to (or greater than) the requested purchase amount. In the example illustrated in FIG. 13A, as part of operation block 1306, the DPC 146 determines that the buy amount included in the received DSC BUY REQUEST message is greater than or equal to the requested purchase amount.

[0218] In operation 1308, the DPC 146 may generate and send a DSC BUY ACCEPT message to the DSC 144 to inform the lessee DSC 144 that it has successfully purchased/leased the resource for use. In various embodiments, the DPC 146 may generate the DSC BUY ACCEPT message to include any or all of a message type information element (IE), a message ID IE, and a bid ID IE. In operation block 1310, the DPC 146 may terminate, stop, or close an active auction for that resource and/or perform similar operations so that the resource is no longer available for bidding or buying by other lessee DSCs.

[0219] With reference to FIG. 13B, in operation block 1312, the DPC 146 may use the information included in the received DSC BUY REQUEST message (e.g., as part of operation 1304) to determine that the bid (buy request) is to be rejected. For example, the DPC 146 may determine that the buy amount specific in buy amount IE in the received DSC BUY REQUEST message is less than the requested purchase amount. As another example, the DPC 146 may determine that the bid ID value included in the bid ID IE is invalid, or that the resource/bid is no longer available for bidding (due to expiry, end of auction, bid withdrawn, invalid bid ID, etc.).

[0220] In operation 1314, the DPC 146 may generate and send a DSC BUY REJECT message to the DSC 144. In various embodiments, the DPC 146 may generate the DSC BUY REJECT message to include any or all of a message type information element (IE), a message ID IE, a bid ID IE and a cause IE. The value of the bid ID IE may be the same as the bid identifier included in the DSC BUY REQUEST message received as part of operation 1304. The cause IE may include a reason code for the rejection of the buy request (e.g., requested purchase price not met, bid not found, etc.). In operation block 1316, the DSC 1316 may perform various failure-response operations, such as determining whether to submit a new purchase request with a higher bid amount. In operation block 1318, the DPC 146 perform various operations so to make that resource available for bidding or buying by other lessee DSCs.

[0221] FIGs. 14A and 14B illustrate a DSAAP resource allocation method 1400 of allocating resources in a lessor network for access and use by components in a lessee network. In the examples illustrated in FIGs. 14A and 14B, the DSAAP resource allocation method 1400 is performed by processing cores in a DPC 146 component, a lessee DSC 144a component, and a lessor DSC 144b component, each of which may include all or portions of a DSAAP module/component.

[0222] In operation block 1402 illustrated in FIGs. 14A and 14B, the DPC 146 may determine that the lessee DSC 144a has successfully purchased or won an auction for a resource in a lessor network represented by the lessor DSC 144b. In operation 1404 illustrated in FIG. 14A, the DPC 146 may generate and send a DSC BID SUCCESS message to the lessor DSC 144b to inform the lessor network that one or more of its allocated resources/bids has been won by the lessee DSC 144a.

[0223] In various embodiments, the DPC 146 may generate the DSC BID SUCCESS message to include any or all of a message type information element (IE), a message ID IE, a cause IE, and a criticality diagnostics IE. In a further embodiment, the DPC 146 may be configured to generate the DSC BID SUCCESS message to also include any or all of a bid ID IE, a DSC ID IE, and a bid value IE. These additional information elements may be used to communicate information regarding the winning bid. For example, the bid ID IE may include a bid ID that corresponds to the bid that successfully participated in and won the auction for the resources. The DSC ID IE may include the DSC ID of the auction winner (i.e., the lessee DSC 144a). The bid value IE may include the winning bid amount and/or the purchase price of the resources.

[0224] In operation 1404, the lessor DSC 144b may generate and send DSC RESOURCES ALLOCATED message to the DPC 146 to allocate/commit the resources for access and use by components in the lessee network. The lessor DSC 144b may be configured to generate DSC RESOURCES ALLOCATED message to include any or all of a message type information element (IE), a message ID IE, a bid iD, a PLMN-ID Grid

ID Cell ID list IE, a PLMN ID IE, a grid ID IE, list of cell IDs IE, and various auction/resource details (e.g., bandwidth, MBPS, duration, etc.). In an embodiment, the PLMN ID IE, a grid ID IE, and list of cell IDs IE may be included in the PLMN-ID Grid ID Cell ID list IE. The PLMN ID IE may include the PLMN ID of the lessor network allocating the resources, which may be the same PLMN ID/network identified in the winning bid. The grid ID IE and list of cell IDs IE may include information suitable for identifying the grid/cells associated with the resources. These values may be the same as the grid/cell values included in the winning bid.

[0225] In operation 1406, the DPC 146 may forward the received DSC RESOURCES ALLOCATED message to the winning lessee DSC 144a to enable the lessee DSC 144a to start using the allocated resources of lessor network resources. In operation block 1408, the lessee DSC 144a may schedule its network equipment to start using lessor network resources from the time of day specified as part of the bid and/or included in the received DSC RESOURCES ALLOCATED message.

[0226] With reference to FIG. 14B, in operation block 1410, the lessor DSC 144b may determine that the resources submitted for auction should be withdrawn and/or to forego allocating the submitted resources to a winner of the auction. The lessor DSC 144b may determine to withdraw the resources after the DPC 146 determines that lessee network purchased or won an auction for those resources and/or for any of a variety of reasons (e.g., unforeseen or administrative reasons, etc.).

[0227] In operation 1412, the lessor DSC 144b may generate and send a DSC RESOURCES WITHDRAWN message to the DPC 146 to withdraw the resources. The lessor DSC 144b may generate the DSC RESOURCES WITHDRAWN message to include any or all of a message type information element (IE), a message ID IE, a bid ID IE, a cause IE, and a PLMN-ID Grid ID Cell ID list IE. The bid ID IE may include information that is suitable for use in identifying the bid. The cause IE may include a reason code that describes the reason for withdrawal of resource allocations (e.g., resources not available, resources withdrawn, administrative, etc.).

[0228] In operation 1414, the DPC 146 may forward the received DSC RESOURCES WITHDRAWN message to the lessee DSC 144a, which may have submitted a winning bid for the withdrawn resources. In operation block 1416, the lessee DSC 144a may perform various failure-response operations, such as determining whether to participate in another auction, whether to bid on a different resource, determining whether to drop calls to free up resources, etc.

[0229] FIGs. 15A and 15B illustrate an embodiment DSAAP backoff method 1500 of selectively handing over a wireless device from a lessor network back to the lessee's network to which the wireless device subscribes (i.e. its home PLMN). In the examples illustrated in FIGs. 15A and 15B, the DSAAP backoff method 1500 is performed by processing cores in a DPC 146 component, a lessee DSC 144a component, and a lessor DSC 144b component, each of which may include all or portions of a DSAAP module/component.

[0230] In operation block 1502 illustrated in FIGs. 15A and 15B, the lessor DSC 144b may determine that its network resources from the cells that are part of a prior auction are in congestion. That is, the lessor DSC 144b may determine that it requires access or use of its allocated resources. In operation 1504, the lessor DSC 144b may generate and send a DSC BACKOFF COMMAND message to the DPC 146 to selectively handover wireless device(s) that are using the allocated resources of the lessor network back to the lessee network (i.e. its home PLMN).

[0231] The lessor DSC 144b may be configured to generate the DSC BACKOFF COMMAND message to include any or all of a message type information element (IE), a message ID IE, a bid ID IE, a UE identity IE, a measurement report IE, handoff cell information IE, a cause IE, and a DSC backoff response timer IE.

[0232] The UE identity IE may include information suitable for use in determining identity related information for the wireless device (or UE), such as the international mobile subscriber identity (IMSI) of the wireless device or its network.

[0233] The measurement report IE may include the latest, last, or most recent measurement report E-UTRAN RRC message received by the lessor network for the identified wireless device (i.e., the wireless devices that are requested to backoff to lessee network).

[0234] The bid ID IE may include a bid ID value corresponding to the bid that successfully participated in and completed/won the auction. The bid ID may be used to identify the auction/contract associated with the backoff operations (i.e., the auction/contract for which the resources were allocated).

[0235] In an embodiment, the lessor DSC 144b may be configured to determine whether there are multiple bid IDs that correspond to a congested cell. In an embodiment, the lessor DSC 144b may be configured to select the bid ID value from a plurality of bid IDs in response to determining that there are multiple bid IDs that correspond to a congested cell. In various embodiments, the lessor DSC 144b may be configured to select the bid ID value based on an operator policy provisioned at the lessor DSC 144b, based on a previous agreement, based on a policy/rule previously negotiated by lessor and lessee network operators, etc.

[0236] In operation 1506, the DPC 146 may forward the received DSC BACKOFF COMMAND message to the lessee DSC 144a. In operation block 1508, the lessee DSC 144a may use the information in the UE identity IE of the received DSC BACKOFF COMMAND message identify wireless device(s) that are to be subjected to the backoff operations (i.e., the wireless devices that are to be handed back).

[0237] In operation block 1510, the lessee DSC 144a may use the information included in the measurement report IE of the received DSC BACKOFF COMMAND message to determine, identify, and/or select a target cell (within lessee network) to which the identified wireless device(s) are to be handed over (the lessor network may have previously enabled measurement reporting from the wireless devices, such as when they attached, or were handed over, to the lessor network.)

[0238] In operation 1512, the lessee DSC 144a may generate and send a DSC BACKOFF RESPONSE message to the DPC 146. The lessee DSC 144a may be configured to generate the DSC BACKOFF RESPONSE message to include any or all of a message type information element (IE), a message ID IE, a bid ID IE, a UE identity IE, a handoff cell information IE, and a cause IE. In an embodiment, the lessee DSC 144a may be configured to generate the DSC BACKOFF RESPONSE message to include the cause IE (or a value for the cause IE) in response to determining that a suitable target cell (within lessee network) could not be identified or selected for the handed over. The value of the cause IE may identify a cause of the failure, such as network overload, no appropriate target cell found, or unknown wireless device/UE. In an embodiment, the lessee DSC 144a may be configured to generate the DSC BACKOFF RESPONSE message to include a value (e.g., target cell information) for the handoff cell information IE in response to successfully identifying a target cell (within lessee network) to which the wireless device may be handed over.

[0239] In operation 1514, the DPC 146 may identify the lessor DSC 144a based on the bid id IE included in the received DSC BACKOFF RESPONSE message, and forward the received DSC BACKOFF RESPONSE message to the lessor DSC 144b. In operation block 1516, the lessor DSC 144b may determine whether the received DSC BACKOFF RESPONSE message includes a handoff cell information IE (or a valid value for the handoff cell information IE). In response to determining that the received DSC BACKOFF RESPONSE message includes a handoff cell information IE (or a valid value for the handoff cell information IE), in operation block 1518, the lessor DSC 144b may use the target cell information included in the handoff cell information IE to encode a HANDOVER REQUIRED message. In operation block 1520, the lessor DSC 144b may and initiate S1 based handover procedure to handover the wireless device from lessor network to lessee network.

[0240] With reference to FIG. 15B, in operation block 1552, the lessor DSC 144b may determine that the DPC 146 has not responded to the DSC BACKOFF COMMAND message (sent as part of operation 1504) within a time period identified in the DSC backoff response timer IE included in the DSC BACKOFF COMMAND message. Alternatively or additionally, in operation block 1554, the lessor DSC 144b may determine that there is significant or severe network congestion or administrative reasons that require withdraw of the allocation of all remaining network resources pertaining to the resources/bid id included or identified in the DSC BACKOFF COMMAND message.

[0241] In operation 1556, the lessor DSC 144b may generate and send a DSC RESOURCES WITHDRAWN message to the DPC 146. In operation 1558, the DPC 146 may forward the received DSC RESOURCES WITHDRAWN message to the lessee DSC 144a to withdraw the allocation of the remaining network resources. In operation block 1560, the lessee DSC 144a may perform various resource withdrawn failure-response operations, such as dropping calls, determining whether to bid for new resources, etc.

[0242] FIG. 16A illustrates an embodiment DSC initiated DSAAP de-registration method 1600 for terminating operations. In the example illustrated in FIG. 16A, the DSC initiated DSAAP de-registration method 1600 is performed by processing cores in a DPC 146 component and a DSC 144 component, each of which may include all or portions of a DSAAP module/component.

[0243] In operation block 1602, the DSC 144 may determine that it needs to terminate DSA operations. In operation 1604, the DSC 144 may generate and send a DSC DE-REGISTER message to the DPC 146. The DSC 144 may be configured to generate the DSC DE-REGISTER message to include any or all of a message type information element (IE), a message ID IE, a backoff timer IE, and a cause IE that identifies a cause for the termination of operations. In operation block 1606, the DPC 146 may clear all the related resources associated with the DSC 144 and/or perform other similar operations to de-register the DSC 144 in response to receiving the DSC DE-REGISTER message.

[0244] FIG. 16B illustrates an embodiment DPC initiated DSAAP de-registration method 1650 for terminating operations. In the example illustrated in FIG. 16B, the DPC initiated DSAAP de-registration method 1650 is performed by processing cores in a DPC 146 component and a DSC 144 component, each of which may include all or portions of a DSAAP module/component.

[0245] In operation block 1652, the DPC 146 may determine that it needs to terminate DSA operations with the DSC 144. In operation 1654, the DPC 146 may generate and send a DSC DE-REGISTER message to the DSC 144. The DPC 146 may be configured to generate the DSC DE-REGISTER message to include any or all of a message type information element (IE), a message ID IE, a backoff timer IE, and a cause IE that identifies a cause for the termination of operations (e.g., overload, unspecified, etc.). In operation block 1656, the DPC 146 may clear all the related resources associated with the DSC 144 and/or perform other similar operations to de-register the DSC 144.

[0246] In operation block 1658, the DSC 144 may perform various de-registration failure response operations based on the information included in the received DSC DE-REGISTER message. For example, the DSC 144 may be configured to not retry registration to the same DPC 146 for at least the duration indicated in the backoff timer IE included in the received DSC DE-REGISTER message when the value of the cause IE in the DSC DE-REGISTER message is set to "overload."

[0247] FIG. 17A illustrates a DSC initiated DSAAP error indication method 1700 for reporting errors in accordance with an embodiment. In the example illustrated in FIG. 17A, method 1700 is performed by processing cores in a DPC 146 component and a DSC 144 component, each of which may include all or portions of a DSAAP module/component.

[0248] In operation block 1702, the DSC 144 may detect an error or error condition (e.g., a protocol error, etc.). In operation 1704, the DSC 144 may generate and send an ERROR INDICATION message to the DPC 146. The DSC 144 may be configured to generate the ERROR INDICATION message to include any or all of a message type information element (IE), a message ID IE, cause IE, and a criticality diagnostics IE. The cause IE may include information suitable for use in identifying a cause or type of the error (e.g., transfer syntax error, abstract syntax error, logical error, etc.). The criticality diagnostics IE may include a procedure code IE, a triggering message IE, and a procedure criticality IE. In operation block 1706, the DSC 144 and/or DPC 146 may perform various error-response operations based on the detected error or information included in the received ERROR INDICATION message. The error detection and response operations are discussed in detail further below.

[0249] FIG. 17B illustrates an embodiment DPC initiated DSAAP error indication method 1750 for reporting errors in accordance with another embodiment. In the example illustrated in FIG. 17B, method 1750 is performed by processing cores in a DPC 146 component and a DSC 144 component, each of which may include all or portions of a DSAAP module/component.

[0250] In operation block 1752, the DPC 146 may detect an error condition. In operation 1754, the DPC 146 may generate and send an ERROR INDICATION message to the DSC 144. The DPC 146 may be configured to generate the ERROR INDICATION message to include a cause information element (IE) that identifies a cause for the error. In operation block 1756, the DSC 144 and/or DPC 146 may perform various error-response operations based on the information included in the received ERROR INDICATION message.

[0251] As mentioned above, the DSC 144 and DPC 146 may be configured perform various error-response or failure response operations in response to detecting an error or failure condition. As part of these operations, the DSC 144 and/or DPC 146 may identify the type or cause of the error/failure condition, and tailor their responses based on the identified type or cause. For example, the DSC 144 and/or DPC 146 may be configured to determine whether a detected error is a protocol error, and tailor their responses accordingly.

[0252] Protocol errors include transfer syntax errors, abstract syntax errors, and logical errors. A transfer syntax error may occur when the receiving functional DSAAP entity (e.g., DSC, DPC, etc.) is not able to decode the received physical message. For example, transfer syntax errors may be detected while decoding ASN.1 information in a received message. In an embodiment, the DSC 144 and DPC 146 components may be configured to retransmit or re-request a DSAAP message in response to determining that a detected error is a transfer syntax error (e.g., as part of the error-response operations).

[0253] An abstract syntax error may occur when the receiving functional DSAAP entity (e.g., DSC, DPC, etc.) receives information elements (IEs) or IE groups that cannot be comprehended or understood (i.e., an unknown IE id). An abstract syntax error may also occur when the entity receives an information element (IE) for which a logical range (e.g., allowed number of copies) is violated. The DSC 144 and DPC 146 components may be configured to detect or identify these types of abstract syntax errors (i.e., cannot comprehend abstract syntax error), and in response, perform error-response operations based on criticality information included in the corresponding DSAAP message. Additional details regarding these operations and the criticality information are provided further below.

[0254] An abstract syntax error may also occur when the receiving functional DSAAP entity does not receive IEs or IE groups, but according to the specified presence of the object, the IEs or IE groups should have been present in the received message. The DSC 144 and DPC 146 components may be configured to detect or identify these particular types of abstract syntax errors (i.e., missing IE or IE group), and in response, perform error-response operations based on criticality information and presence information for the missing IE/IE group. Additional details regarding these operations, criticality information, and presence information are provided further below.

[0255] An abstract syntax error may also occur when the receiving entity receives IEs or IE groups that are defined to be part of that message in wrong order or with too many occurrences of the same IE or IE group. In addition, an abstract syntax error may also occur when the receiving entity receives IEs or IE groups, but according to the conditional presence of the concerning object and the specified condition, the IEs or IE groups should not have been present in the received message. The DSC 144 and DPC 146 components may be configured to detect or identify such abstract syntax errors (i.e., wrong order, too many occurrences, erroneously present, etc.), and in response, reject or terminate a procedure or method associated with the error (e.g., the method that caused the error). The DSC 144 and DPC 146 components may reject or terminate the procedure/method as part of the error-response operations.

[0256] In the various embodiments, the DSC 144 and DPC 146 components may be configured to continue to decode, read, or process a DSAAP message after detecting, identifying, or determining that an abstract syntax error occurred for that message. For example, the DSC 144 and DPC 146 components may skip a portion of the message that includes an error, and continue processing the other portions of the message. As part of this continued processing, the DSC 144 and DPC 146 components may detect or identify additional abstract syntax errors.

[0257] In an embodiment, the DSC 144 and DPC 146 components may be configured to perform error-response operations for each detected abstract syntax error and/or based on the criticality information and presence information for the IE/IE group associated with the abstract syntax error.

[0258] As mentioned above, each DSAAP message may include, or may be associated with, criticality information, presence information, range information, and assigned criticality information. In the various embodiments, a receiving functional DSAAP entity (e.g., DSC, DPC, etc.) may be configured to use any or all of such information (e.g., criticality information, presence information, etc.) when detecting an error, identifying the type of the error, or the specific error-response that are to be performed. That is, the entity may perform different operations depending on the values of the criticality information, presence information, range information, and/or assigned criticality information.

[0259] In an embodiment, the receiving functional DSAAP entity (e.g., DSC, DPC, etc.) may be configured to use the presence information included in a DSAAP message when identifying the type of error and the specific error-response operations that are to be performed for the identified error type. For example, the entity may use the presence information to determine whether the presence of an information element (IE) is optional, conditional, or mandatory (e.g., with respect to RNS application) for that message or communication. The entity may determine that an abstract syntax error has occurred when a received message is missing one or more information elements that are determined to be mandatory (or conditional when the condition is true).

[0260] In an embodiment, the receiving functional DSAAP entity (e.g., DSC, DPC, etc.) may be configured use the criticality information when identifying the specific error-response operations that are to be performed. That is, each DSAAP message may include criticality information for each individual information element (IE) or IE group included in that message. The values of criticality information for each IE or IE group may include "Reject IE," "Ignore IE and Notify Sender," and "Ignore IE." The receiving entity (e.g., DSC, DPC, etc.) may use this criticality information to determine that an IE, an IE group, or an EP is incomprehensible, identify the condition as an abstract syntax error (i.e., a cannot comprehend abstract syntax error), and/or to identify the error-response operations that are to be performed (e.g., reject, ignore, notify, etc.).

[0261] In an embodiment, the receiving entity (e.g., DSC, DPC, etc.) may be configured to reject a method/procedure and initiate a DSAAP error indication method (discussed above with reference to FIGs. 17A-B) in response to determining that an information element (IE) included in a message received during the performance of that method/procedure is incomprehensible, and that value of the criticality information for that IE is set to "Reject IE."

[0262] For example, when a message that initiates a method/procedure (e.g., a DSC REGISTER REQUEST message, etc.) is received, determined to include one or more IEs/IE groups that are incomprehensible and marked as "Reject IE," the receiving entity may the reject the method/procedure by not executing any of the functional requests included in that message. The receiving entity may also report the rejection of one or more IEs/IE groups using the message normally used to report unsuccessful outcome of the procedure. When the information in the received initiating message is insufficient and cannot be used to determine a value for all IEs that are required to be present in the message used to report the unsuccessful outcome of the procedure, the receiving entity may terminate the procedure and initiate a DSAAP error indication method/procedure.

[0263] As a further example, when a message initiating a method/procedure that does not have a message to report unsuccessful outcome is received, and that message includes one or more IEs/IE groups marked with "Reject IE" which the receiving entity does not comprehend, the receiving entity may terminate the method/procedure and initiate a DSAAP error indication method/procedure.

[0264] As yet another example, when a response message (e.g., a DSC REGISTER RESPONSE message, etc.) is received that includes one or more IEs marked with "Reject IE" which the receiving entity does not comprehend, the receiving entity may consider the method/procedure as being unsuccessfully terminated, and initiate a local error handling method.

[0265] In an embodiment, the receiving entity (e.g., DSC, DPC, etc.) may be configured to ignore or skip a method/procedure and initiate an DSAAP error indication method (discussed above with reference to FIGs. 17A-B) in response to determining that an information element (IE) included in a message received during the performance of that method/procedure is incomprehensible, and that value of the criticality information for that IE is set to "Ignore IE and Notify Sender."

[0266] As an example, when a message initiating a method/procedure is received containing one or more IEs/IE groups marked with "Ignore IE and Notify Sender" which the receiving entity does not comprehend, the receiving entity may ignore the content of the incomprehensible IEs/IE groups, continue with the method/procedure as if the incomprehensible IEs/IE groups were not received (except for the reporting) using the comprehended IEs/IE groups, and report in the response message of the method/procedure that one or more IEs/IE groups have been ignored. When the information received in the initiating message is insufficient to determine a value for all IEs that are required to be present in the response message, the receiving entity may terminate the method/procedure and initiate a DSAAP error indication method/procedure.

[0267] As a further example, when a message initiating a method/procedure that does not have a message to report the outcome of the method/procedure is received containing one or more IEs/IE groups marked with "Ignore IE and Notify Sender" which the receiving entity does not comprehend, the receiving entity may ignore the content of the not comprehended IEs/IE groups, continue with the method/procedure as if the not comprehended IEs/IE groups were not received (except for the reporting) using the understood IEs/IE groups, and initiate a DSAAP error indication method/procedure to report that one or more IEs/IE groups have been ignored.

[0268] As yet another example, when a response message is received containing one or more IEs/IE groups marked with "Ignore IE and Notify Sender" which the receiving entity does not comprehend, the receiving entity may ignore the content of the not comprehended IE/IE groups, continue with the method/procedure as if the not comprehended IEs/IE groups were not received (except for the reporting) using the understood IEs/IE groups and initiate a DSAAP error indication method/procedure.

[0269] In an embodiment, the receiving entity (e.g., DSC, DPC, etc.) may be configured to ignore or skip a method/procedure in response to determining that an information element (IE) included in a message received during the performance of that method/procedure is incomprehensible, and that value of the criticality information for that IE is set to "Ignore IE."

[0270] As an example, when a message initiating a method/procedure is received containing one or more IEs/IE groups marked with "Ignore IE" which the receiving entity does not comprehend, the receiving entity may ignore the content of the not comprehended IEs/IE groups and continue with the method/procedure as if the not comprehended IEs/IE groups were not received using only the understood IEs/IE groups.

[0271] As a further example, when a response message is received that includes one or more IEs/IE groups marked with "Ignore IE" which the receiving entity does not comprehend, the receiving entity may ignore the content of the not comprehended IEs/IE groups and continue with the method/procedure as if the not comprehended IEs/IE groups were not received using the understood IEs/IE groups.

[0272] When reporting not comprehended IEs/IE groups marked with "Reject IE" or "Ignore IE and Notify Sender" using a response message defined for the method/procedure, the Information Element Criticality Diagnostics IE may be included in the Criticality Diagnostics IE for each reported IE/IE group.

[0273] In an embodiment, the receiving entity (e.g., DSC, DPC, etc.) may be configured to initiate a DSAAP error indication method (discussed above with reference to FIGs. 17A-B) in response to determining that it cannot decode a type of message IE in a received message. In an embodiment, the entity may be configured to only consider the IEs specified in the specification version used by the component when determining the correct order for the IE included in a message.

[0274] In an embodiment, the receiving entity (e.g., DSC, DPC, etc.) may be configured to treat the missing IE/IE group according to the criticality information for the missing IE/IE group in the received message specified in the version of the present document used by the receiver.

[0275] As an example, the receiving entity (e.g., DSC, DPC, etc.) may be configured to not execute any of the functional requests of a received initiating message in response to determining that the received message is missing one or more IEs/IE groups with specified criticality "Reject IE." The receiving entity may reject the method/procedure and report the missing IEs/IE groups using the message normally used to report unsuccessful outcome of the method/procedure. When it is determined that the information received in the initiating message was insufficient to determine a value for all IEs that are required to be present in the message used to report the unsuccessful outcome of the method/procedure, the receiving entity may terminate the method/procedure and initiate a DSAAP error indication method/procedure.

[0276] As a further example, when a received message initiating a method/procedure that does not have a message to report unsuccessful outcome is missing one or more IEs/IE groups with specified criticality "Reject IE", the receiving entity may terminate the method/procedure and initiate a DSAAP error indication method/procedure.

[0277] As yet another example, when a received response message is missing one or more IEs/IE groups with specified criticality "Reject IE, the receiving entity may consider the method/procedure as unsuccessfully terminated and initiate a local error handling method/procedure.

[0278] As another example, when a received message initiating a method/procedure is missing one or more IEs/IE groups with specified criticality "Ignore IE and Notify Sender", the receiving entity may ignore that those IEs are missing and continue with the method/procedure based on the other IEs/IE groups present in the message and report in the response message of the method/procedure that one or more IEs/IE groups were missing. When the information received in the initiating message is insufficient to determine a value for all IEs that are required to be present in the response message, the receiving entity may terminate the method/procedure and initiate a DSAAP error indication method/procedure.

[0279] As another example, when a received message initiating a method/procedure that does not have a message to report the outcome of the method/procedure is missing one or more IEs/IE groups with specified criticality “Ignore IE and Notify Sender”, the receiving entity may ignore that those IEs are missing and continue with the method/procedure based on the other IEs/IE groups present in the message and initiate a DSAAP error indication method/procedure to report that one or more IEs/IE groups were missing.

[0280] As another example, when a received message a received response message is missing one or more IEs/IE groups with specified criticality “Ignore IE and Notify Sender”, the receiving entity may ignore that those IEs are missing and continue with the method/procedure based on the other IEs/IE groups present in the message and initiate a DSAAP error indication method/procedure to report that one or more IEs/IE groups were missing.

[0281] As another example, when a received message initiating a method/procedure is missing one or more IEs/IE groups with specified criticality “Ignore IE”, the receiving entity may ignore that those IEs are missing and continue with the method/procedure based on the other IEs/IE groups present in the message.

[0282] As another example, when a received response message is missing one or more IEs/IE groups with specified criticality “Ignore IE”, the receiving entity may ignore that those IEs/IE groups are missing and continue with the method/procedure based on the other IEs/IE groups present in the message.

[0283] The receiving entity (e.g., DSC, DPC, etc.) may be configured to respond to messages that include IEs or IE groups that received in wrong order, include too many occurrences, or are erroneously present (i.e., are included and marked as "conditional" when the condition is not met) in various ways. For example, the receiving entity (e.g., DSC, DPC, etc.) may be configured to not execute any of the functional requests of a received initiating message in response to determining that the received message includes IEs or IE groups in wrong order, includes too many occurrences of an IE, or includes erroneously present IEs. The receiving entity may reject the method/procedure and report the cause value "Abstract Syntax Error (Falsely Constructed Message)" using the message normally used to report unsuccessful outcome of the method/procedure. When the information received in the initiating message is insufficient to determine a value for all IEs that are required to be present in the message used to report the unsuccessful outcome of the method/procedure, the receiving entity may terminate the method/procedure and initiate a DSAAP error indication method/procedure.

[0284] As another example, when a message initiating a method/procedure that does not have a message to report unsuccessful outcome is received containing IEs or IE groups in wrong order or with too many occurrences or erroneously present, the receiving entity may terminate the method/procedure, and initiate a DSAAP error indication method/procedure using the cause value "Abstract Syntax Error (Falsely Constructed Message)".

[0285] As another example, when a response message is received containing IEs or IE groups in wrong order or with too many occurrences or erroneously present, the receiving entity may consider the method/procedure as unsuccessfully terminated and initiate local error handling.

[0286] As mentioned above, protocol errors include transfer syntax errors, abstract syntax errors, and logical errors. A logical error occurs when a message is comprehended correctly, but the information contained within the message is not valid (i.e. semantic error), or describes a method/procedure which is not compatible with the state of the receiving entity.

[0287] In an embodiment, a receiving entity (e.g., DSC, DPC, etc.) may be configured to perform error response operations based on the class of the method/procedure and irrespective of the criticality information of the IE's/IE groups containing the erroneous values in response to determining/detecting an logical error.

[0288] For example, when a logical error is detected in a request message of a class 1 method/procedure, and the method/procedure has a message to report this unsuccessful outcome, this message may be sent with an appropriate cause value (i.e., in the clause IE), such as "semantic error" or "message not compatible with receiver state." When a logical error is detected in a request message of a class 1 method/procedure, and the method/procedure does not have a message to report this unsuccessful outcome, the method/procedure may be terminated and a DSAAP error indication method/procedure may be initiated with an appropriate cause value. Where the logical error exists in a response message of a class 1 procedure, the procedure may be considered as unsuccessfully terminated and local error handling may be initiated.

[0289] When a logical error is detected in a message of a class 2 procedure, the procedure may be terminated and a DSAAP error indication procedure may be initiated with an appropriate cause value.

[0290] In the various embodiments, the receiving entity (e.g., DSC, DPC, etc.) may be configured to perform a local error handling method/procedure (as opposed to a DSAAP error indication method/procedure) when a protocol error is detected in the ERROR INDICATION message. In case a response message or error indication message needs to be returned, but the information necessary to determine the receiver of that message is missing, the procedure may be considered as unsuccessfully terminated and local error handling may be initiated. When an error that terminates a procedure occurs, the returned cause value may reflect the error that caused the termination of the procedure even if one or more abstract syntax errors with criticality "ignore and notify" have earlier occurred within the same procedure.

[0291] As discussed above, in the various embodiments, the dynamic spectrum arbitrage application part (DSAAP) protocol or component may be configured to allow, facilitate, support smaller cell architectures, such as the femtocell architectures. In an embodiment, all or portions of the DSAAP protocol/component may be included in a HeNB 117 and/or a HGW 145.

[0292] FIG. 18 illustrates various communication links in an embodiment DSA system 1800 that includes femtocells. In the example illustrated in FIG. 18, the DSA system 1800 includes HeNBs 117, a HGW 145, a DSC 144, and a DPC 146. The DSA system 1800 may also optionally include a SGW 118, MME 130, a HeNB management system 1802.

[0293] Each HeNB 117 may be configured to host the same functions as an eNodeB. Further, each HeNB 117 may serve or operate as an eNodeB to a single cell or to a small geographical area. As such, each HeNB 117 may be a femtocell.

[0294] The HeNBs 117 may be configured to establish communication links and/or communicate with components in the core network 120 via a set of S1 interfaces, namely the illustrated S1-U and S1-MME interfaces. The S1-U data plane may be established via (or between) the HeNB 117, HGW 145 and the SGW 118. S1-MME based communications between a HeNB 117 and the core network 120 may be established, facilitated, or provided by the HGW 145. In an embodiment, the HGW 145 may be configured to establish connections to components in the core network 120 so that inbound and outbound mobility to cells served by the HGW 145 do not require inter-MME handovers.

[0295] In the various embodiments, the HGW 145 may be configured to operate, communicate, and/or appear as an eNodeB 116 to an MME 130, and as an MME 130 to an eNodeB 116. Thus, an eNodeB 116 may communicate with the HGW 145 in the same manner (and using the same communication links/protocols) as it would communicate with the MME 130. Likewise, an MME 130 may communicate with the HGW 145 in the same manner as it would communicate with an eNodeB 116. This allows the system (or a controller) to dynamically add or remove components (e.g., HeNBs, eNodeBs, MMEs, etc.) without negatively impacting the performance or responsiveness of the system 1800. This also allows a large number of additional HeNBs 117 to be deployed into the network or system 1800 without significant preparation or network planning.

[0296] The HGW 145 may be configured to operate as a gateway between the HeNB 117 (or tens, hundreds, or thousands of HeNBs 117), the DSC 144, and the core network 120. Further, the HGW 145 may be configured represent many different HeNBs 117 so that they appear as a single eNodeB 116 to the DSC 144. This allows the DSC 144 to interface and communicate with a single HGW 145 that manages or represents a large number of different HeNBs 117 (i.e., rather than the DSC communicating with a large number of individual HeNBs).

[0297] In an embodiment, one or more of the HeNBs 117 may be configured to operate in local IP access (LIPA) mode. In the example illustrated in FIG. 18, HeNB 117a includes a LIPA local gateway (HeNB LIPA LGW) 1804 module, which may be configured to allow, facilitate, or support communications between the HeNB 117a and the core network 120 via the S5 interface when operating in LIPA mode. As such, HeNB 117a may support the LIPA function system regardless of the HGW 145 connection.

[0298] The HeNB LIPA LGW 1804 module may set up and maintain an S5 connection to the core network 120 so that the HGW 145 is not required or used to establish the S5 interface. The HeNB LIPA LGW 1804 module may reuse an IP address used for S1 interface/connection for the S5 interface/connection. This allows the system to reuse an S1 secure interface. The HeNB LIPA LGW 1804 module may also use another IP address, which may result another secure interface. The S5 LIPA connection may be released at outgoing handover, in which case the HeNB LIPA LGW 1804 may trigger a release over the S5 interface.

[0299] In addition, the HeNB LIPA LGW 1804 module may be configured to perform various operations to support various additional functions independent of the presence of a HGW 145 in the system 1800. For example, the HeNB LIPA LGW 1804 module may be configured to transfer collocated LGW IP address of the HeNB 117 over S1-MME to the core network 120 at every idle-active transition, transfer collocated LGW IP address of the HeNB 117 over S1-MME to the core network 120 for an uplink NAS transport procedure, and support basic PGW 128 functions in the collocated LGW function. The HeNB LIPA LGW 1804 module may support a SGi interface corresponding to LIPA, provide additional support for sending first packets, buffer subsequent packets, provide internal direct LGW-to-HeNB user path management, provide in sequence packet delivery to the wireless device 102, etc. Further, the HeNB LIPA LGW 1804 module may be configured to support restricted S5 procedures (e.g., corresponding to the strict support of LIPA function), send notifications to the core network 120 for collocated LGW functions. The HeNB LIPA LGW 1804 module may be configured to uplink TEIDs for the LIPA bearers over S5 interface within the restricted set of procedures to be forwarded over S1-MME, and further used by the HeNB 117 as 'correlation id' for correlation purposes between the collocated L-GW function and the HeNB 117. In case of outgoing handover triggering the LGW function to release the LIPA PDN connection, the HeNB LIPA LGW 1804 module may hand over the non-LIPA E-RABs.

[0300] In case of LIPA support, the MME 130 may support the following additional functions: verification of UE authorization to request LIPA activation for the requested APN at this CSG and transfer of the received collocated L-GW IP address; transfer of the 'correlation id' i.e. collocated L-GW uplink TEID to the HeNB 117 within the UE context setup procedure and E-RAB setup procedure; verification of whether the LIPA PDN connection has been released during the handover procedure; deactivation of the

LIPA PDN connection of an idle-mode UE if it detects that the UE has moved out of the coverage area of the HeNB 117 collocated with LGW function.

[0301] The various embodiments may support direct X2-connectivity between HeNBs 117, independent of whether any of the involved HeNBs 117 is connected to a HGW 145. In an embodiment, the system and/or it components may be configured so that the Tracking Area Code (TAC) and PLMN ID used by a HeNB 117 is also supported by the HGW 145.

[0302] As mentioned above, a HeNB 117 may be configured to host the same functions as an eNodeB 116. In addition to these functions, the HeNB 117 may be configured to discover a suitable serving HGW 145. The HeNB 117 may be configured to connect to a single HGW 145 at a time (e.g., no S1 Flex function used at the HeNB). The HeNB 117 may be configured to not simultaneously connect to a second HGW 145 or to an MME 130.

[0303] In an embodiment, the system 1800 and/or it components may be configured so that a HeNB 117 may be moved from one geographical area to another. In such systems, the HeNB 117 may be configured to automatically discover and suitable serving HGW 145, establish a communication link to the discovered HGW 145, and terminate the communication link to the previous HGW 145.

[0304] In an embodiment, the HGW 145 may be configured to host the selection of a MME 130. Thus, the system 1800 and/or it components may be configured so that the selection of an MME 130 (e.g., when a wireless device 102 attaches) is hosted by a HGW 145 (as opposed to a HeNB).

[0305] In an embodiment, the HeNB 117 may be configured to support a fixed broadband access network interworking function to signal tunnel information to the MME 130 via INITIAL UE MESSAGE, PATH SWITCH REQUEST message and HANDOVER

NOTIFY message. In an embodiment, the tunnel information may include a HeNB IP address (and the UDP port if NAT/NAPT is detected).

[0306] In an embodiment, the HeNB 117 may be configured to receive a Globally Unique Mobility Management Entity Identifier (GUMMEI) from a wireless device 102, and include the received GUMMEI in the INITIAL UE communication message. The HeNB 117 may be further configured to a GUMMEI Type in the INITIAL UE communication message. In an embodiment, the system and/or it components may be configured to support signaling the GUMMEI of a source MME 130 to the HGW 145 in the S1 PATH SWITCH REQUEST message.

[0307] In an embodiment, the HGW 145 may be configured to relay S1 application part messages between the MME 130 and HeNB 117 serving a wireless device 102.

[0308] In an embodiment, the HGW 145 may be configured to terminate a S1 context release request procedure and release an S1 context in response to receiving a UE CONTEXT RELEASE REQUEST message from a HeNB 117, such as when the message includes an explicit gateway context release indication and/or in response to determining that the wireless device identified by the received message is no longer served by the attached HeNB 117.

[0309] In an embodiment, the HGW 145 may be configured to inform a HeNB 117 about a GUMMEI corresponding to a serving MME 130, the MME UE S1AP ID assigned by the MME 130, and the MME UE S1AP ID assigned by the HGW 145 for the wireless device 102 in response to receiving a S1 INITIAL CONTEXT SETUP REQUEST message and S1 HANDOVER REQUEST message.

[0310] In an embodiment, the HGW 145 117 may be configured to inform a HeNB 117 about the MME UE S1AP ID assigned by the MME 130 and the MME UE S1AP ID assigned by the HGW 145 for the wireless device in response to receiving a S1 PATH SWITCH REQUEST ACKNOWLEDGE message.

[0311] In an embodiment, the HGW 145 may be configured to verify that an indicated cell access mode is valid for a HeNB 117 in response to receiving an S1 INITIAL UE message, S1 PATH SWITCH REQUEST, and/or S1 HANDOVER REQUEST ACKNOWLEDGE message. The HGW 145 may be further configured to verify that a CSG ID is also valid for that HeNB 117 when the access mode is closed (i.e., is a closed access HeNB).

[0312] In various embodiments, the system and/or it components may be configured so that a component may terminate non-UE associated S1 application part procedures towards a HeNB 117 and towards an MME 130.

[0313] In an embodiment, the HGW 145 may be configured verify that an identity used by the HeNB is valid in response to receiving a S1 SETUP REQUEST message. In an embodiment, the HGW 145 may be configured so that, upon receiving an OVERLOAD message, the HGW 145 may send the OVERLOAD message towards the HeNB(s), including in the message the identities of the affected MME node. In an embodiment, if a HGW 145 is deployed, a non-UE associated procedure may be performed between HeNBs and the HGW 145 and between the HGW 145 and the MME 130.

[0314] In various embodiments, the system and/or it components may be configured so that a component may optionally terminate S1-U interface with the HeNB 117 and with the SGW 118. In various embodiments, the system and/or it components may be configured to support TAC and PLMN ID used by the HeNB 117. In various embodiments, the system and/or it components may be configured so that the X2 interfaces are not be established between the HGW 145 and other nodes.

[0315] In various embodiments, the system and/or it components may be configured to route the S1 PATH SWITCH REQUEST message towards the MME 130 based on the GUMMEI received from the HeNB 117. In an embodiment, a list of CSG IDs may be included in the PAGING message, and the HGW 145 may be configured to use the list of CSG IDs for paging optimization.

[0316] In an embodiment, the MME 130 may be configured to provide access control functionality for wireless devices 102 that are members of a closed subscriber group (CSG). In case of handovers to CSG cells, access control may be based on the target CSG ID of the selected target PLMN provided to the MME 130 by the serving network.

[0317] In an embodiment, the MME 130 may be configured to provide membership verification for wireless devices that are handed over to hybrid cells. In case of handovers to hybrid cells, the MME 130 may perform membership verification based on a wireless device's selected target PLMN, cell access mode related information, and the CSG ID of the target cell provided by the source network in S1 handover (or by the target network in X2 handover).

[0318] In an embodiment, the MME 130 may be configured to provide CSG membership status signaling to the network, such as in case of attachment/handover to hybrid cells and in case of the change of membership status when a wireless device is served by a CSG cell or a hybrid cell. In an embodiment, the MME 130 may be configured to supervise the network operations/actions after the change in the membership status of a wireless device.

[0319] In an embodiment, the MME 130 may be configured so that, when a HeNB 117 is directly connected, the MME 130 verifies that the identity used by the HeNB 117 is valid. The MME 130 may verify the identity in response to receiving a S1 SETUP REQUEST message. In addition, the MME 130 may verify that the indicated cell access mode is valid, and when the access mode is closed, that the provided CSG ID is valid when receiving the INITIAL UE MESSAGE message, the PATH SWITCH REQUEST and the HANDOVER REQUEST ACKNOWLEDGE message.

[0320] In an embodiment, the MME 130 may be configured to route handover messages, which may be accomplished via MME configuration transfer messages and MME Direct Information Transfer messages towards HGWs 145 based on the TAI contained in these messages. In an embodiment, the MME 130 may be configured to determine whether routing ambiguities are to be avoided. The MME 130 may be configured to not reuse the system TAI used in a HGW 145 in another HGW 145 in response to determining that routing ambiguities are to be avoided.

[0321] In various embodiments, the MME 130 and/or HGW 145 may be configured to not include the list of CSG IDs for paging when sending the paging message directly to an un-trusted HeNB 117 or eNodeB 116. In an embodiment, the MME 130 may be configured to support the LIPA function with HeNB 117. In an embodiment, the MME 130 may be configured to fixed broadband access network interworking with HeNB 117.

[0322] FIG. 19 illustrates the relationships between a source component and a target component for X2-based handover (HO) support in accordance with an embodiment. Specifically, FIG. 19 illustrates that when the target node is a eNodeB, the source may be any HeNB. The target may be an open access HeNB or a hybrid access HeNB when the source is the eNodeB or any HeNB in the system. The target may be a closed access HeNB when the source is a hybrid access HeNB or a closed access HeNB. This case may be particularly relevant when the wireless device that is to be handed over is a member of a CSG cells and source/target nodes include the same CSG Id and PLMN.

[0323] FIG. 20A illustrates a protocol stack for user plane communications via the S1-U interface between a HeNB 117 component and a SGW 118 component. FIG. 20B illustrates a protocol stack for user plane communications for S1-U interface between the HeNB 117 component and the SGW 118 component via an HGW 145 component. These figures illustrate that the HGW 145 may optionally terminate the user plane towards the HeNB 117 and towards the SGW 118, and relay user plane data between the HeNB 117 and the SGW 118.

[0324] FIG. 21A illustrates a protocol stack for control plane communications via the S1-MME interface between a HeNB 117 component and a MME 130 component. FIG. 21B illustrates a protocol stack for control plane communications via the S1-MME interface between the HeNB 117 component and the MME 130 component via an HGW 145 component. These figures illustrate that when the HGW 145 is not present (e.g., FIG. 21A), all the S1-AP procedures may be terminated at the HeNB 117 and the MME 130. When the HGW 145 is present (FIG. 21B), the HGW 145 may terminate the non-UE-dedicated procedures, both with the HeNB 117, and with the MME 130.

[0325] The HGW 145 may relay control plane data between the HeNB 117 and the MME. The scope of any protocol function associated to a non-UE-dedicated procedure may be between HeNB 117 and HGW 145 and/or between HGW 145 and MME 130. Any protocol function associated to an UE-dedicated-procedure may reside within the HeNB 117 and the MME 130.

[0326] FIG. 22 illustrates a protocol stack for control plane communications via the S1-MME interface between an HeNB 117 and HGW 145, and via the Xe interface between the HGW 145 and DSC 144.

[0327] FIG. 23 illustrates embodiment home eNodeB (HeNB) method 2300 of dynamically determining a most suitable serving home eNodeB gateway (HGW) through which to connect to the core network and/or a DSA system. Method 2300 may be performed by a processing core of a femtocell or HeNB.

[0328] In block 2302, the processing core may establish a first communication link defined over the S1 interface between a femtocell/HeNB and a first home eNodeB gateway (HGW). In block 2304, the processing core may monitor various conditions (e.g., GPS information, signal strengths, etc.) to determine whether the HeNB has been moved. In block 2306, the processing core may determine that the HeNB has been moved. In block 2308, the processing core may determine whether there are suitable serving HGWs in the same telecommunication network. In block 2310, the processing core may establish a second communication link between the HeNB and a new serving HGW in response to determining that there is a suitable serving HGW in the telecommunication network. In block 2312, the processing core may terminate the first communication link to the first HGW.

[0329] FIG. 24 illustrates a home eNodeB (HeNB) method 2400 of generating congestion reports. Method 2400 may be performed in a processing core of a HeNB component. In block 2402, the processing core may monitor various network conditions (network congestion, resource usage, resource availability, etc.). In block 2404, the processing core may generate congestion reports based on the results of the monitoring (e.g., based on the detected network conditions). In block 2406, the processing core may send the generated congestion reports to a home eNodeB gateway (HGW) via a first communication link that is defined over the S1 interface.

[0330] FIG. 25 illustrates a home eNodeB gateway (HGW) method 2500 of generating congestion state information based on information received from many femtocells. Method 2500 may be performed in a processing core of a HGW component. In block 2502, the processing core may receive congestion reports from a plurality of femtocells via first communication links defined over the S1 interface. In block 2504, the processing core may generate congestion state information based on the received congestion reports. In block 2506, the processing core may send the generated congestion state information to a DSC via a second communication link defined over a Xe interface.

[0331] FIG. 26 illustrates a DSC method 2600 of managing congestion in a telecommunication network. Method 2600 may be performed in a processing core of a DSC component. In block 2602, the processing core may receive congestion state information via a second communication link defined over a Xe interface. In block 2602, the processing core may use the received congestion state information to determine whether to perform handover operations to transfer selected wireless devices to a non-congested target eNodeB. In block 2602, the processing core may communicate with a DPC component via a third communication link defined over a Xd interface so as to cause the DPC to instruct a second DSC in a second telecommunication network to restrict further handovers to the femtocells in the first telecommunication network.

[0332] The various embodiments may include or use a dynamic spectrum arbitrage application part (DSAAP) protocol and/or component that is configured to allow, facilitate, support, or augment communications between two or more DSA components (e.g., DPC, DSC, eNodeB, MME, HSS, etc.) so as to improve the efficiency and speed of the DSA system. A DSA component may be any component discussed in this application and/or any component that participates in any of the DSA operations, communications, or methods discussed in this application. As such, the DSAAP component(s) may be configured to allow, facilitate, support, or augment communications between any of the components discussed in this application, including the communications between a DPC component and a DSC component, between the DSC component and a eNodeB component, between the DSC component and an MME component, between the DSC component and an HSS component, between the MME component and the HSS component, between the eNodeB component and a wireless device, etc.

[0333] To facilitate the communications between two or more DSA components, the DSAAP component(s) may publish application programming interfaces (API) and/or include client modules that facilitate communications between the DSA components. In addition, the DSAAP component(s) may be configured to allow the DSA components to communicate specific information, use specific communication messages, and/or perform specific operations that together provide various DSA functions that further improve the efficiency and speed of the DSA system and participating networks.

[0334] As an example, the DSAAP component(s) may be configured to allow an eNodeB to communicate with a DSC component (e.g., via the Xe interface), with other eNodeBs (e.g., via an X2 interface), and with various other components (e.g., via the S1 interface). As a further example, the DSAAP component(s) may be configured to allow, facilitate, support, or augment communications between the DSC component and the DPC component so as to allow the DPC and/or DSC components to better pool resources across the different networks, better monitor traffic and resource usage in the various networks, to more efficiently communicate bids and bidding information, to quickly and efficiently register and deregister components, and better perform backoff operations. The DSAAP component(s) may also improve the DSA resource auctioning operations by improving the performance and efficiency of the procedures for bidding, generating invoices, advertizing resources, requesting resources, purchasing resources, validating bid credentials, etc.

[0335] In the various embodiments, all or portions of the DSAAP component may be included in one or more DSA components, such as a DPC component, a DSC component, an eNodeB component, an MME component, and an HSS component. The DSAAP component may be implemented in hardware, software, or a combination of hardware and software. In an embodiment, the DSAAP component may be configured to implement a DSAAP protocol, which may be defined over the Xe, Xd, and/or X2 reference points. In various embodiments, the Xe reference point between DSC and eNodeB may use the DSAAP protocol, TR-069 protocol, and/or TR-192 data model extensions to support listing available resources at the eNodeB and notifying the eNodeB of bid/buy confirmations. The Xd reference point between DSC and DPC may use the DSAAP protocol for dynamic spectrum and resource arbitrage operations. The X2 interface/reference point between the eNodeBs may also use the DSAAP protocol to communicate information.

[0336] In various embodiments, the DSAAP component(s) may be configured to allow the various DSA components (e.g., DSC, DPC, eNodeB, etc.) to communicate using the DSAAP protocol and/or to perform various DSAAP methods. DSAAP methods may be performed in any of the DSA systems discussed in this application, such as a system that includes a first DSC server in a first telecommunication network (e.g., a lessee network), a second DSC server in second telecommunication network (e.g., a lessor network), and a DPC server that is outside of the first and second telecommunication networks.

[0337] The various embodiments may be implemented on a variety of mobile wireless computing devices, an example of which is illustrated in FIG. 27. Specifically, FIG. 27 is a system block diagram of a mobile transceiver device in the form of a smartphone/cell phone 2700 suitable for use with any of the embodiments. The cell phone 2700 may include a processor 2701 coupled to internal memory 2702, a display 2703, and to a speaker 2704. Additionally, the cell phone 2700 may include an antenna 2705 for sending and receiving electromagnetic radiation that may be connected to a wireless data link and/or cellular telephone transceiver 2706 coupled to the processor 2701. Cell phones 2700 typically also include menu selection buttons or rocker switches 2707 for receiving user inputs.

[0338] A typical cell phone 2700 also includes a sound encoding/decoding (CODEC) circuit 2708 which digitizes sound received from a microphone into data packets suitable for wireless transmission and decodes received sound data packets to generate analog signals that are provided to the speaker 2704 to generate sound. Also, one or more of the processor 2701, wireless transceiver 2706 and CODEC 2708 may include a digital signal processor (DSP) circuit (not shown separately). The cell phone 2700 may further include a ZigBee transceiver (i.e., an IEEE 802.15.4 transceiver) for low-power short-range communications between wireless devices, or other similar communication circuitry (e.g., circuitry implementing the Bluetooth® or WiFi protocols, etc.).

[0339] The embodiments described above, including the spectrum arbitrage functions, may be implemented within a broadcast system on any of a variety of commercially available server devices, such as the server 2800 illustrated in FIG. 28. Such a server 2800 typically includes a processor 2801 coupled to volatile memory 2802 and a large capacity nonvolatile memory, such as a disk drive 2803. The server 2800 may also include a floppy disc drive, compact disc (CD) or DVD disc drive 2804 coupled to the processor 2801. The server 2800 may also include network access ports 2806 coupled to the processor 2801 for establishing data connections with a network 2807, such as a local area network coupled to other communication system computers and servers.

[0340] The processors 2701, 2801, may be any programmable microprocessor, microcomputer or multiple processor chip or chips that can be configured by software instructions (applications) to perform a variety of functions, including the functions of the various embodiments described below. In some wireless devices, multiple processors 2801 may be provided, such as one processor dedicated to wireless communication functions and one processor dedicated to running other applications. Typically, software applications may be stored in the internal memory 2702, 2802, before they are accessed and loaded into the processor 2701, 2801. The processor 2701, 2801 may include internal memory sufficient to store the application software instructions. In some servers, the processor 2801 may include internal memory sufficient to store the application software instructions. In some receiver devices, the secure memory may be in a separate memory chip coupled to the processor 2701. The internal memory 2702, 2802 may be a volatile or nonvolatile memory, such as flash memory, or a mixture of both. For the purposes of this description, a general reference to memory refers to all memory accessible by the processor 2701, 2801, including internal memory 2702, 2802, removable memory plugged into the device, and memory within the processor 2701, 2801 itself.

[0341] The foregoing method descriptions and the process flow diagrams are provided merely as illustrative examples and are not intended to require or imply that the steps of the various embodiments must be performed in the order presented. As will be appreciated by one of skill in the art the order of steps in the foregoing embodiments may be performed in any order. Words such as 'thereafter,' 'then,' 'next,' etc. are not intended to limit the order of the steps; these words are simply used to guide the reader through the description of the methods. Further, any reference to claim elements in the singular, for example, using the articles 'a,' 'an' or 'the' is not to be construed as limiting the element to the singular.

[0342] The various illustrative logical blocks, modules, circuits, and algorithm steps described in connection with the embodiments disclosed herein may be implemented as electronic hardware, computer software, or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the present invention.

[0343] The hardware used to implement the various illustrative logics, logical blocks, modules, and circuits described in connection with the embodiments disclosed herein may be implemented or performed with a general purpose processor, a digital signal processor (DPC), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but, in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DPC and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DPC core, or any other such configuration. Alternatively, some steps or methods may be performed by circuitry that is specific to a given function.

[0344] In one or more exemplary aspects, the functions described may be implemented in hardware, software, firmware, or any combination thereof. If implemented in software, the functions may be stored as one or more instructions or code on a non-transitory computer-readable medium or non-transitory processor-readable medium. The steps of a method or algorithm disclosed herein may be embodied in a processor-executable software module which may reside on a non-transitory computer-readable or processor-readable storage medium. Non-transitory computer-readable or processor-readable storage media may be any storage media that may be accessed by a computer or a processor. By way of example but not limitation, such non-transitory computer-readable or processor-readable media may include RAM, ROM, EEPROM, FLASH memory, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium that may be used to store desired program code in the form of instructions or data structures and that may be accessed by a computer. Disk and disc, as used herein, includes compact disc (CD), laser disc, optical disc, digital versatile disc (DVD), floppy disk, and blu-ray disc where disks usually reproduce data magnetically, while discs reproduce data optically with lasers. Combinations of the above are also included within the scope of non-transitory computer-readable and processor-readable media. Additionally, the operations of a method or algorithm may reside as one or any combination or set of codes and/or instructions on a non-transitory processor-readable medium and/or computer-readable medium, which may be incorporated into a computer program product.

[0345] The preceding description of the disclosed embodiments is provided to enable any person skilled in the art to make or use the present invention. Various modifications to these embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments without departing from the spirit or scope of the invention. Thus, the present invention is not intended to be limited to the embodiments shown herein but is to be accorded the widest scope consistent with the following claims and the principles and novel features disclosed herein.

CLAIMS

What is claimed is:

1. A dynamic spectrum arbitrage (DSA) system, comprising:

a plurality of femtocells in a first telecommunication network;

a home eNodeB gateway (HGW) comprising a HGW processor coupled to each of the plurality of femtocells via first communication links;

a dynamic spectrum controller (DSC) comprising DSC processor coupled to the HGW via a second communication link; and

a dynamic spectrum policy controller (DPC) comprising a DPC processor coupled to the DSC via a third communication link.

2. The DSA system of claim 1, wherein:

the first communication links are defined over a S1 interface;

the second communication link is defined over a Xe interface; and

the third communication link is defined over a Xd interface.

3. The DSA system of claim 1, wherein the plurality of femtocells include a home eNodeB (HeNB) comprising a HeNB processor that is configured with processor-executable instructions to perform operations comprising:

monitoring network conditions;

generating congestion reports based on a result of the monitoring; and

sending the generated congestion reports to the HGW via the first communication links.

4. The DSA system of claim 3, wherein the HeNB processor is configured with processor-executable instructions to perform operations such that monitoring network

conditions comprises monitoring one of a network congestion, a resource usage, and a resource availability.

5. The DSA system of claim 3, wherein the HeNB processor is configured with processor-executable instructions to perform operations further comprising:

determining that the HeNB has been moved;

determining whether there is are suitable serving HGWs in the first telecommunication network;

establishing a communication link to one of the identified serving HGWs; and

terminating one of the first communication links to the HGW.

6. The DSA system of claim 1, wherein the HGW processor is configured with processor-executable instructions to perform operations comprising:

receiving congestion reports from the plurality of femtocells via the first communication links;

generating congestion state information based on the received congestion reports; and

sending the generated congestion state information to the DSC via the second communication link.

7. The DSA system of claim 6, wherein the DSC processor is configured with processor-executable instructions to perform operations comprising:

receiving the congestion state information from the HGW via the second communication link; and

using the received congestion state information to determine whether there are excess network resources available in the first telecommunication network for allocation and use by a second telecommunication network.

8. The DSA system of claim 6, wherein the DSC processor is configured with processor-executable instructions to perform operations comprising:

receiving the congestion state information from the HGW via the second communication link; and

using the received congestion state information to determine whether to perform handover operations to transfer selected wireless devices to a non-congested target eNodeB.

9. The DSA system of claim 8, wherein the DSC processor is configured with processor-executable instructions to perform operations further comprising:

communicating with the DPC via the third communication link to cause the DPC to instruct a second DSC in a second telecommunication network to restrict further handovers to one or more of the plurality of femtocells in the first telecommunication network.

10. The DSA system of claim 1, wherein the DPC processor is configured with processor-executable instructions to perform operations further comprising:

receiving a request for radio frequency (RF) spectrum resources;

determining server an amount of RF spectrum resources available for allocation within the first telecommunication network; and

dynamically allocating a portion of available RF spectrum resources of the first telecommunication network for access and use by multiple cell sites in a second communication network.

11. A femtocell, comprising:

a processor configured with processor-executable instructions to perform operations comprising:

monitoring network conditions;

generating congestion reports based on a result of the monitoring; and sending the generated congestion reports to a home eNodeB gateway (HGW) via a communication link defined over a S1 interface.

12. The femtocell of claim 11, wherein the processor is configured with processor-executable instructions to perform operations such that monitoring network conditions comprises monitoring one of a network congestion, a resource usage, and a resource availability.

13. The femtocell of claim 12, wherein the processor is configured with processor-executable instructions to perform operations further comprising:

determining that the femtocell has been moved;

determining whether there is a suitable serving HGW available;

establishing a second communication link to an identified serving HGW in response to determining that there is a suitable serving HGW available; and

terminating the communication link to the HGW in response to establishing the second communication link to the serving HGW.

14. A home eNodeB gateway (HGW), comprising:

a processor configured with processor-executable instructions to perform operations comprising:

establishing first communication links to a plurality of femtocells in a first telecommunication network;

establishing a second communication link to a dynamic spectrum controller (DSC) in the first telecommunication network;

receiving congestion reports from the plurality of femtocells via the first communication links;

generating congestion state information based on the received congestion reports; and sending the generated congestion state information to the DSC via the second communication link.

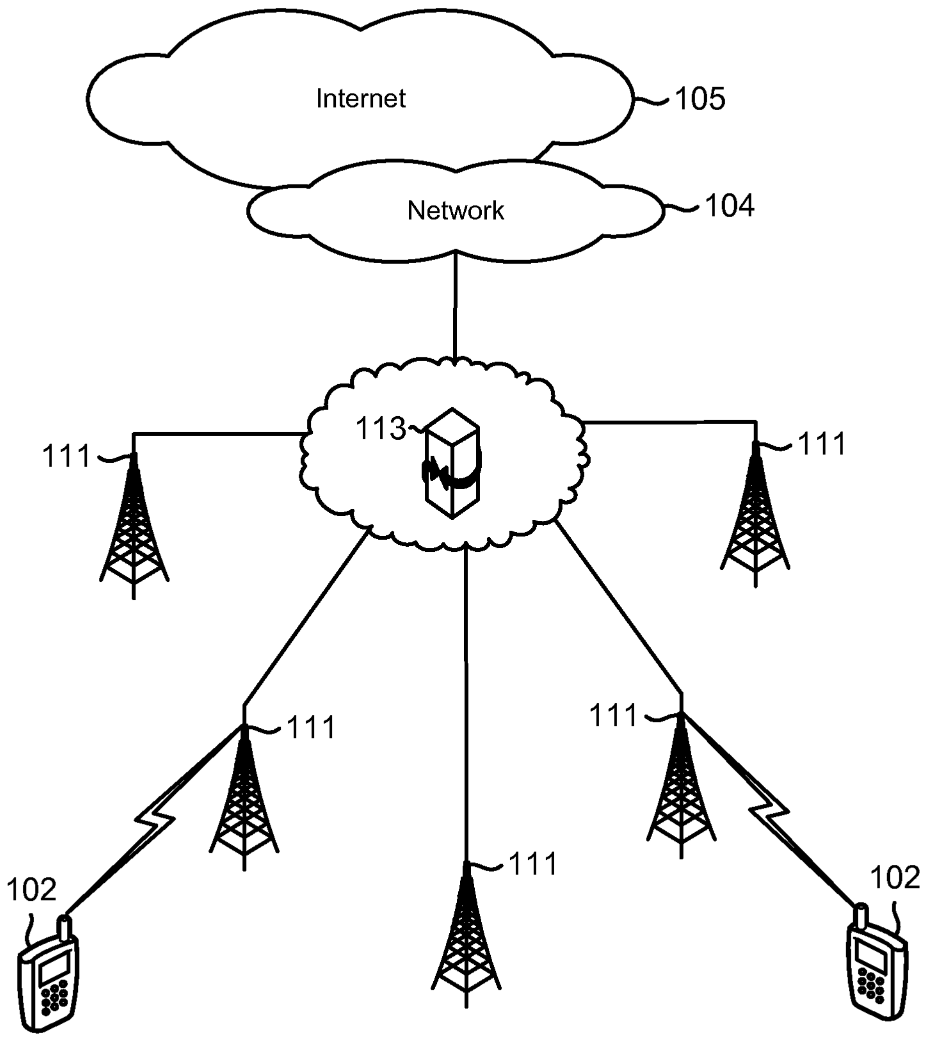


FIG. 1A

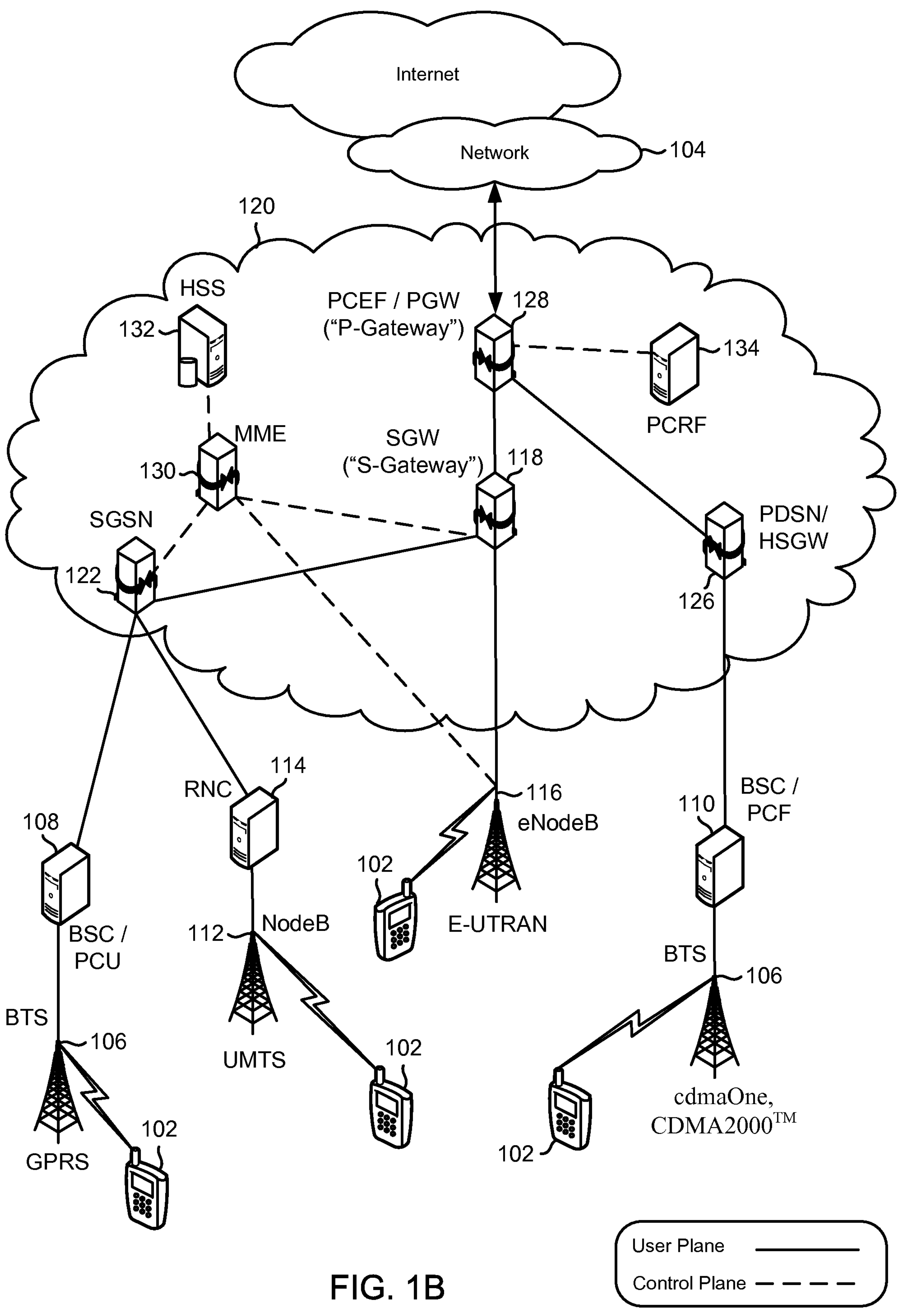

Internet
Network
104
120
HSS
132
PCEF / PGW
("P-Gateway")
128
134
PCRF
MME
130
SGW
("S-Gateway")
118
SGSN
122
PDSN/
HSGW
126
RNC
114
116
eNodeB
BSC /
PCF
110
108
102
E-UTRAN
BSC /
PCU
NodeB
112
BTS
106
BTS
106
UMTS
102
GPRS
102
cdmaOne,
CDMA2000™
102
User Plane
Control Plane

FIG. 1B

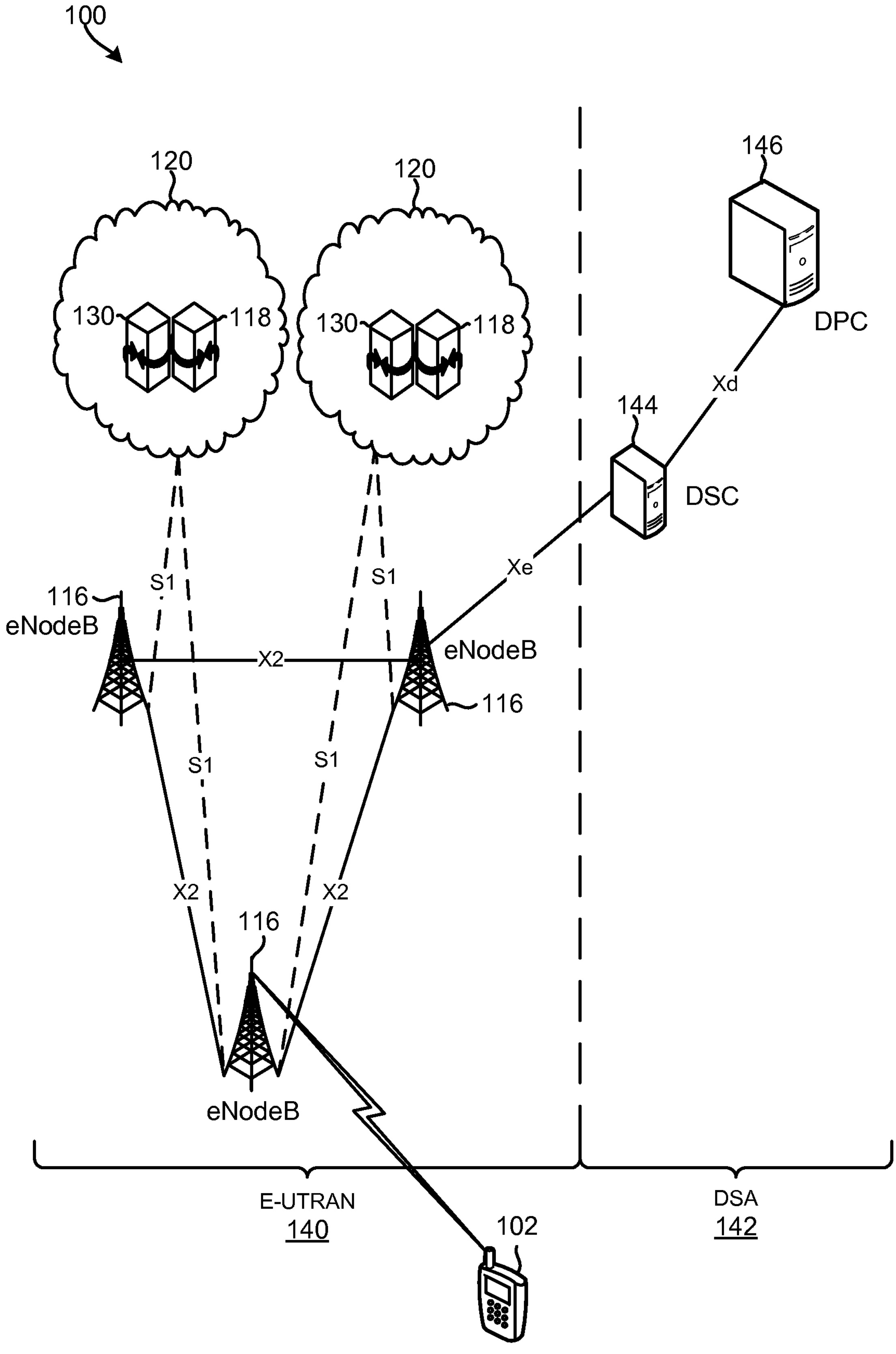

100
120
120
130
118
130
118
146
DPC
Xd
144
DSC
Xe
S1
S1
116
eNodeB
X2
eNodeB
116
S1
S1
X2
X2
116
eNodeB
E-UTRAN
140
DSA
142
102

FIG. 1C

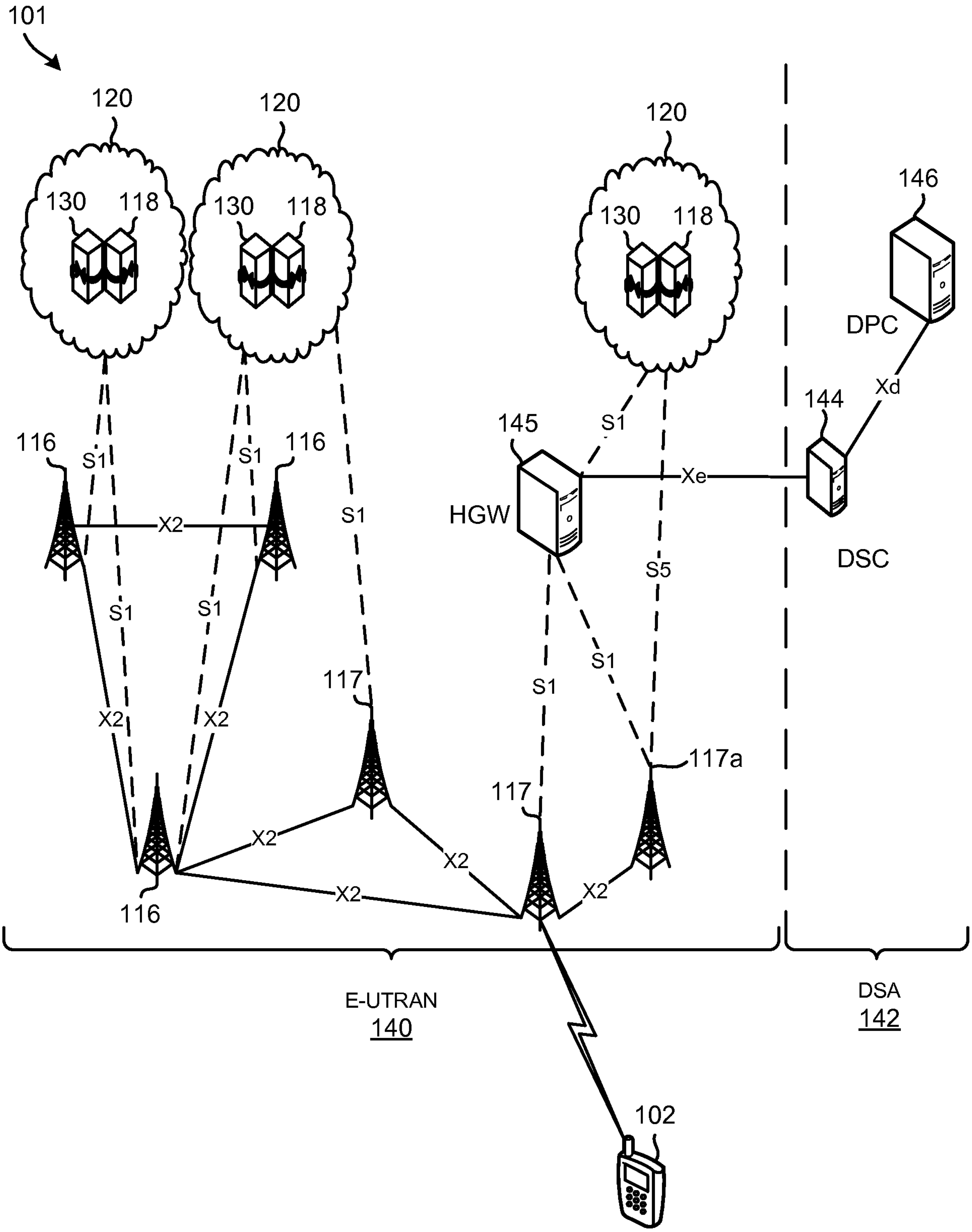

101
120
120
120
130
118
130
118
130
118
146
DPC
Xd
144
145
S1
116
S1
S1
116
Xe
HGW
X2
S1
S1
S1
S1
S5
DSC
X2
X2
117
S1
S1
117a
117
X2
X2
X2
X2
116
E-UTRAN
140
DSA
142
102

FIG. 1D

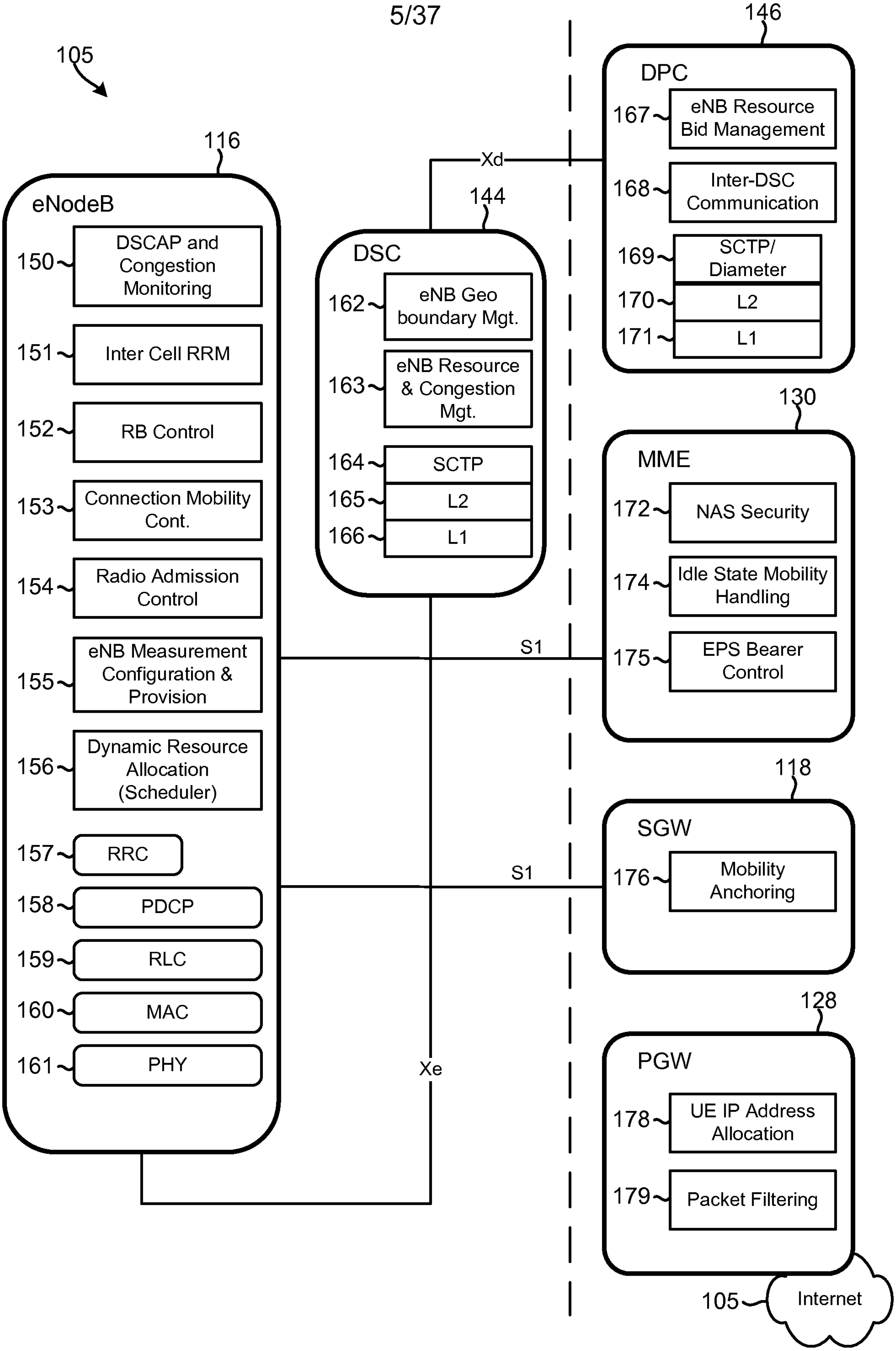

105
116
eNodeB
150
DSCAP and Congestion Monitoring
151
Inter Cell RRM
152
RB Control
153
Connection Mobility Cont.
154
Radio Admission Control
155
eNB Measurement Configuration & Provision
156
Dynamic Resource Allocation (Scheduler)
157
RRC
158
PDCP
159
RLC
160
MAC
161
PHY
144
DSC
162
eNB Geo boundary Mgt.
163
eNB Resource & Congestion Mgt.
164
SCTP
165
L2
166
L1
Xd
Xe
S1
S1
146
DPC
167
eNB Resource Bid Management
168
Inter-DSC Communication
169
SCTP/ Diameter
170
L2
171
L1
130
MME
172
NAS Security
174
Idle State Mobility Handling
175
EPS Bearer Control
118
SGW
176
Mobility Anchoring
128
PGW
178
UE IP Address Allocation
179
Packet Filtering
105
Internet

FIG. 1E

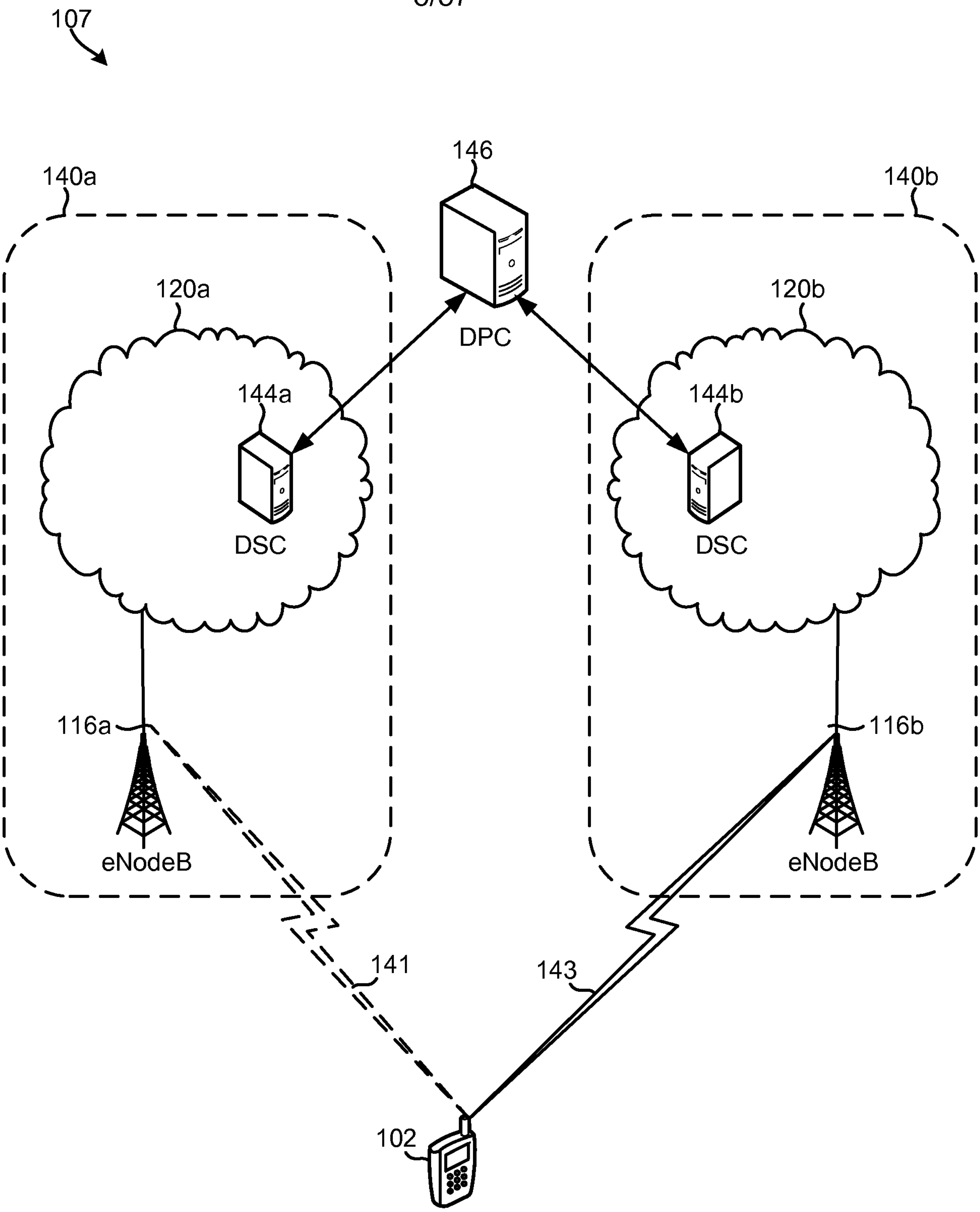

107
146
140a
140b
DPC
120a
120b
144a
144b
DSC
DSC
116a
116b
eNodeB
eNodeB
141
143
102

FIG. 1F

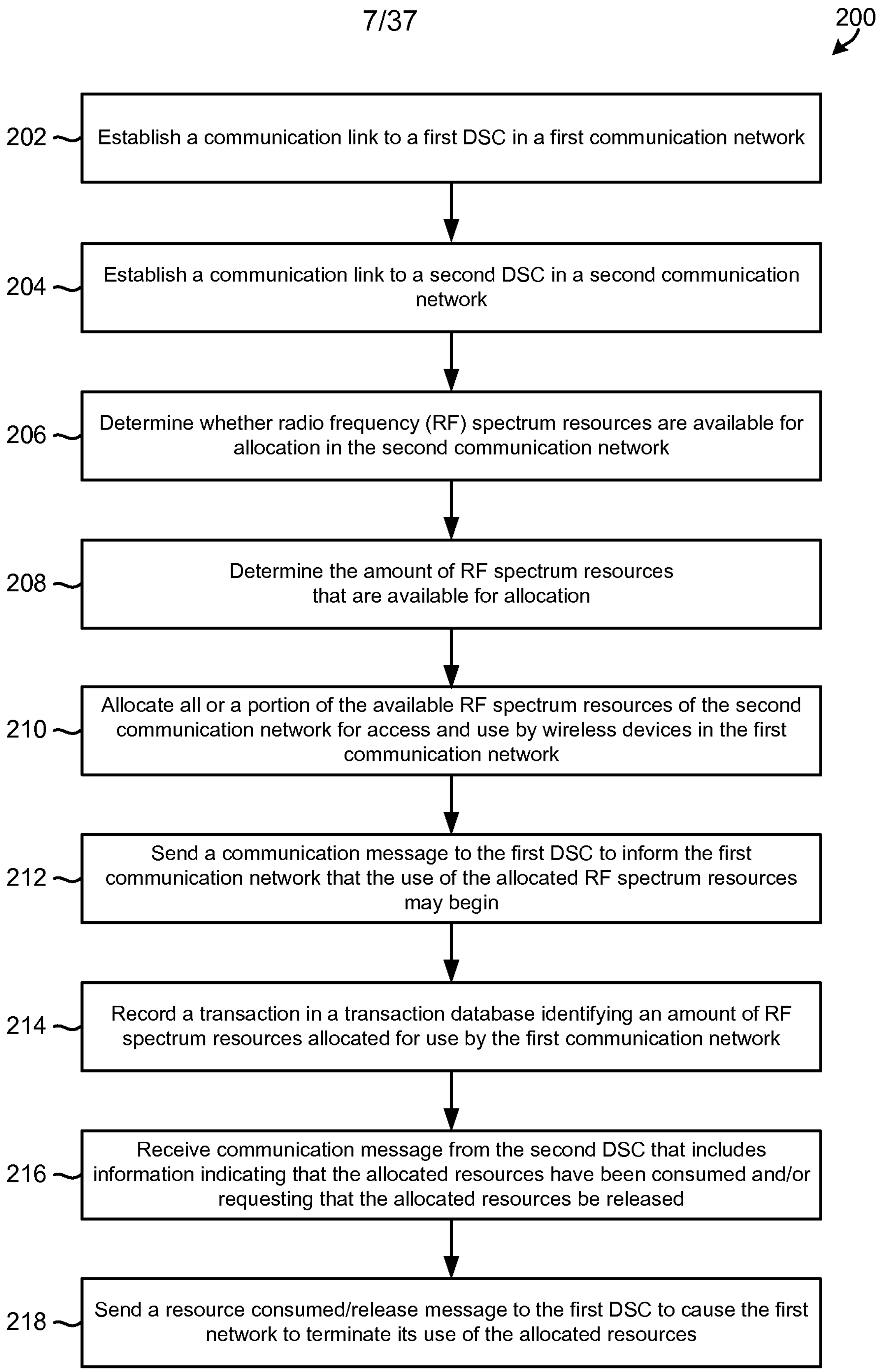

200
202
Establish a communication link to a first DSC in a first communication network
204
Establish a communication link to a second DSC in a second communication network
206
Determine whether radio frequency (RF) spectrum resources are available for allocation in the second communication network
208
Determine the amount of RF spectrum resources that are available for allocation
210
Allocate all or a portion of the available RF spectrum resources of the second communication network for access and use by wireless devices in the first communication network
212
Send a communication message to the first DSC to inform the first communication network that the use of the allocated RF spectrum resources may begin
214
Record a transaction in a transaction database identifying an amount of RF spectrum resources allocated for use by the first communication network
216
Receive communication message from the second DSC that includes information indicating that the allocated resources have been consumed and/or requesting that the allocated resources be released
218
Send a resource consumed/release message to the first DSC to cause the first network to terminate its use of the allocated resources

FIG. 2A

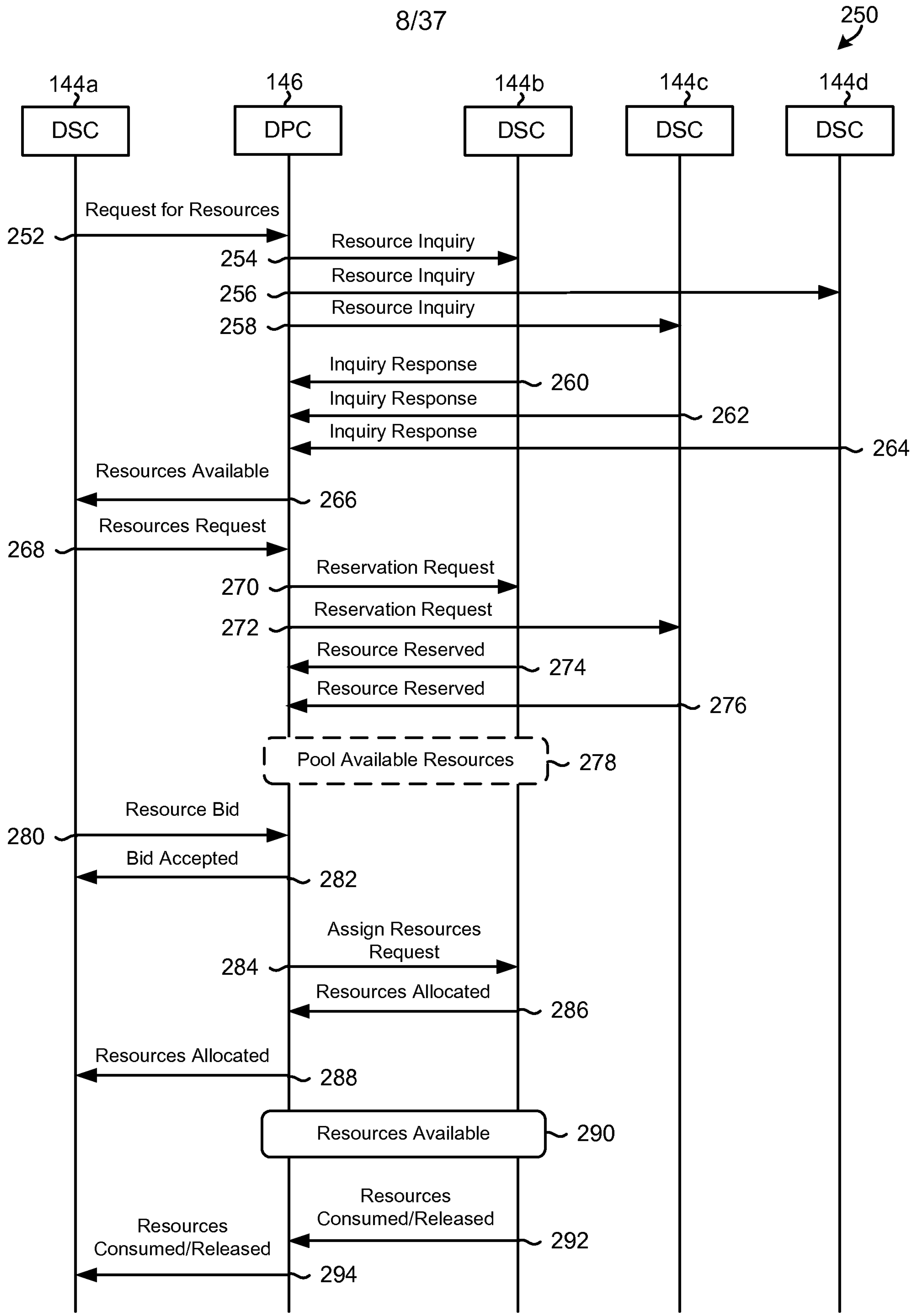

250
144a
146
144b
144c
144d
DSC
DPC
DSC
DSC
DSC
Request for Resources
252
Resource Inquiry
254
Resource Inquiry
256
Resource Inquiry
258
Inquiry Response
260
Inquiry Response
262
Inquiry Response
264
Resources Available
266
Resources Request
268
Reservation Request
270
Reservation Request
272
Resource Reserved
274
Resource Reserved
276
Pool Available Resources
278
Resource Bid
280
Bid Accepted
282
Assign Resources Request
284
Resources Allocated
286
Resources Allocated
288
Resources Available
290
Resources Consumed/Released
292
Resources Consumed/Released
294

FIG. 2B

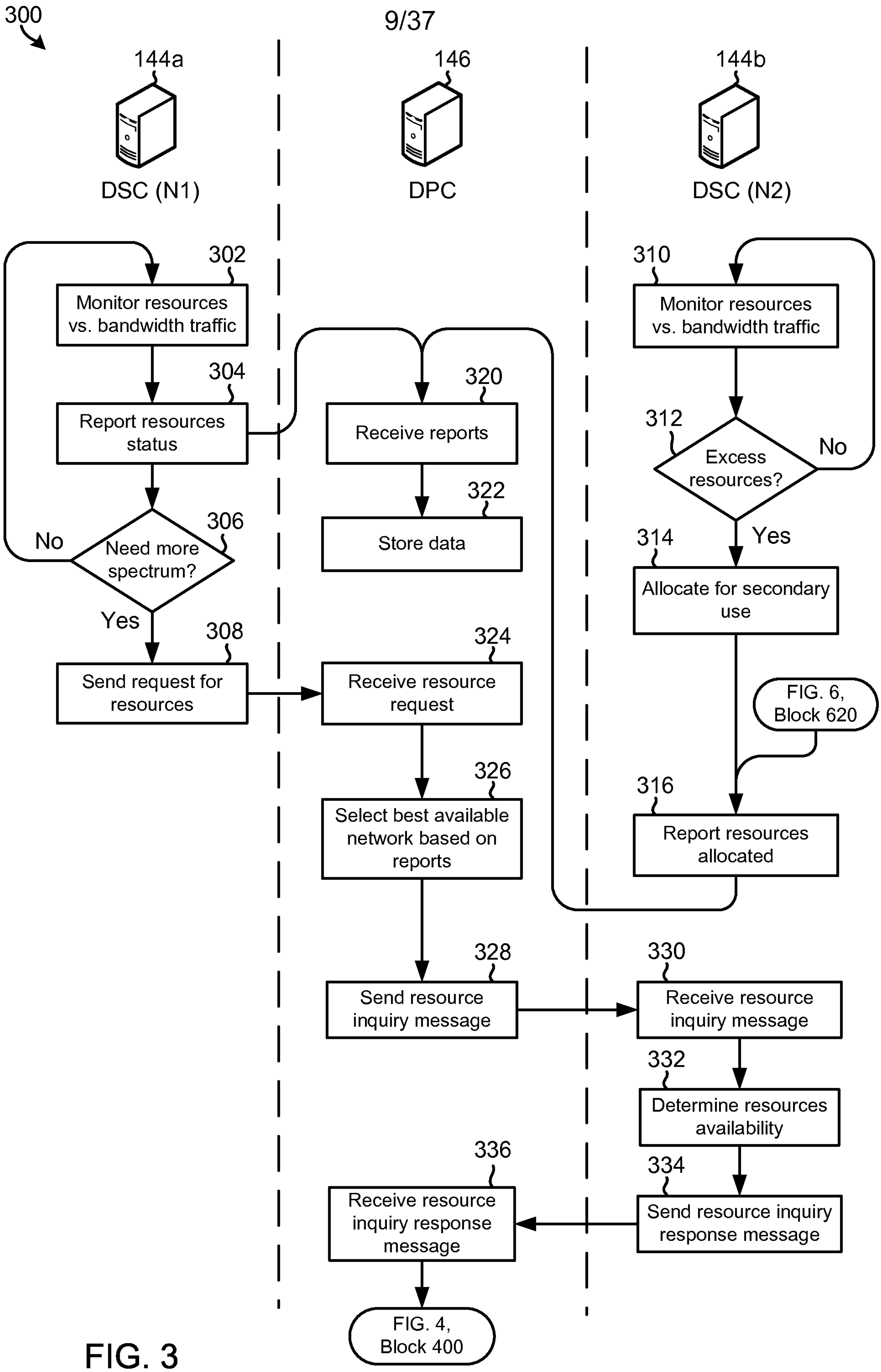

300
144a
DSC (N1)
146
DPC
144b
DSC (N2)
302
Monitor resources vs. bandwidth traffic
304
Report resources status
306
Need more spectrum?
No
Yes
308
Send request for resources
320
Receive reports
322
Store data
324
Receive resource request
326
Select best available network based on reports
328
Send resource inquiry message
336
Receive resource inquiry response message
FIG. 4, Block 400
310
Monitor resources vs. bandwidth traffic
312
Excess resources?
No
Yes
314
Allocate for secondary use
FIG. 6, Block 620
316
Report resources allocated
330
Receive resource inquiry message
332
Determine resources availability
334
Send resource inquiry response message

FIG. 3

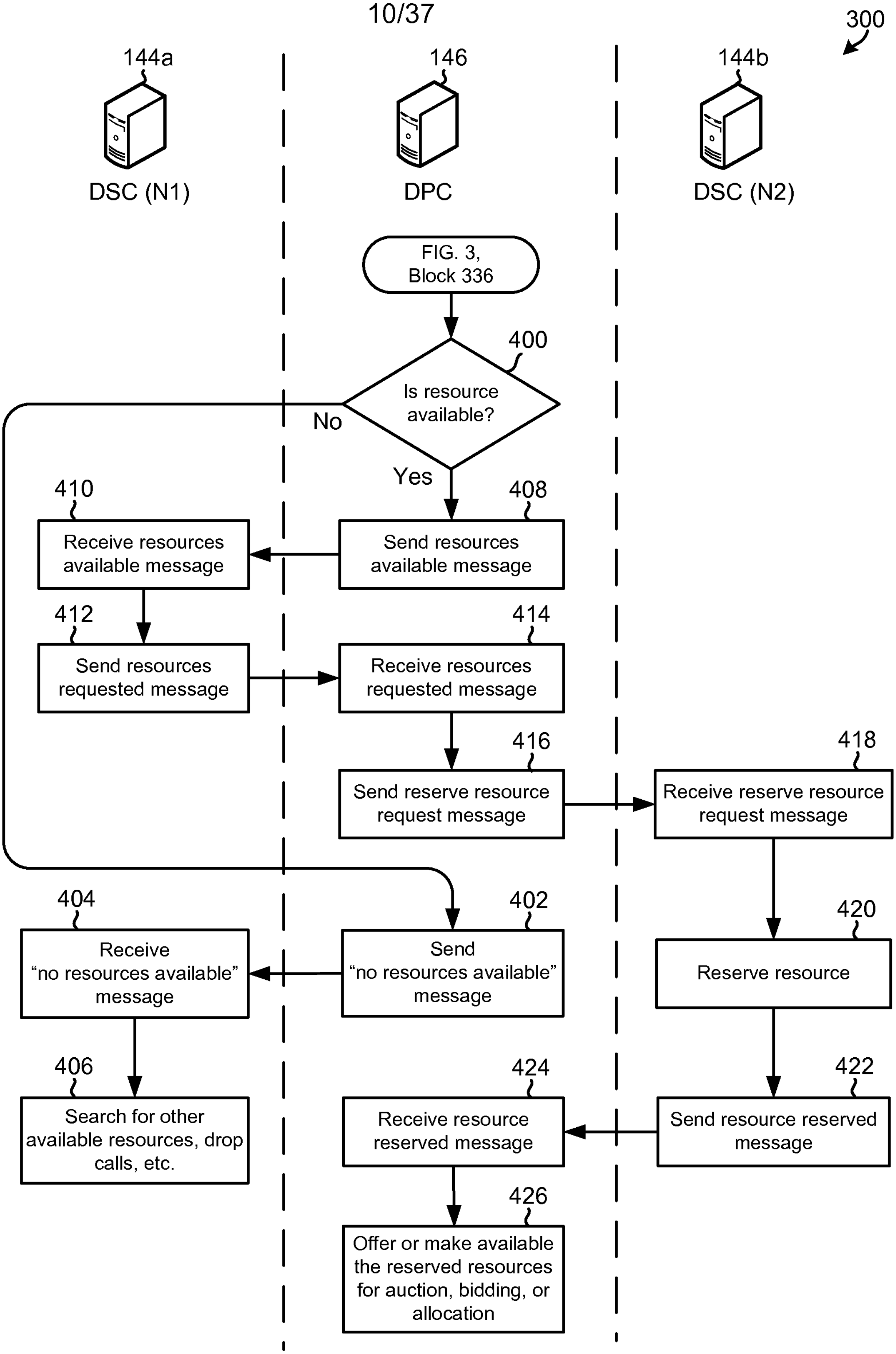

300
144a
146
144b
DSC (N1)
DPC
DSC (N2)
FIG. 3, Block 336
400
Is resource available?
No
Yes
410
Receive resources available message
408
Send resources available message
412
Send resources requested message
414
Receive resources requested message
416
Send reserve resource request message
418
Receive reserve resource request message
404
Receive "no resources available" message
402
Send "no resources available" message
420
Reserve resource
406
Search for other available resources, drop calls, etc.
424
Receive resource reserved message
422
Send resource reserved message
426
Offer or make available the reserved resources for auction, bidding, or allocation

FIG. 4

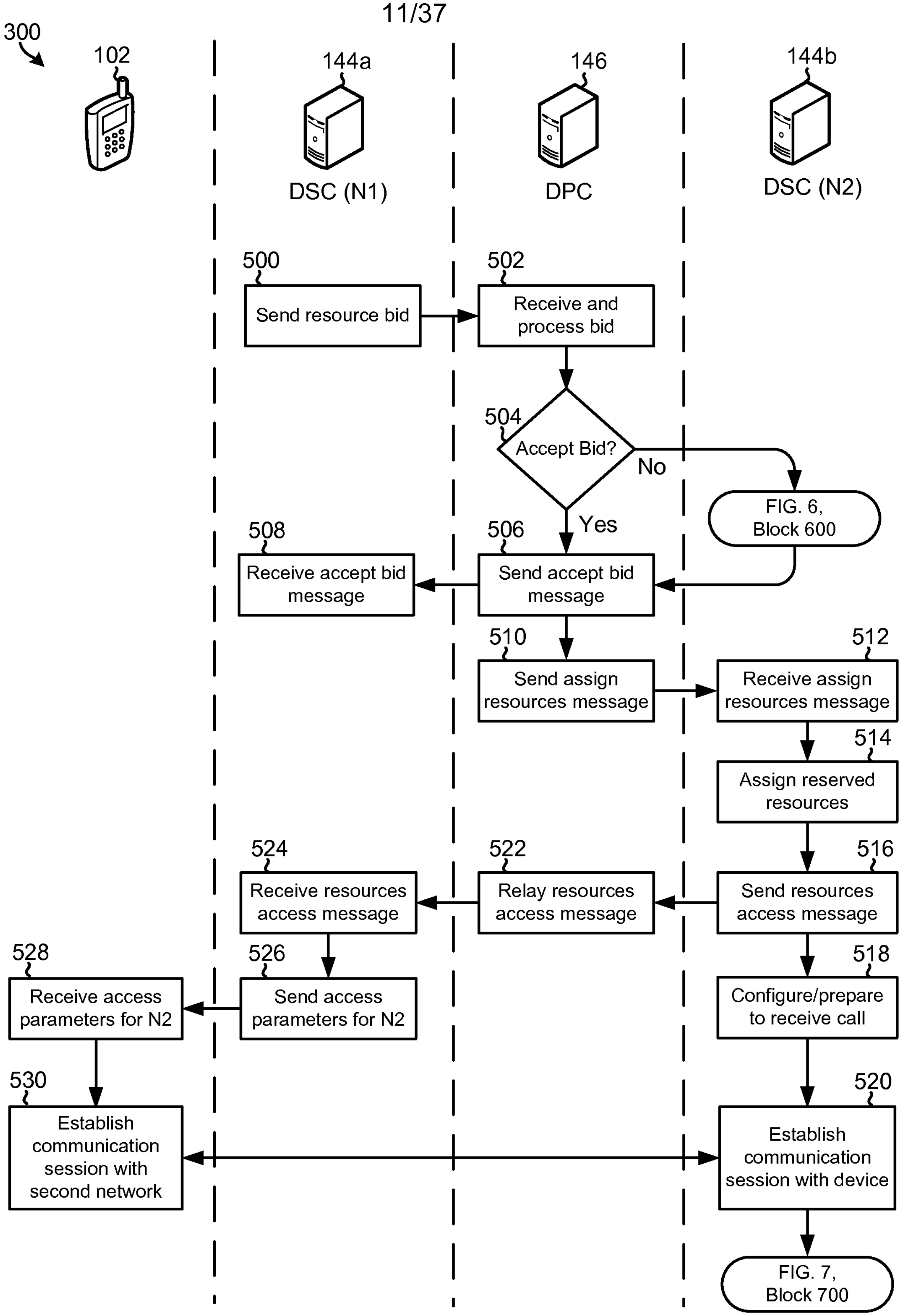

300
102
144a
DSC (N1)
146
DPC
144b
DSC (N2)
500
Send resource bid
502
Receive and process bid
504
Accept Bid?
No
FIG. 6, Block 600
Yes
506
Send accept bid message
508
Receive accept bid message
510
Send assign resources message
512
Receive assign resources message
514
Assign reserved resources
516
Send resources access message
522
Relay resources access message
524
Receive resources access message
526
Send access parameters for N2
528
Receive access parameters for N2
518
Configure/prepare to receive call
530
Establish communication session with second network
520
Establish communication session with device
FIG. 7, Block 700

FIG. 5

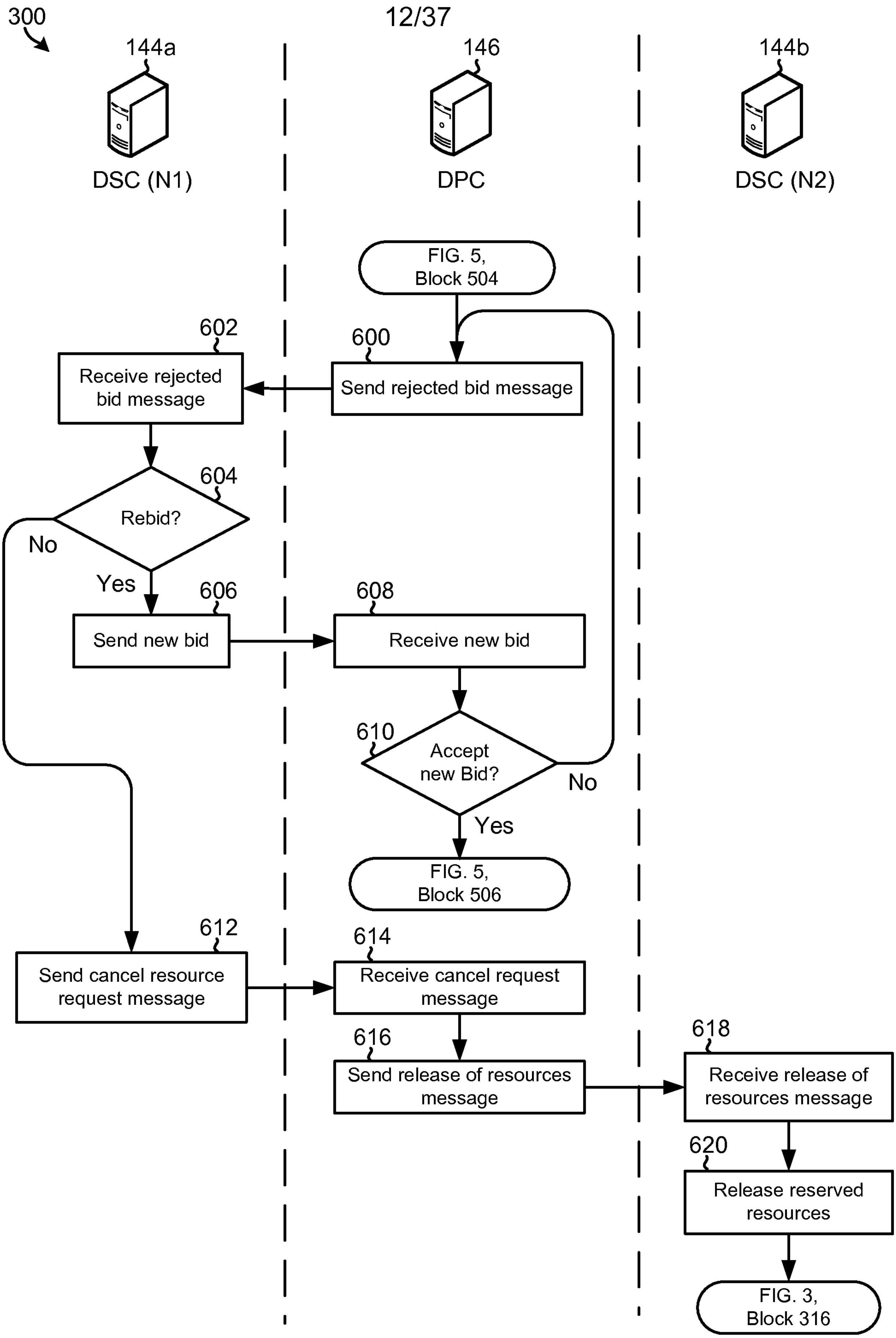
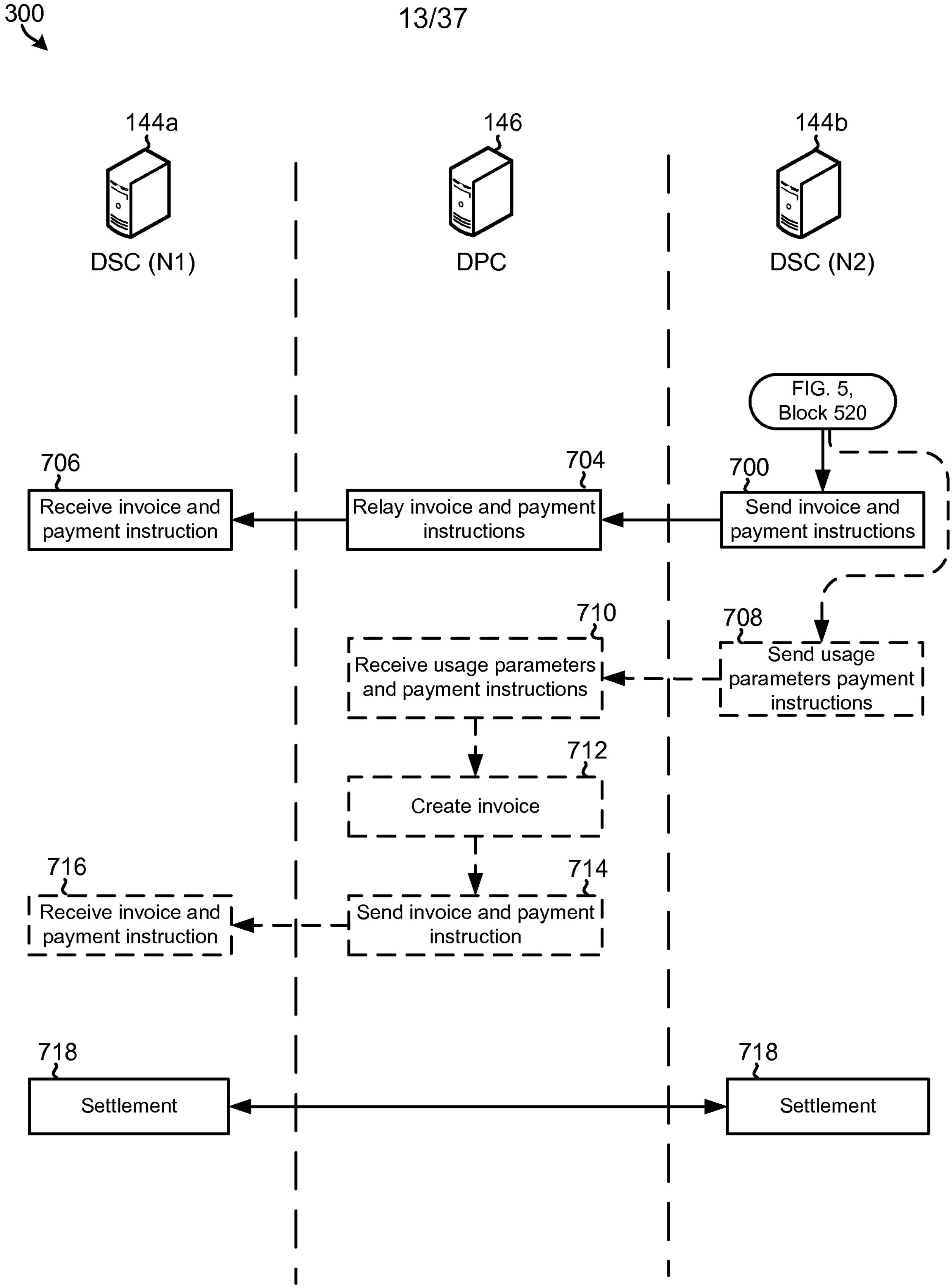

300
144a
DSC (N1)
146
DPC
144b
DSC (N2)
FIG. 5, Block 504
600
Send rejected bid message
602
Receive rejected bid message
604
Rebid?
No
Yes
606
Send new bid
608
Receive new bid
610
Accept new Bid?
No
Yes
FIG. 5, Block 506
612
Send cancel resource request message
614
Receive cancel request message
616
Send release of resources message
618
Receive release of resources message
620
Release reserved resources
FIG. 3, Block 316

FIG. 6



300
144a
146
144b
DSC (N1)
DPC
DSC (N2)
FIG. 5, Block 520
706
Receive invoice and payment instruction
704
Relay invoice and payment instructions
700
Send invoice and payment instructions
710
Receive usage parameters and payment instructions
708
Send usage parameters payment instructions
712
Create invoice
716
Receive invoice and payment instruction
714
Send invoice and payment instruction
718
Settlement
718
Settlement

FIG. 7

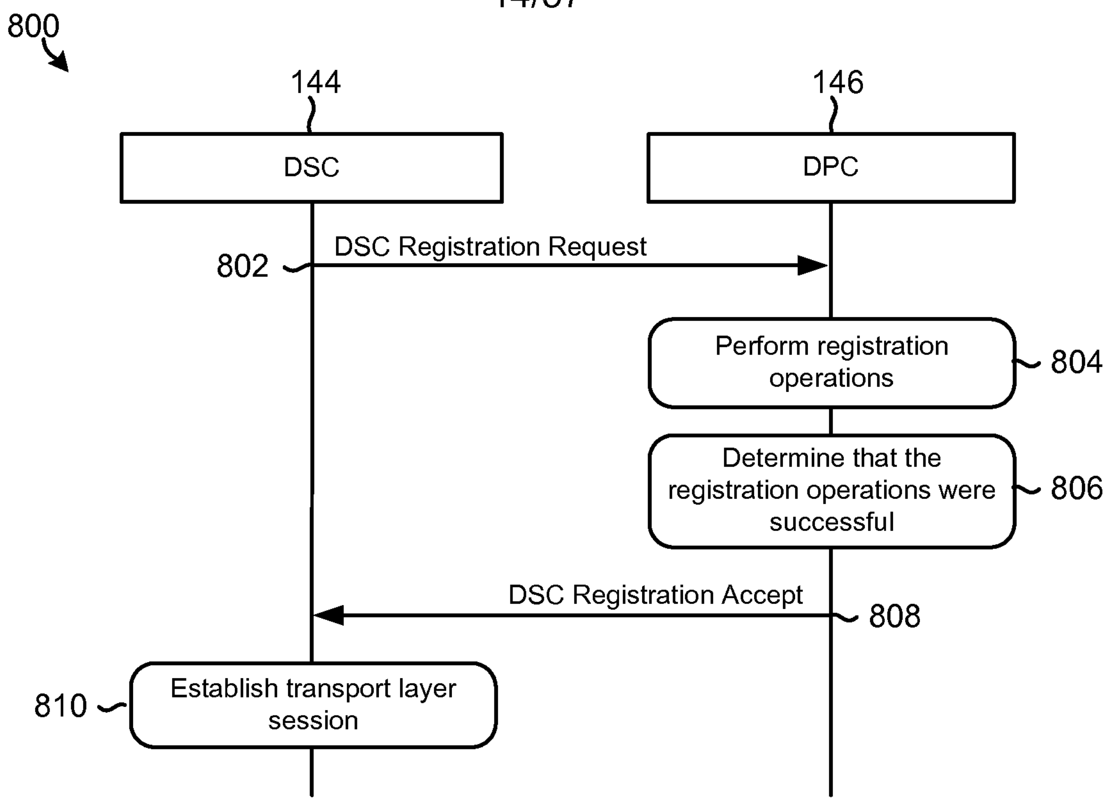

800
144
146
DSC
DPC
802
DSC Registration Request
Perform registration operations
804
Determine that the registration operations were successful
806
DSC Registration Accept
808
810
Establish transport layer session

FIG. 8A

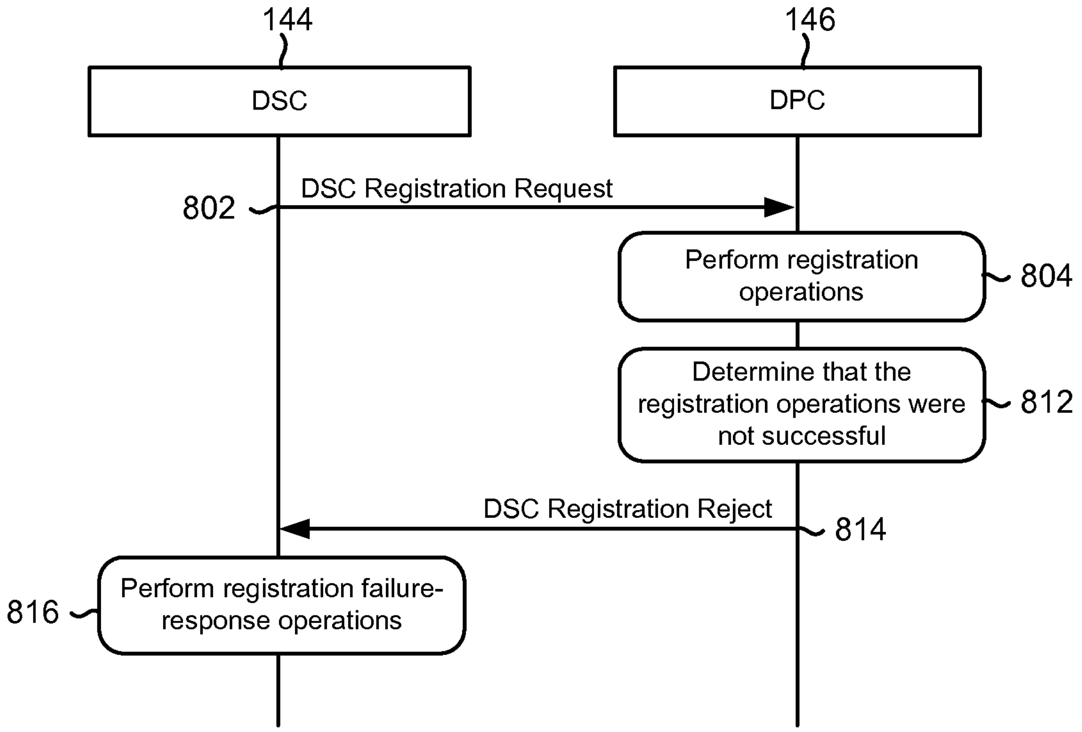

144
146
DSC
DPC
802
DSC Registration Request
Perform registration operations
804
Determine that the registration operations were not successful
812
DSC Registration Reject
814
816
Perform registration failure-response operations

FIG. 8B

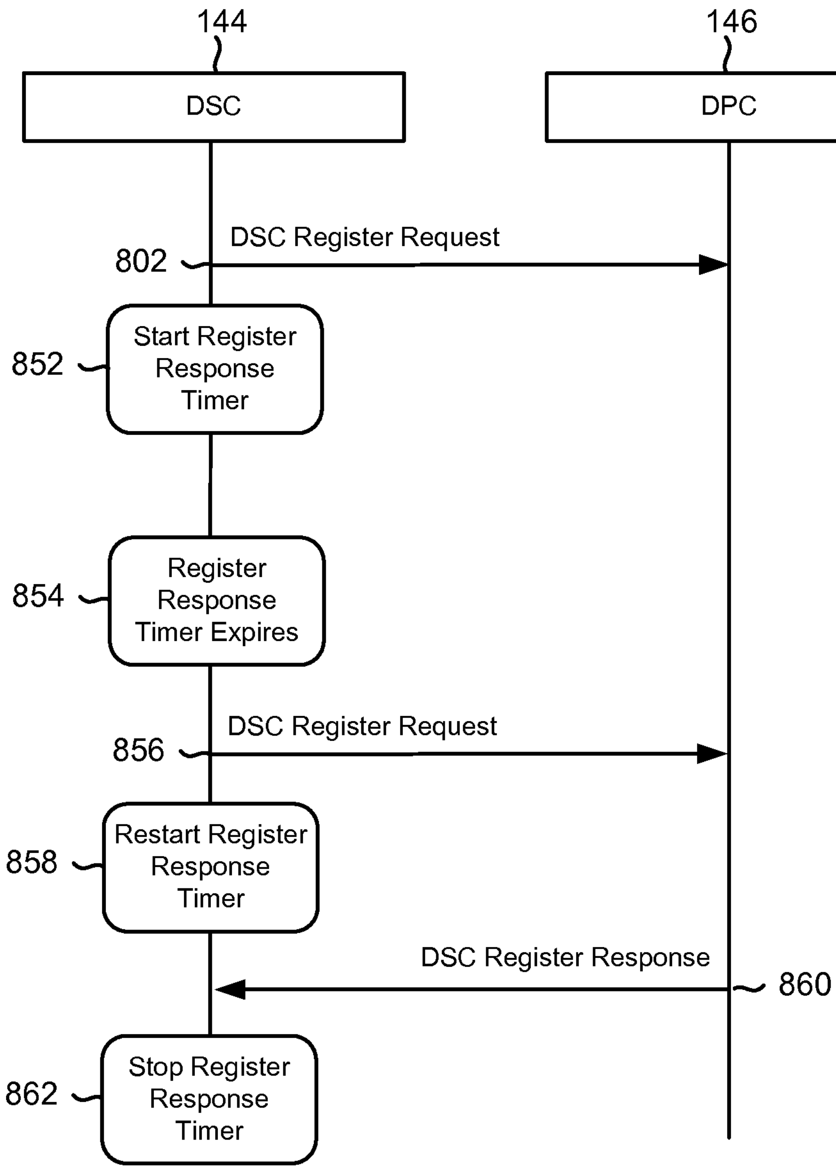
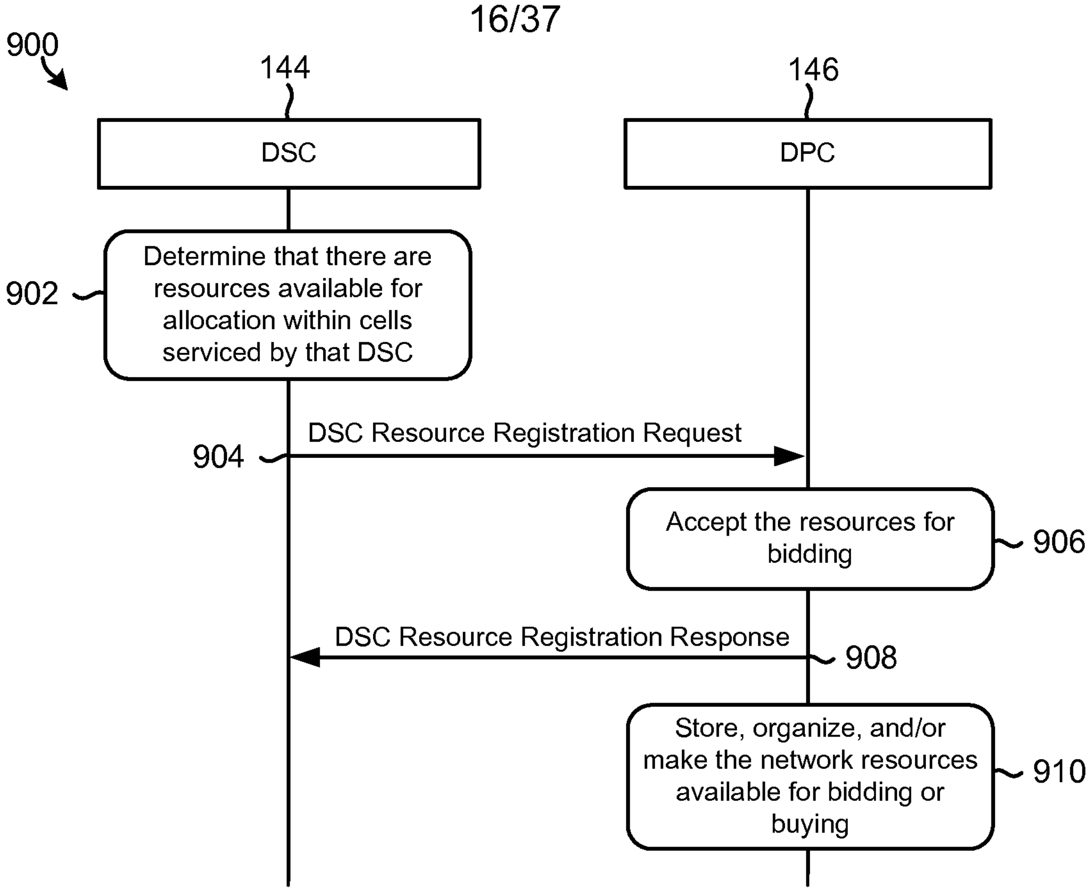
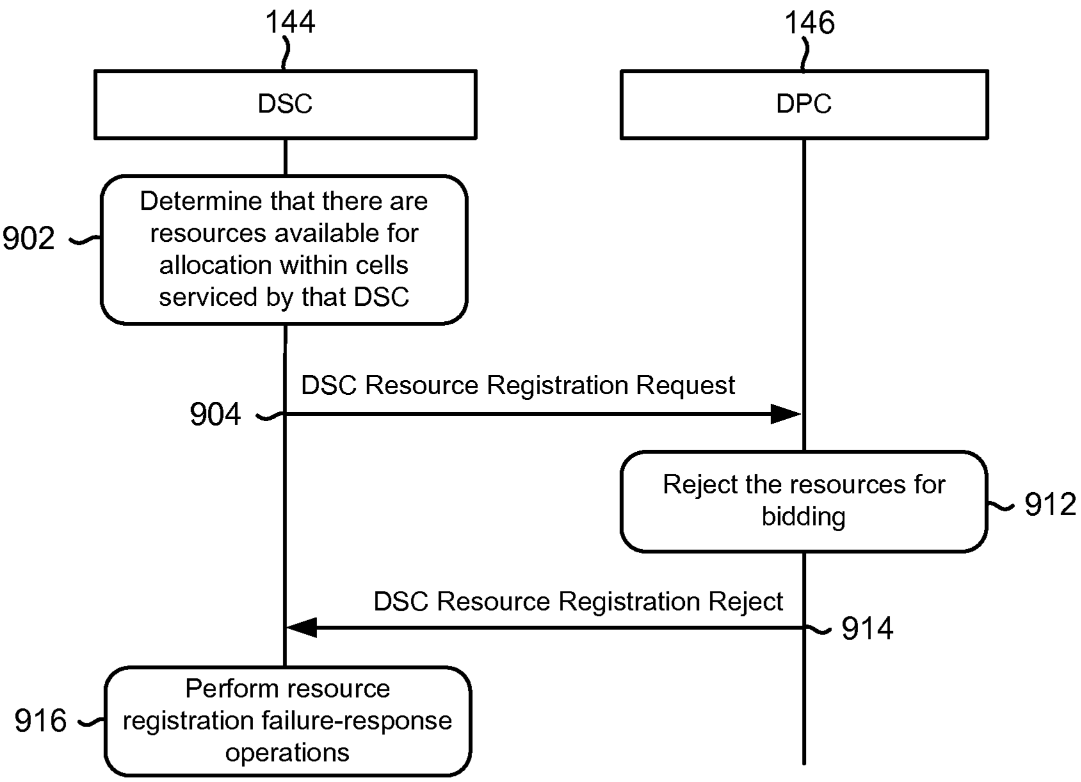

144
146
DSC
DPC
DSC Register Request
802
Start Register Response Timer
852
Register Response Timer Expires
854
DSC Register Request
856
Restart Register Response Timer
858
DSC Register Response
860
Stop Register Response Timer
862

FIG. 8C



900
144
DSC
146
DPC
902
Determine that there are resources available for allocation within cells serviced by that DSC
904
DSC Resource Registration Request
Accept the resources for bidding
906
DSC Resource Registration Response
908
Store, organize, and/or make the network resources available for bidding or buying
910

FIG. 9A



144
DSC
146
DPC
902
Determine that there are resources available for allocation within cells serviced by that DSC
904
DSC Resource Registration Request
Reject the resources for bidding
912
DSC Resource Registration Reject
914
916
Perform resource registration failure-response operations

FIG. 9B

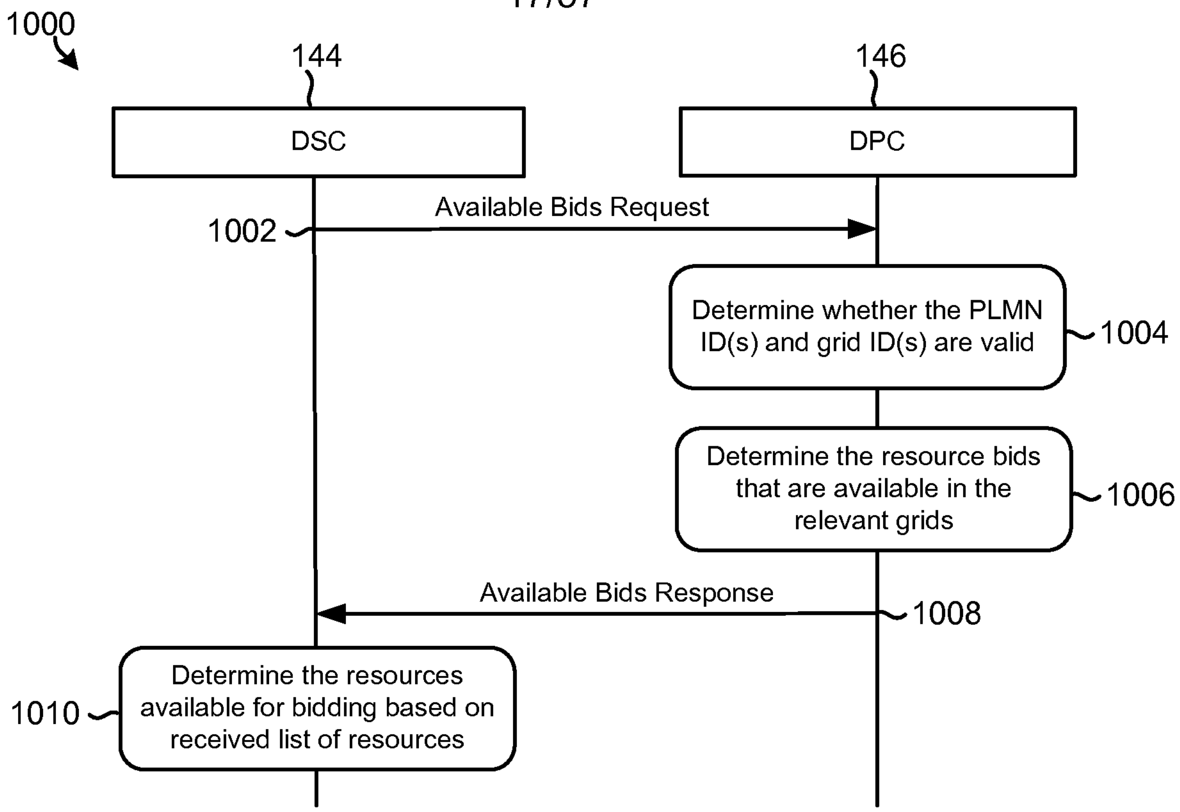


FIG. 10A

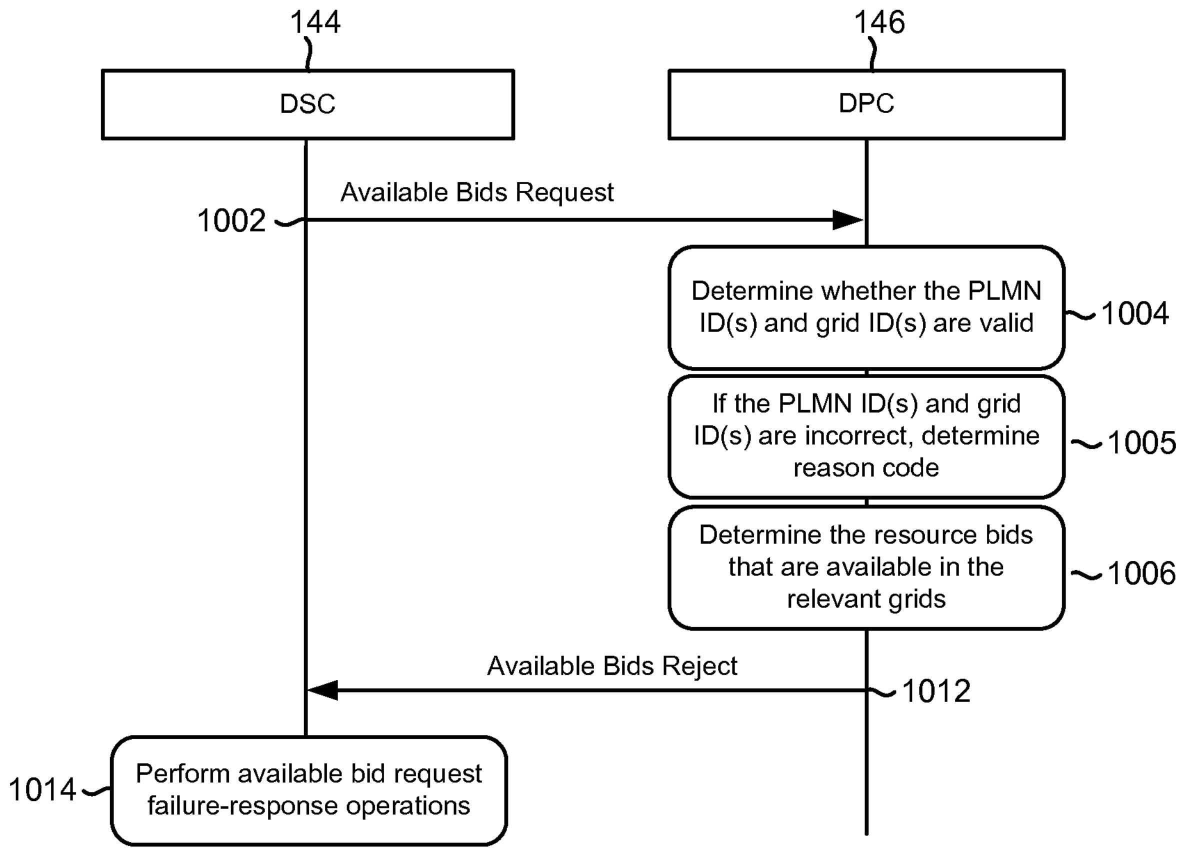


FIG. 10B

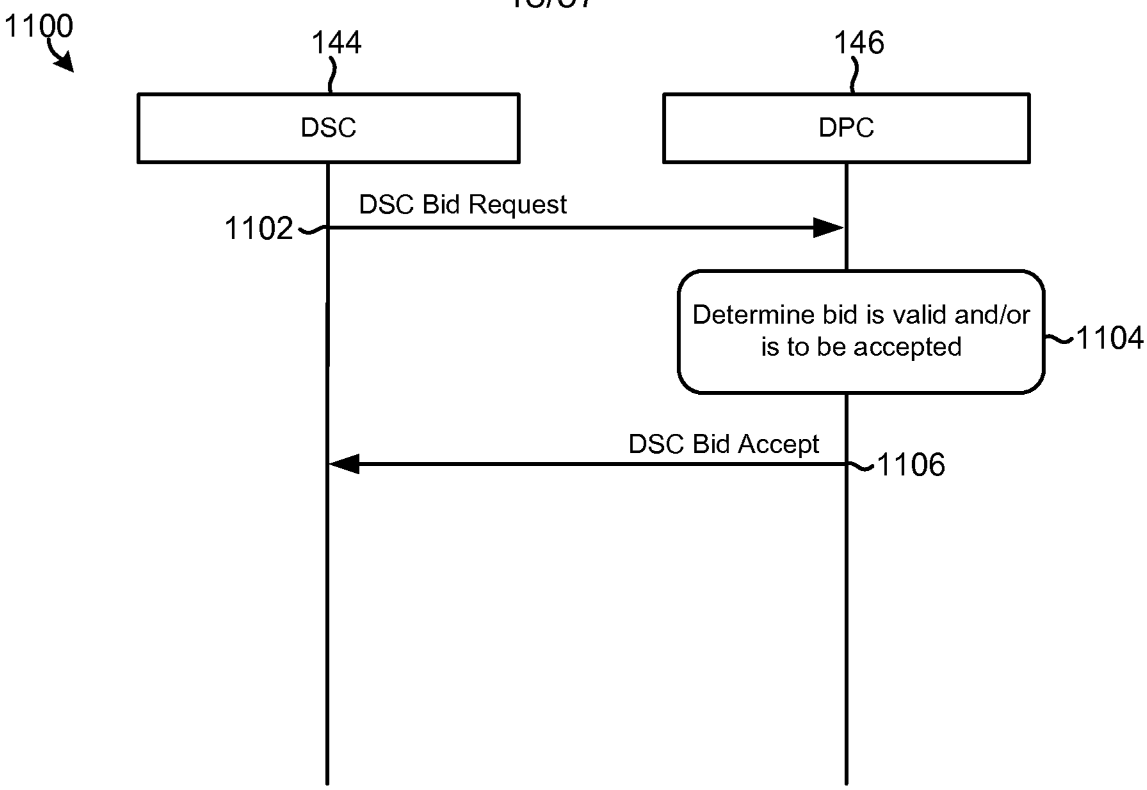


FIG. 11A

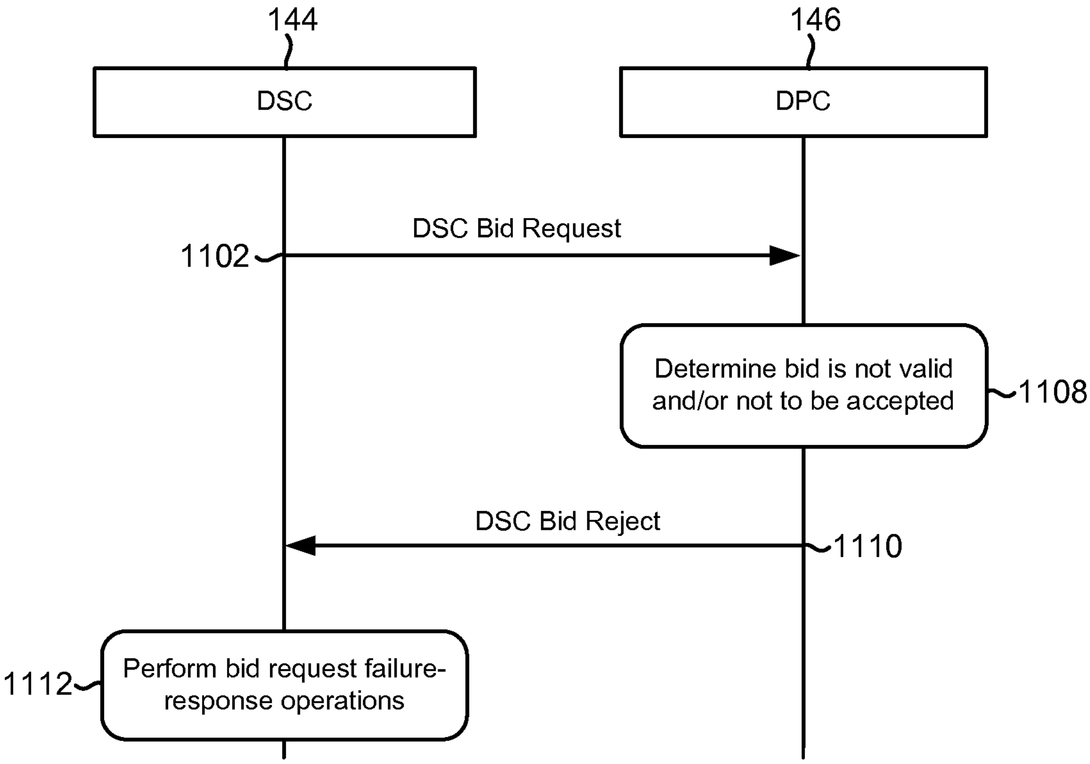


FIG. 11B

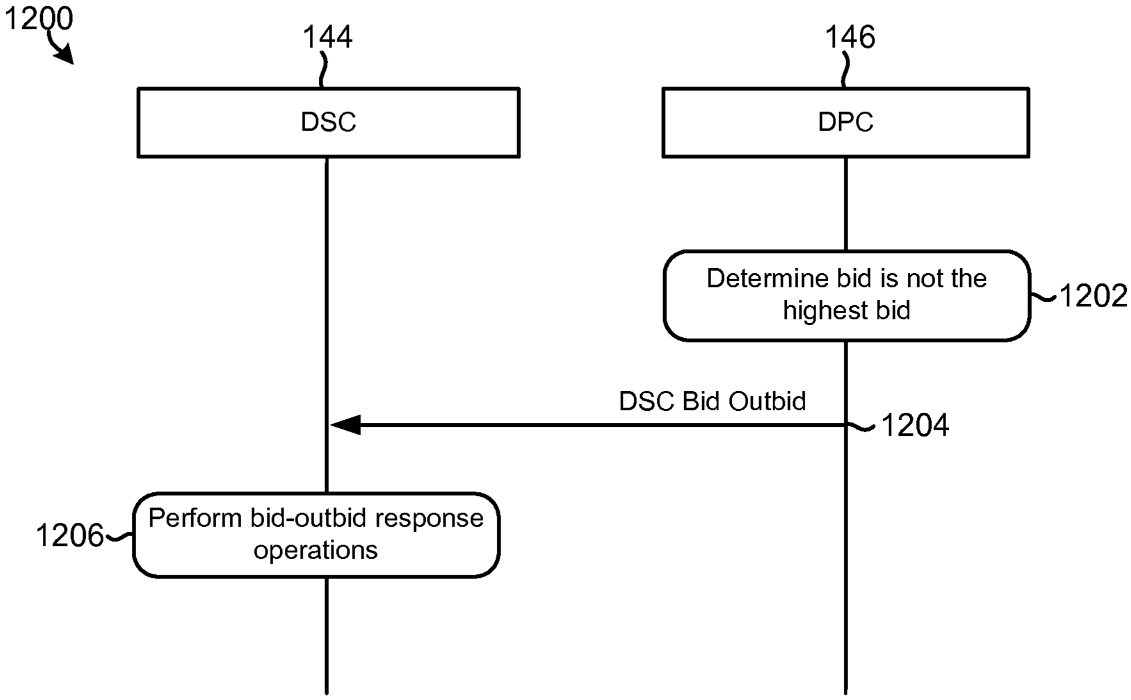


FIG. 12A

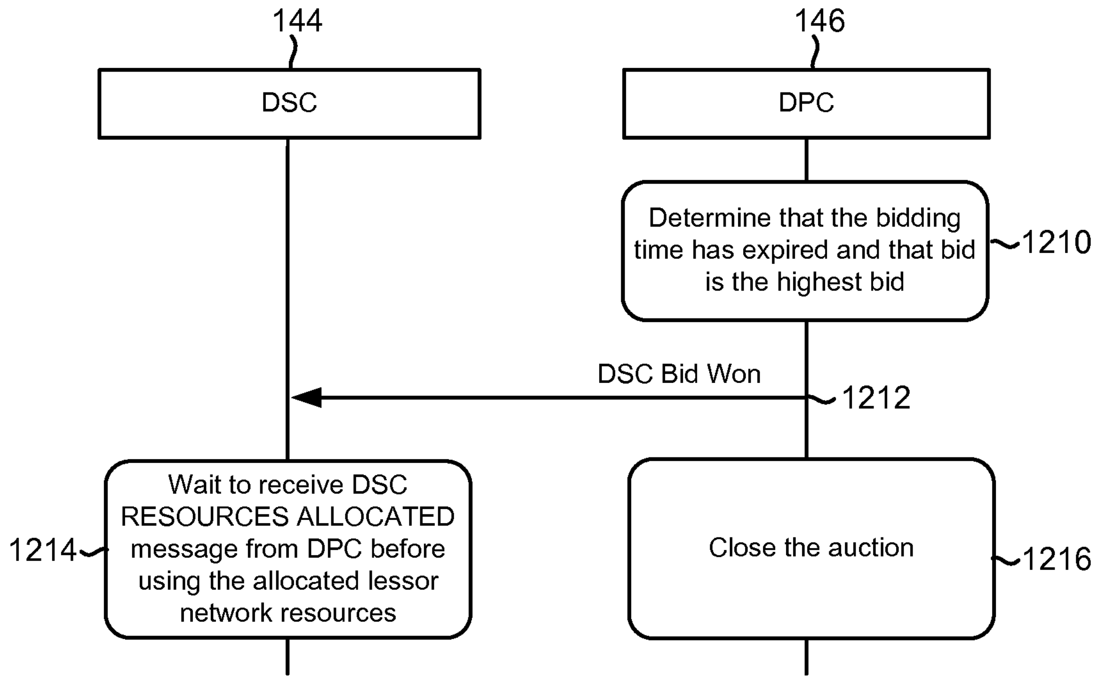


FIG. 12B

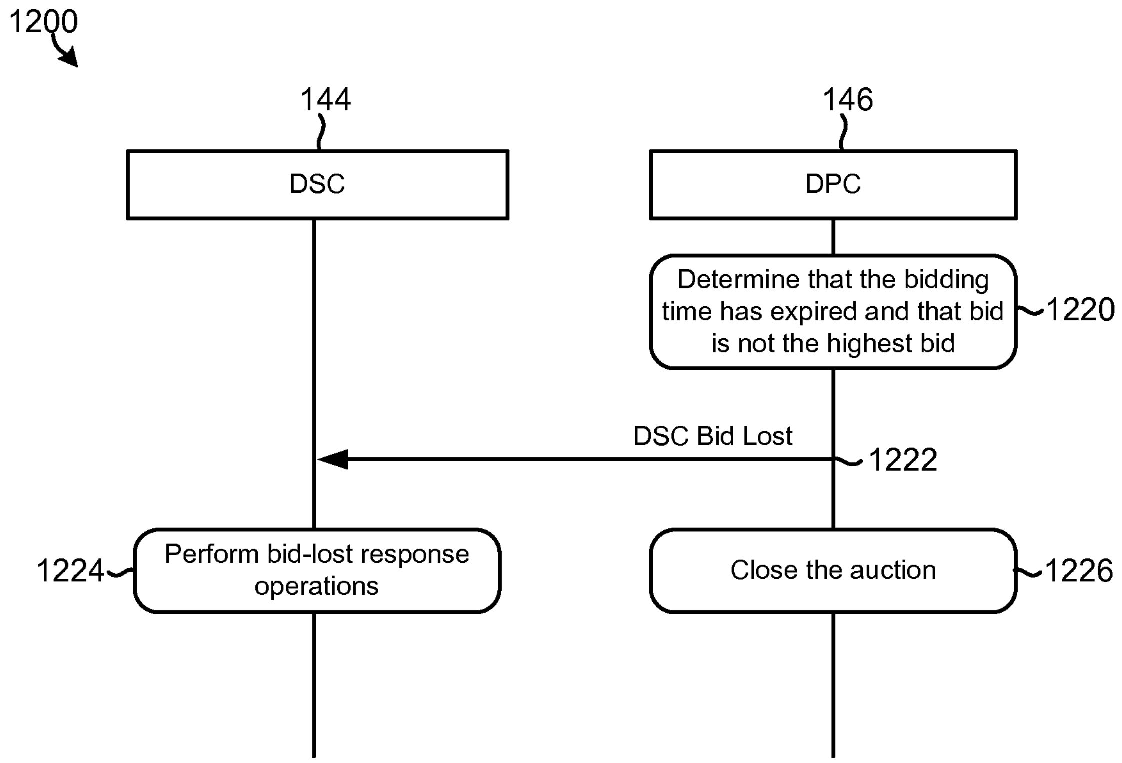


FIG. 12C

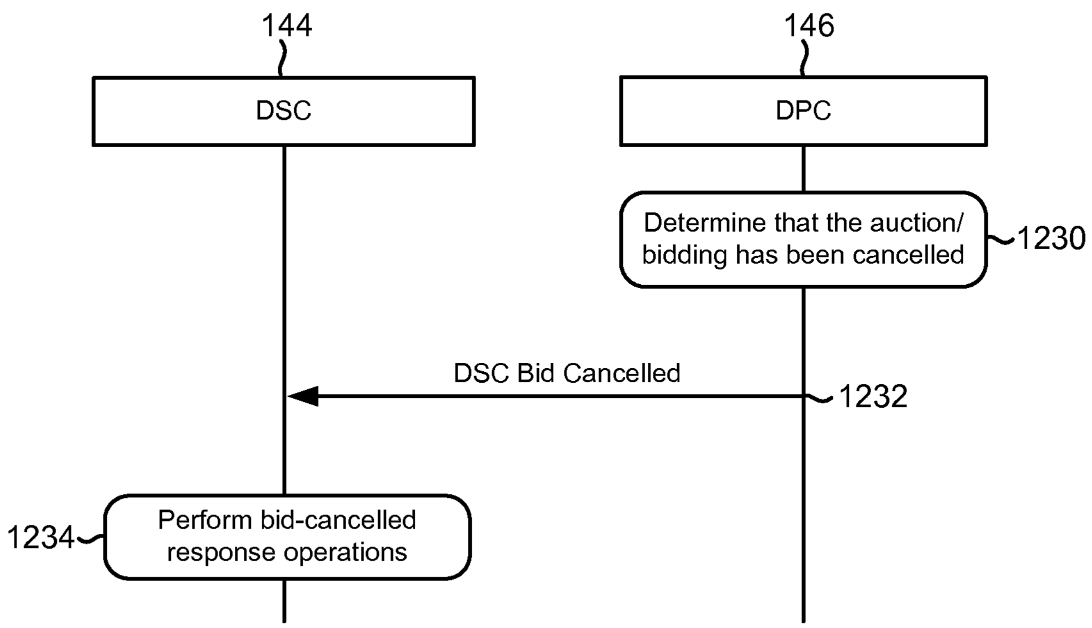


FIG. 12D

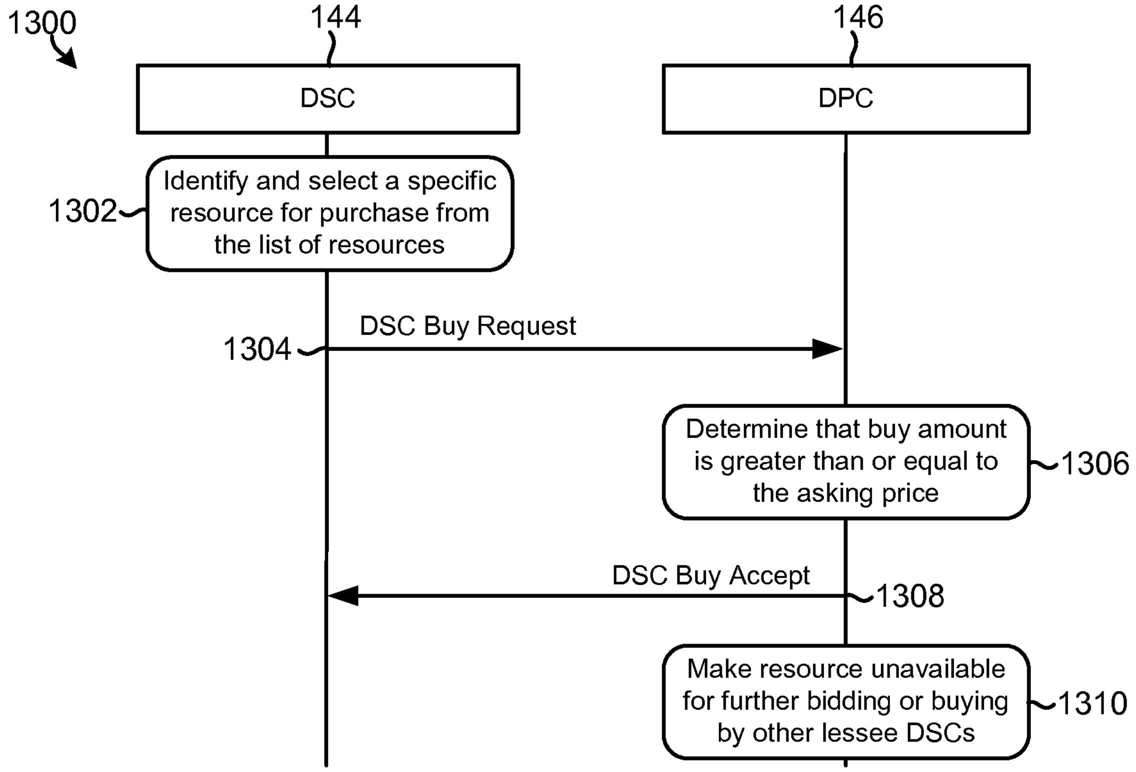


FIG. 13A

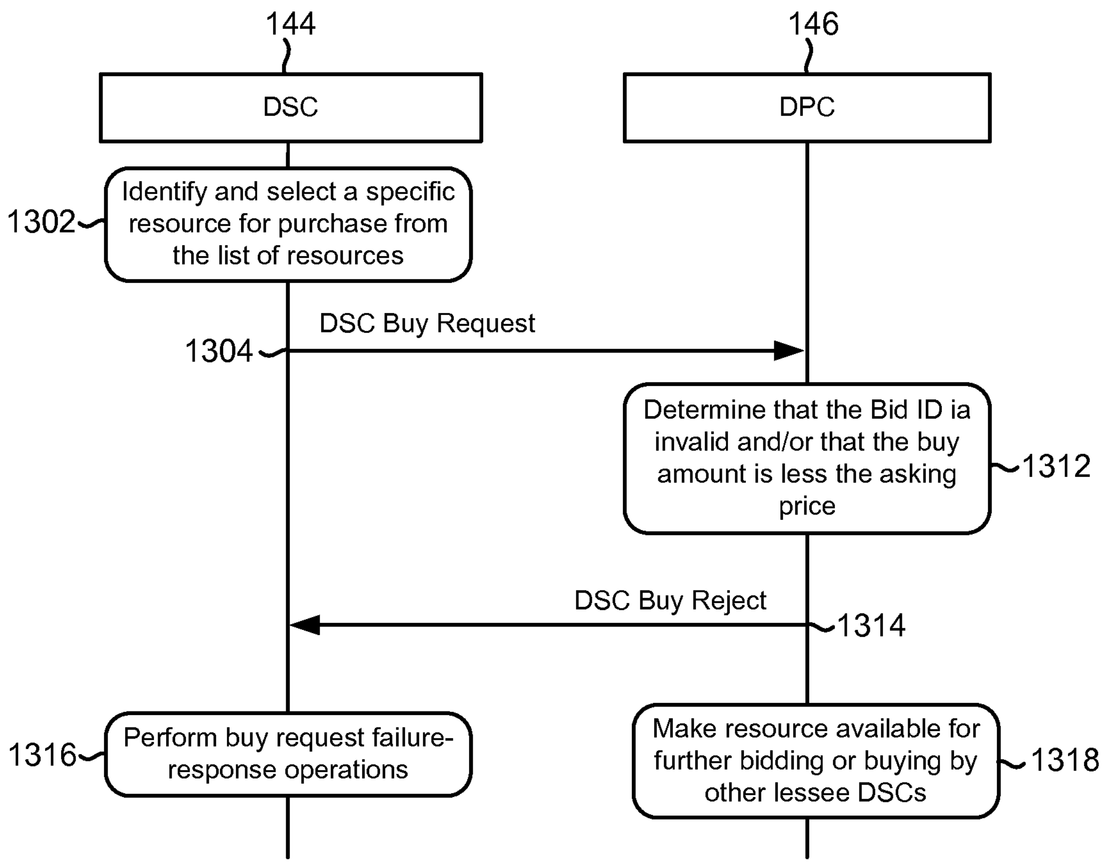


FIG. 13B

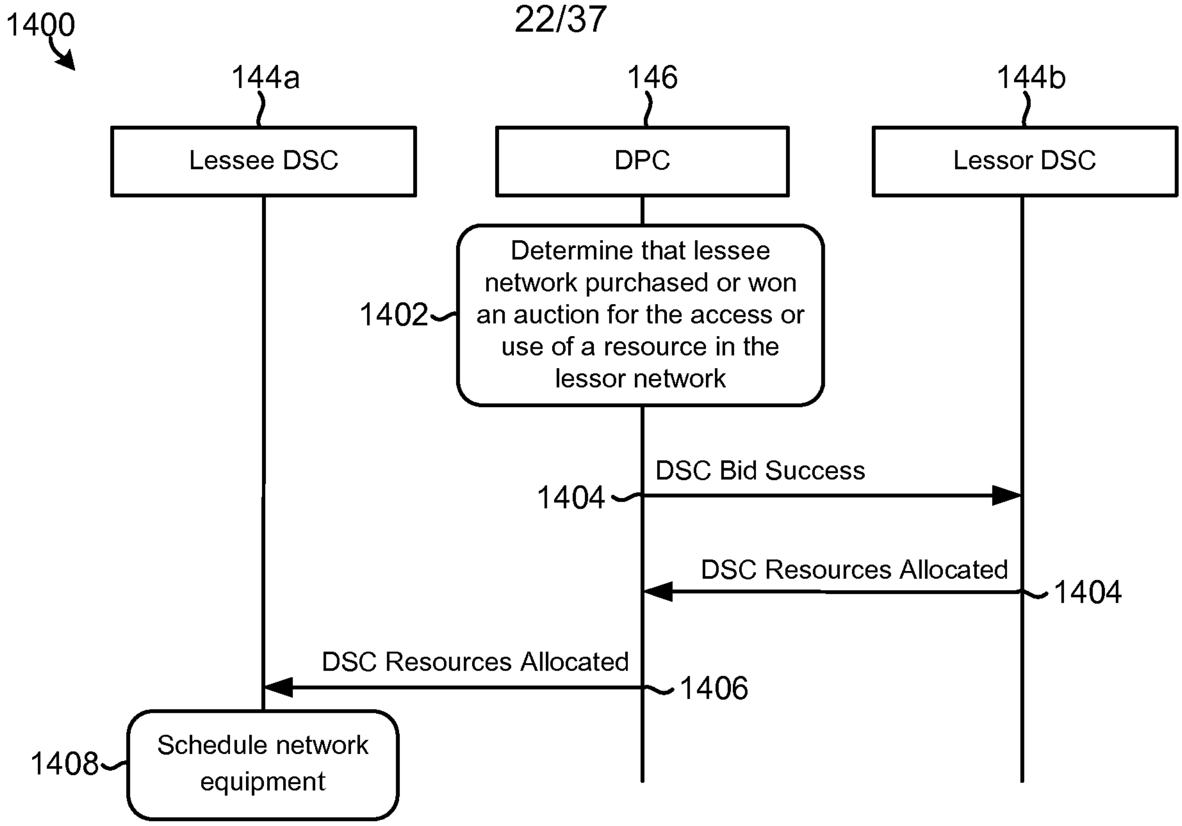


FIG. 14A

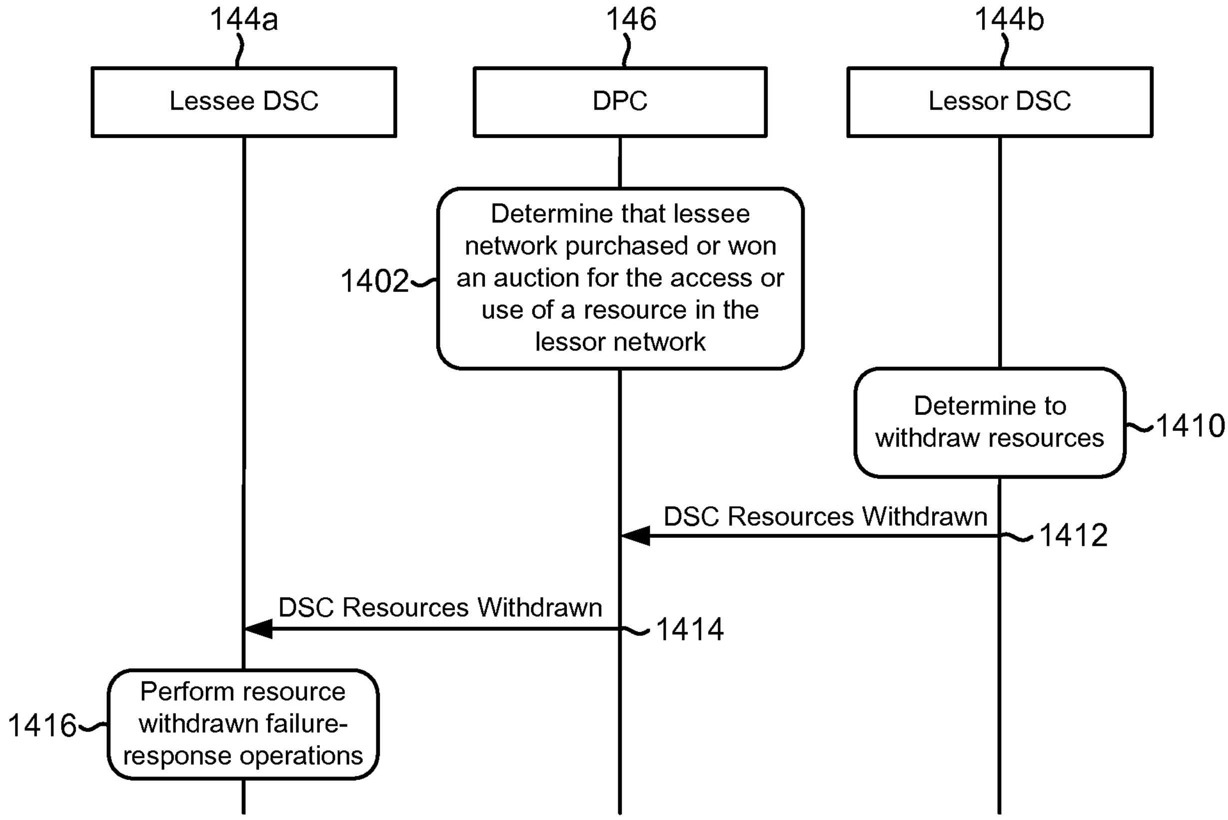


FIG. 14B

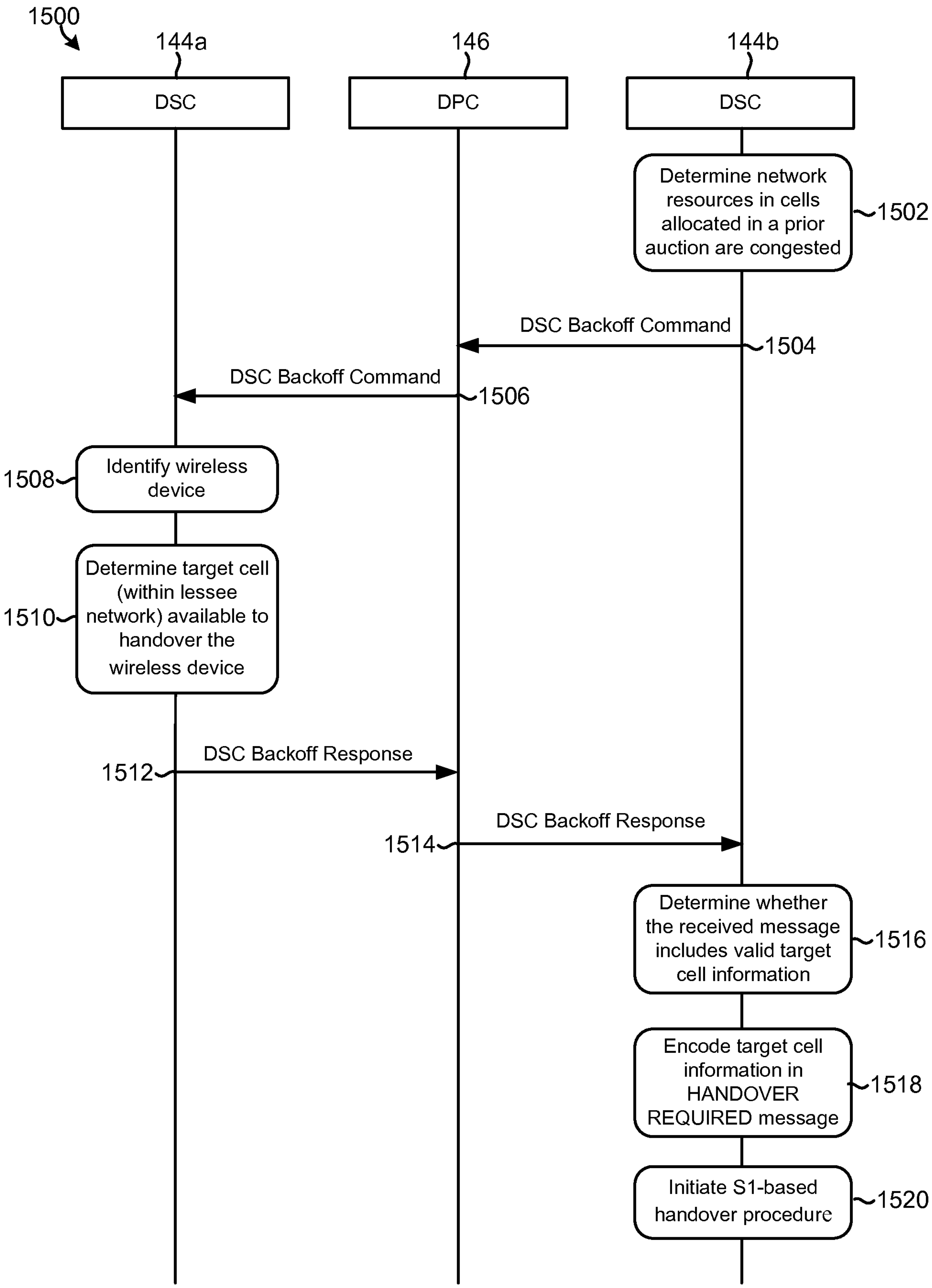
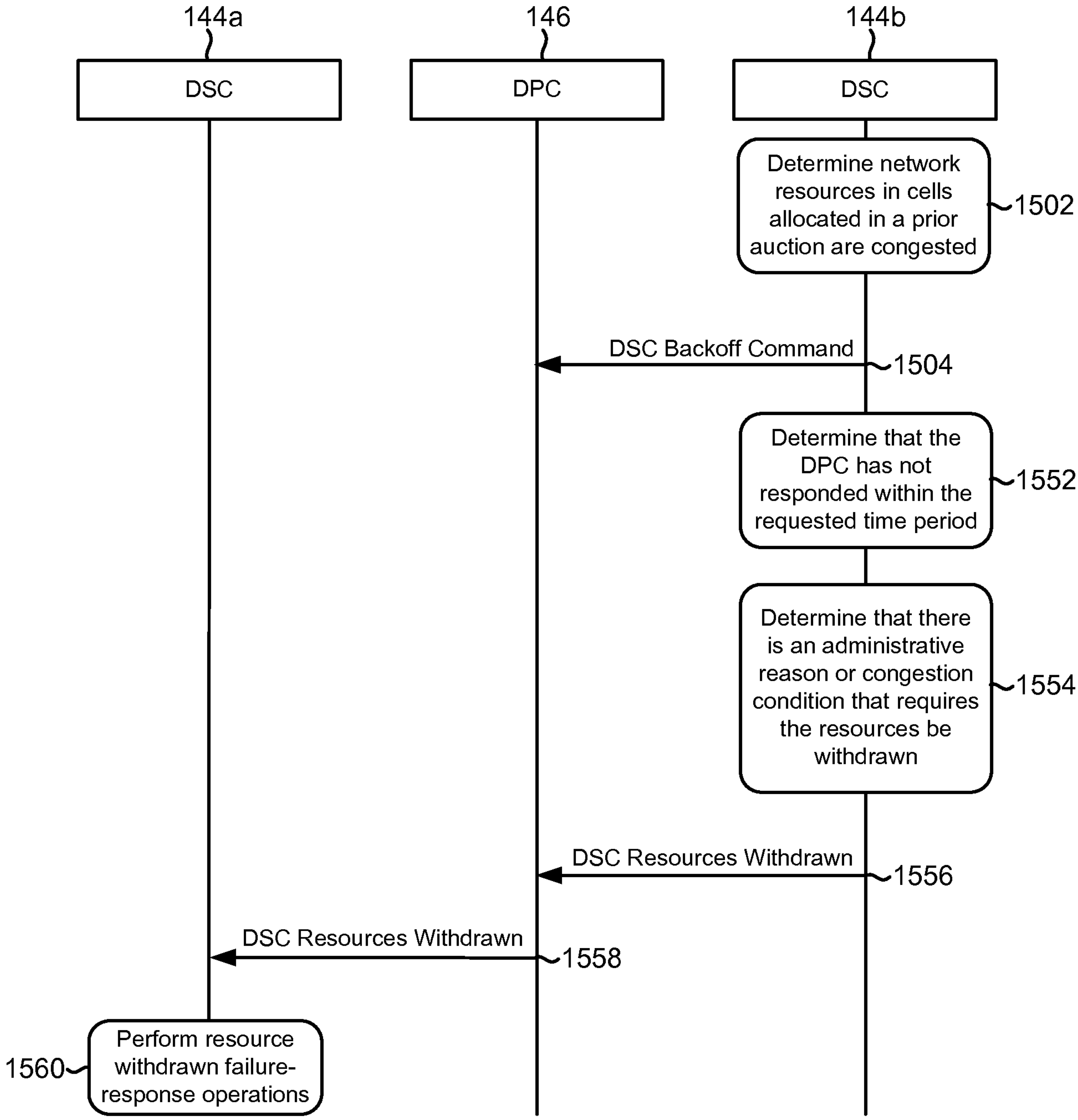

1500
144a
146
144b
DSC
DPC
DSC
Determine network resources in cells allocated in a prior auction are congested
1502
DSC Backoff Command
1504
DSC Backoff Command
1506
1508
Identify wireless device
1510
Determine target cell (within lessee network) available to handover the wireless device
DSC Backoff Response
1512
DSC Backoff Response
1514
Determine whether the received message includes valid target cell information
1516
Encode target cell information in HANDOVER REQUIRED message
1518
Initiate S1-based handover procedure
1520

FIG. 15A



144a
146
144b
DSC
DPC
DSC
Determine network resources in cells allocated in a prior auction are congested
1502
DSC Backoff Command
1504
Determine that the DPC has not responded within the requested time period
1552
Determine that there is an administrative reason or congestion condition that requires the resources be withdrawn
1554
DSC Resources Withdrawn
1556
DSC Resources Withdrawn
1558
1560
Perform resource withdrawn failure-response operations

FIG. 15B

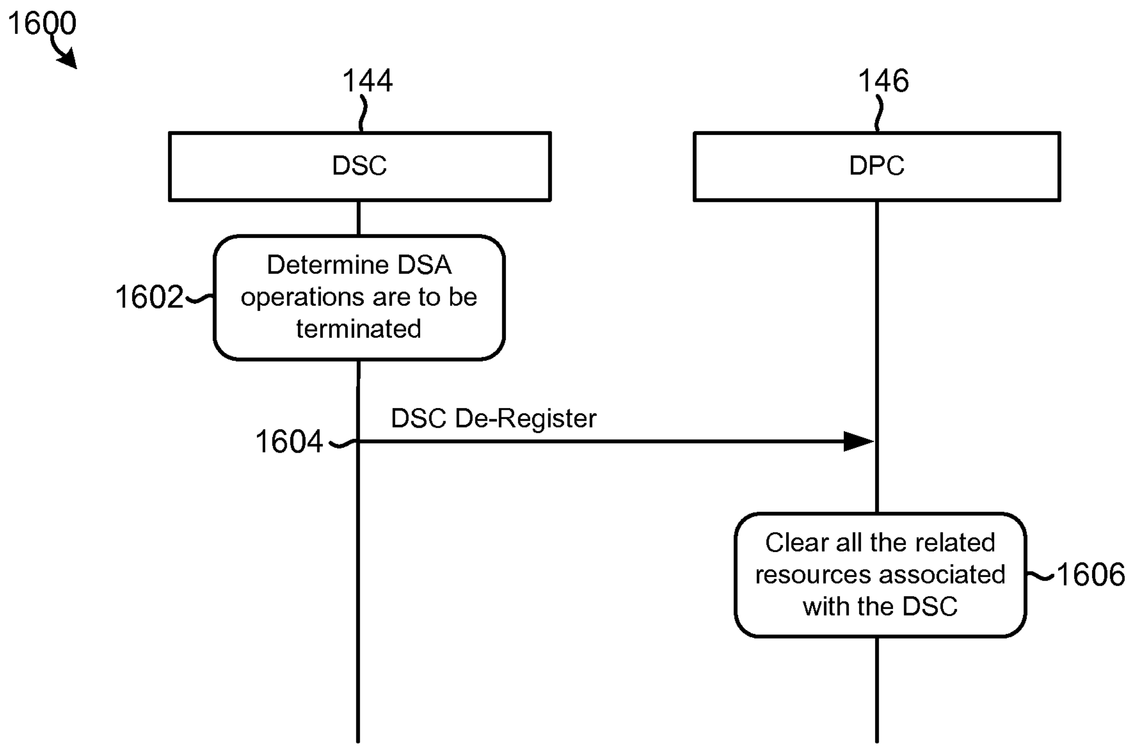


FIG. 16A

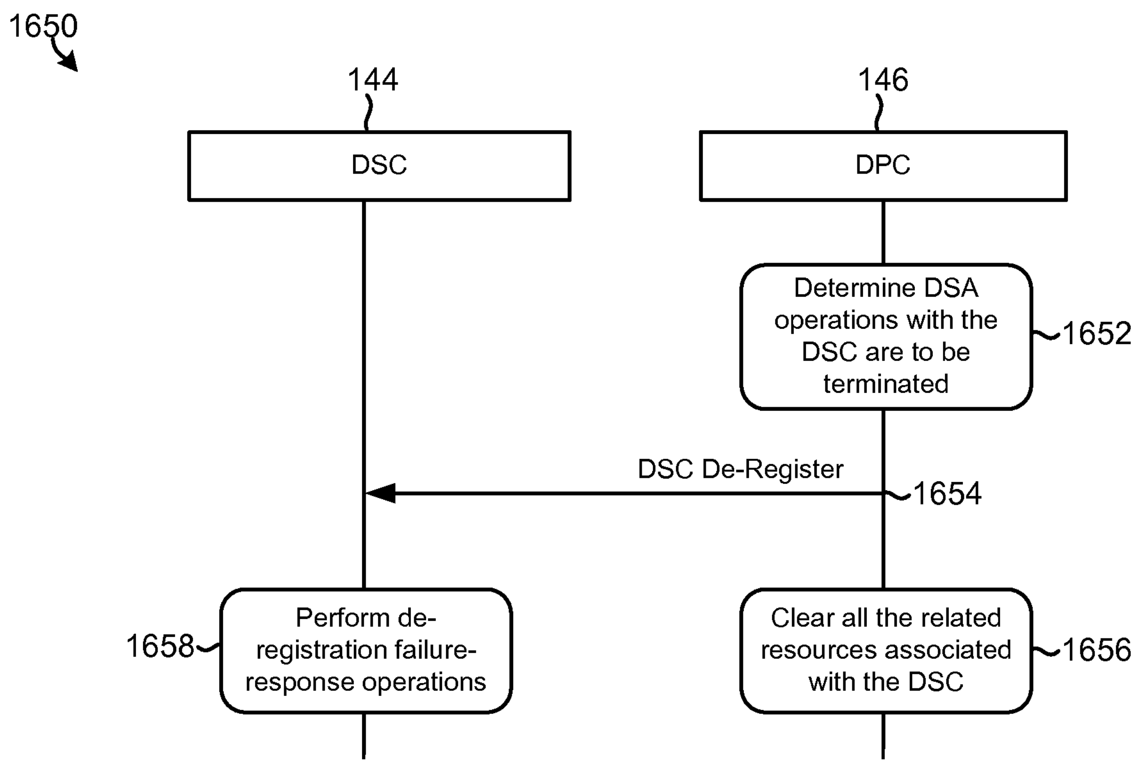


FIG. 16B

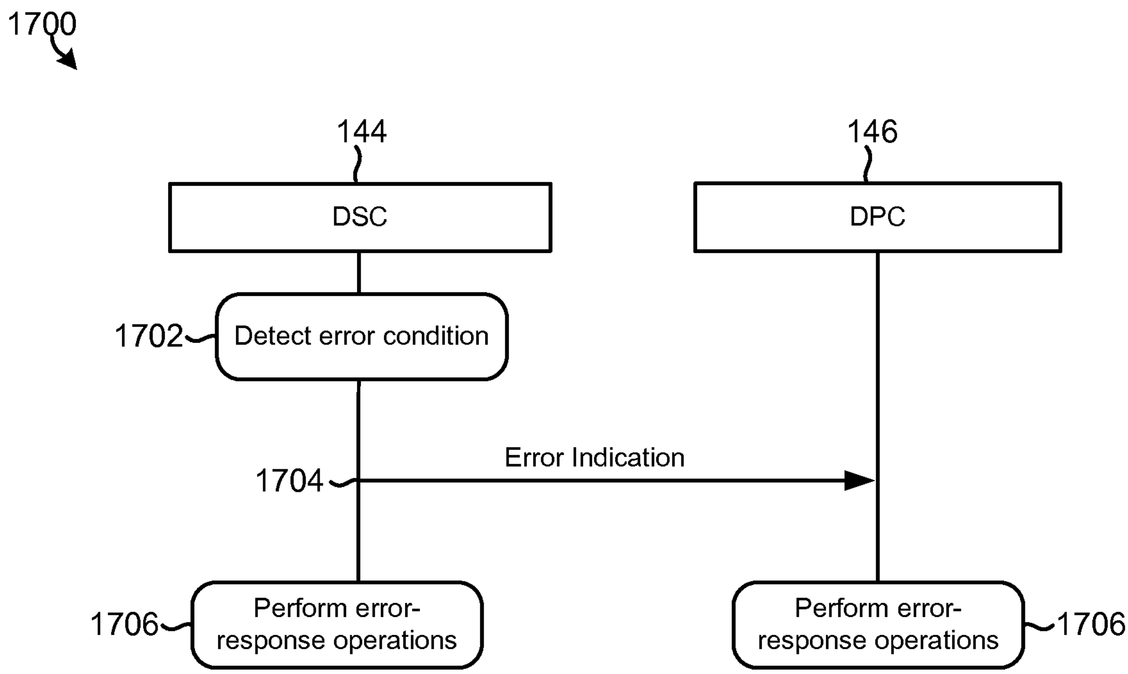


FIG. 17A

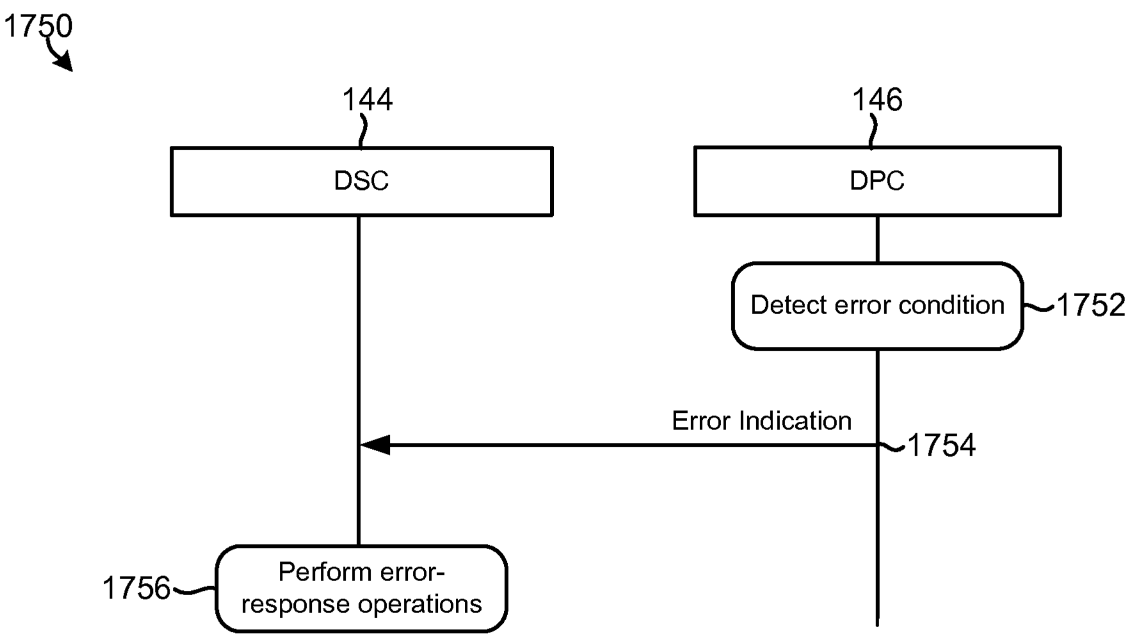


FIG. 17B

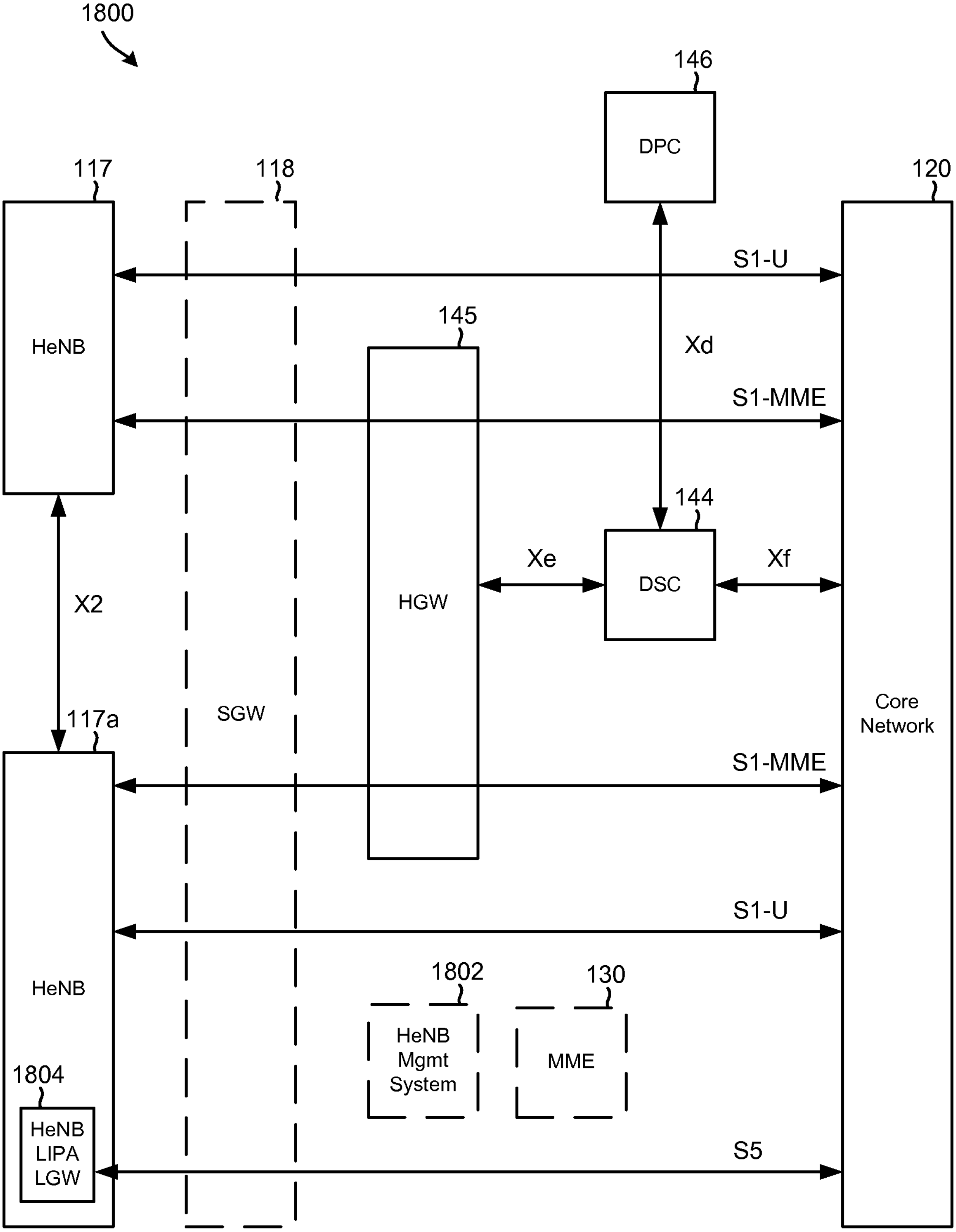

1800
146
DPC
117
118
120
S1-U
145
Xd
HeNB
S1-MME
144
Xe
Xf
DSC
HGW
X2
117a
SGW
Core
Network
S1-MME
S1-U
1802
130
HeNB
Mgmt
System
MME
HeNB
1804
HeNB
LIPA
LGW
S5

FIG. 18

Source	Target	Note
eNB or any HeNB	Open access HeNB	N/A
eNB or any HeNB	Hybrid Access HeNB	N/A
Hybrid Access HeNB or Closed Access HeNB	Closed Access HeNB	Applies for same CSG ID and PLMN, and when wireless device is a member of the CSG cell
Any HeNB	eNB	N/A

FIG. 19

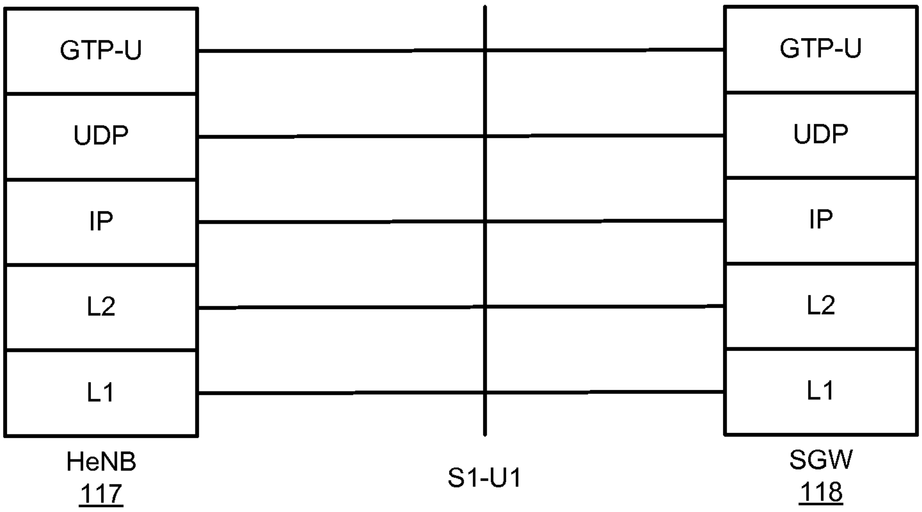


FIG. 20A

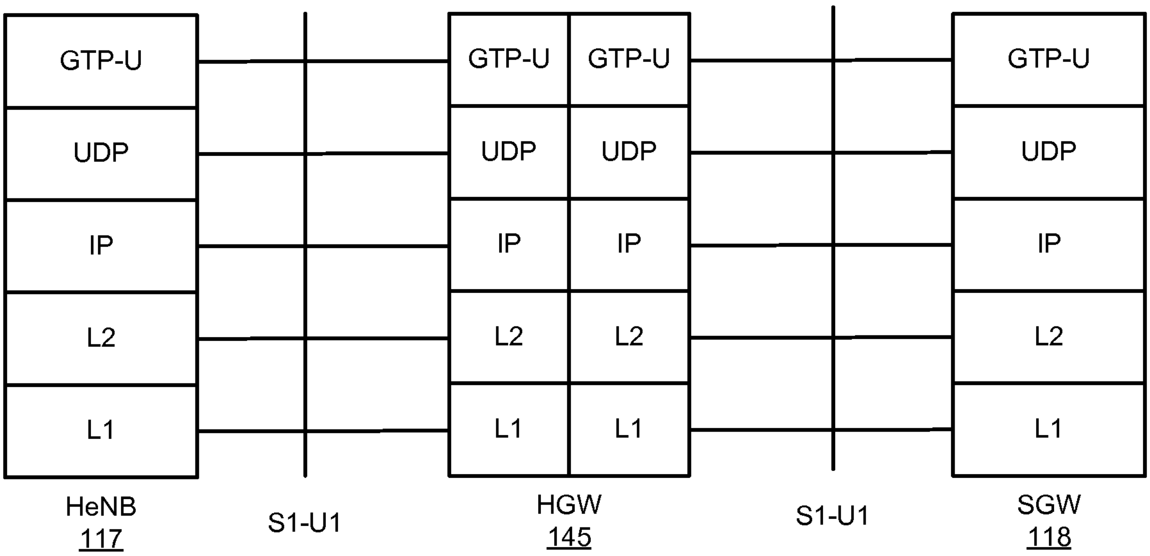


FIG. 20B

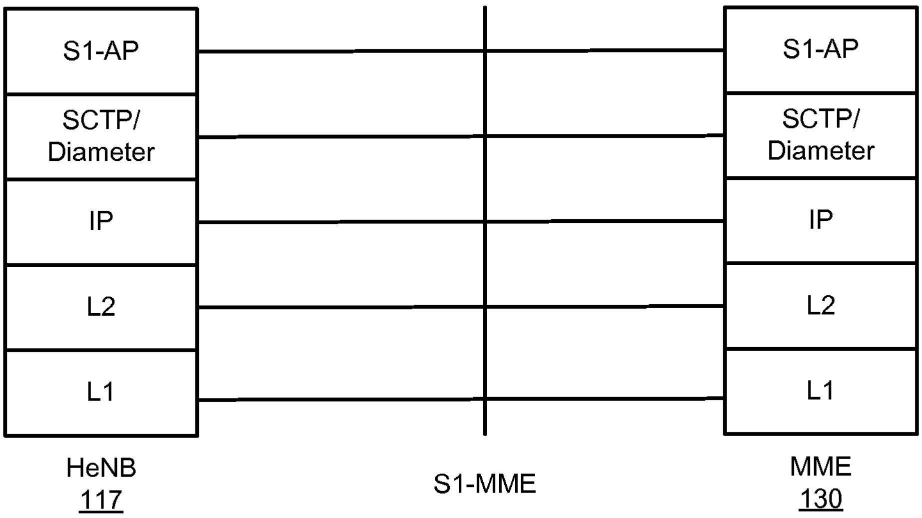


FIG. 21A

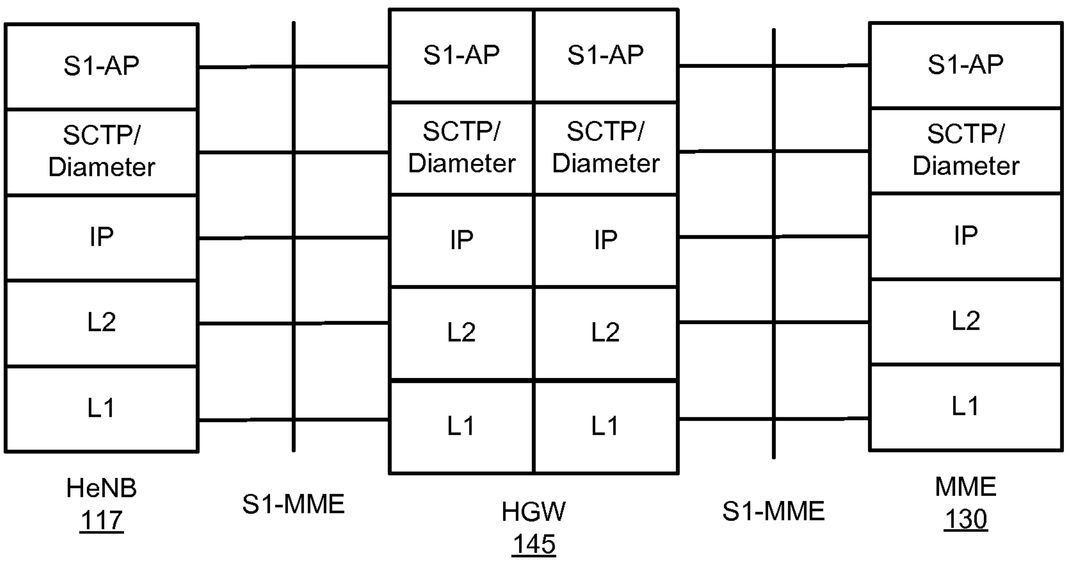


FIG. 21B

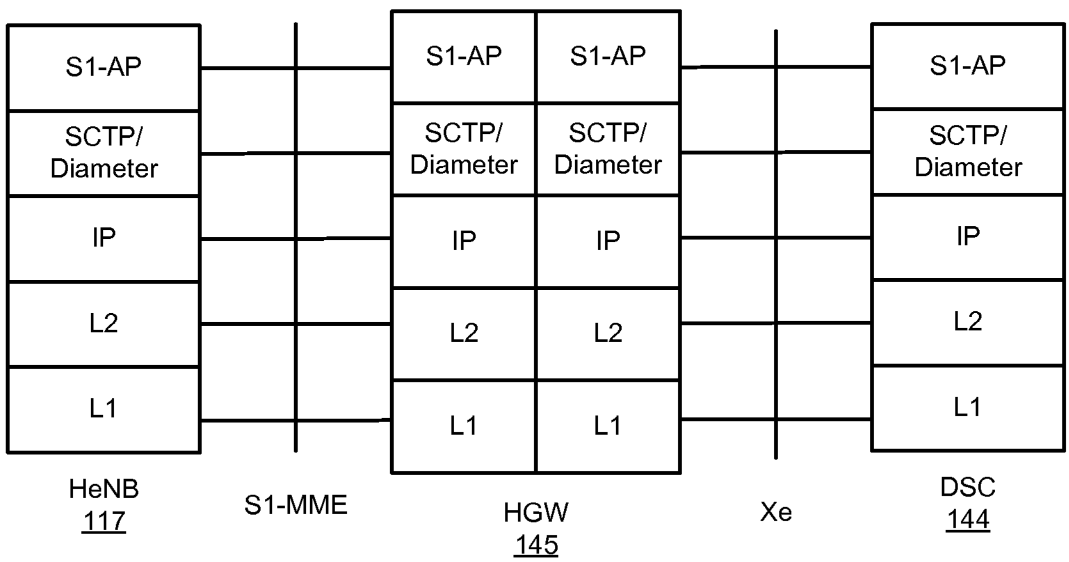

S1-AP
SCTP/ Diameter
IP
L2
L1
S1-AP
S1-AP
SCTP/ Diameter
SCTP/ Diameter
IP
IP
L2
L2
L1
L1
S1-AP
SCTP/ Diameter
IP
L2
L1
HeNB 117
S1-MME
HGW 145
Xe
DSC 144

FIG. 22

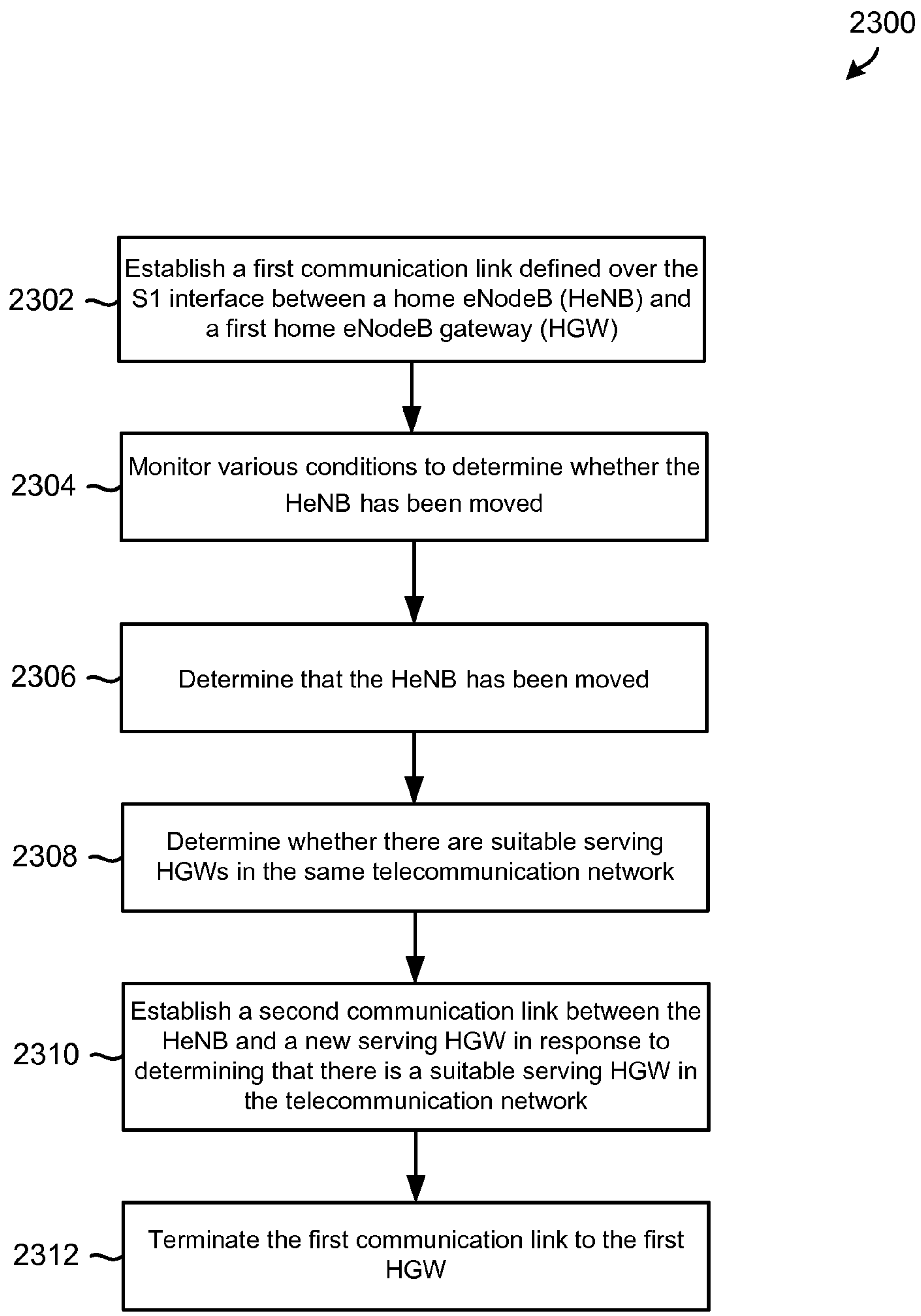

2300
2302
Establish a first communication link defined over the S1 interface between a home eNodeB (HeNB) and a first home eNodeB gateway (HGW)
2304
Monitor various conditions to determine whether the HeNB has been moved
2306
Determine that the HeNB has been moved
2308
Determine whether there are suitable serving HGWs in the same telecommunication network
2310
Establish a second communication link between the HeNB and a new serving HGW in response to determining that there is a suitable serving HGW in the telecommunication network
2312
Terminate the first communication link to the first HGW

FIG. 23

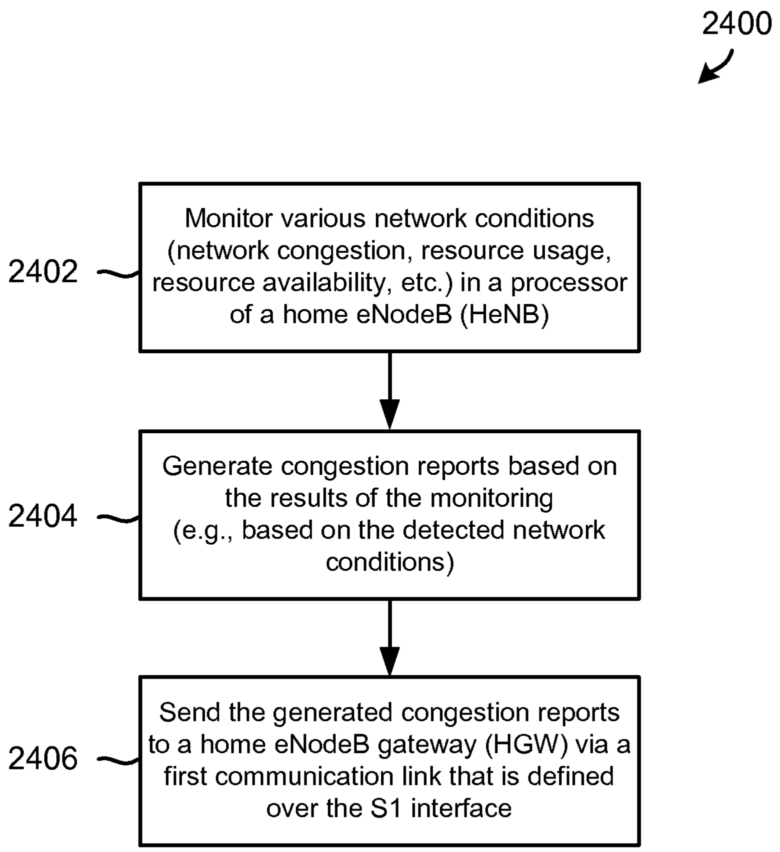

2400
2402
Monitor various network conditions (network congestion, resource usage, resource availability, etc.) in a processor of a home eNodeB (HeNB)
2404
Generate congestion reports based on the results of the monitoring (e.g., based on the detected network conditions)
2406
Send the generated congestion reports to a home eNodeB gateway (HGW) via a first communication link that is defined over the S1 interface

FIG. 24

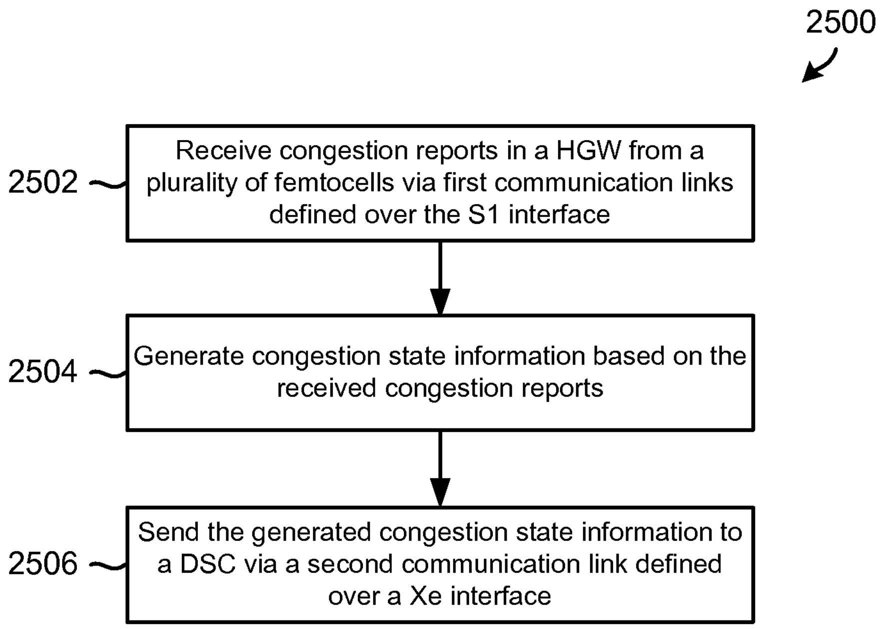

2500
2502
Receive congestion reports in a HGW from a plurality of femtocells via first communication links defined over the S1 interface
2504
Generate congestion state information based on the received congestion reports
2506
Send the generated congestion state information to a DSC via a second communication link defined over a Xe interface

FIG. 25

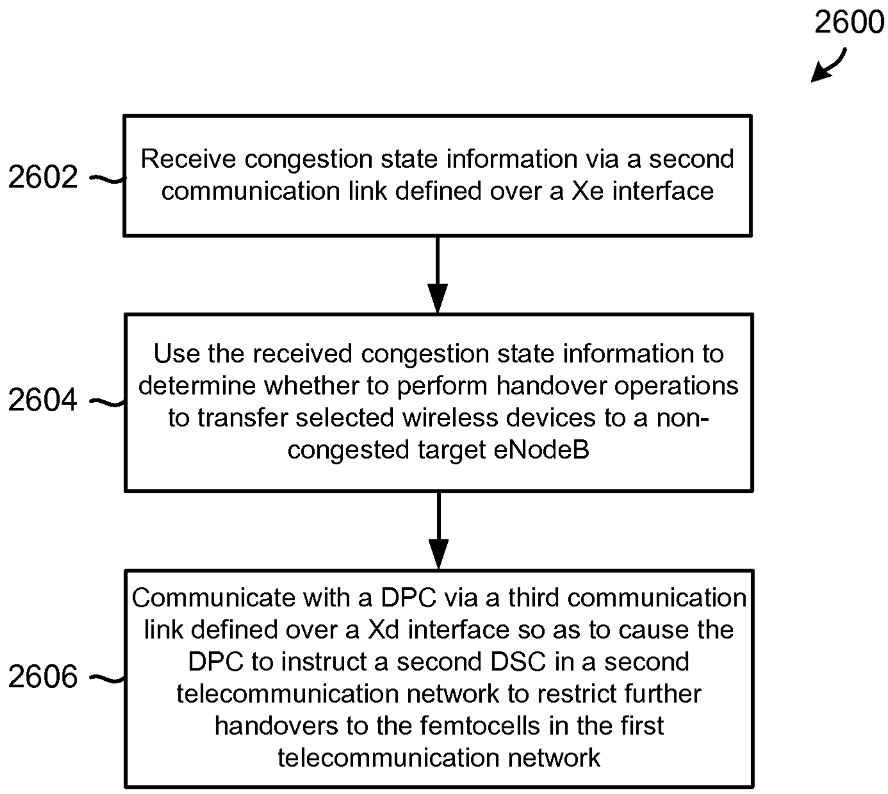

2600
2602
Receive congestion state information via a second communication link defined over a Xe interface
2604
Use the received congestion state information to determine whether to perform handover operations to transfer selected wireless devices to a non-congested target eNodeB
2606
Communicate with a DPC via a third communication link defined over a Xd interface so as to cause the DPC to instruct a second DSC in a second telecommunication network to restrict further handovers to the femtocells in the first telecommunication network

FIG. 26

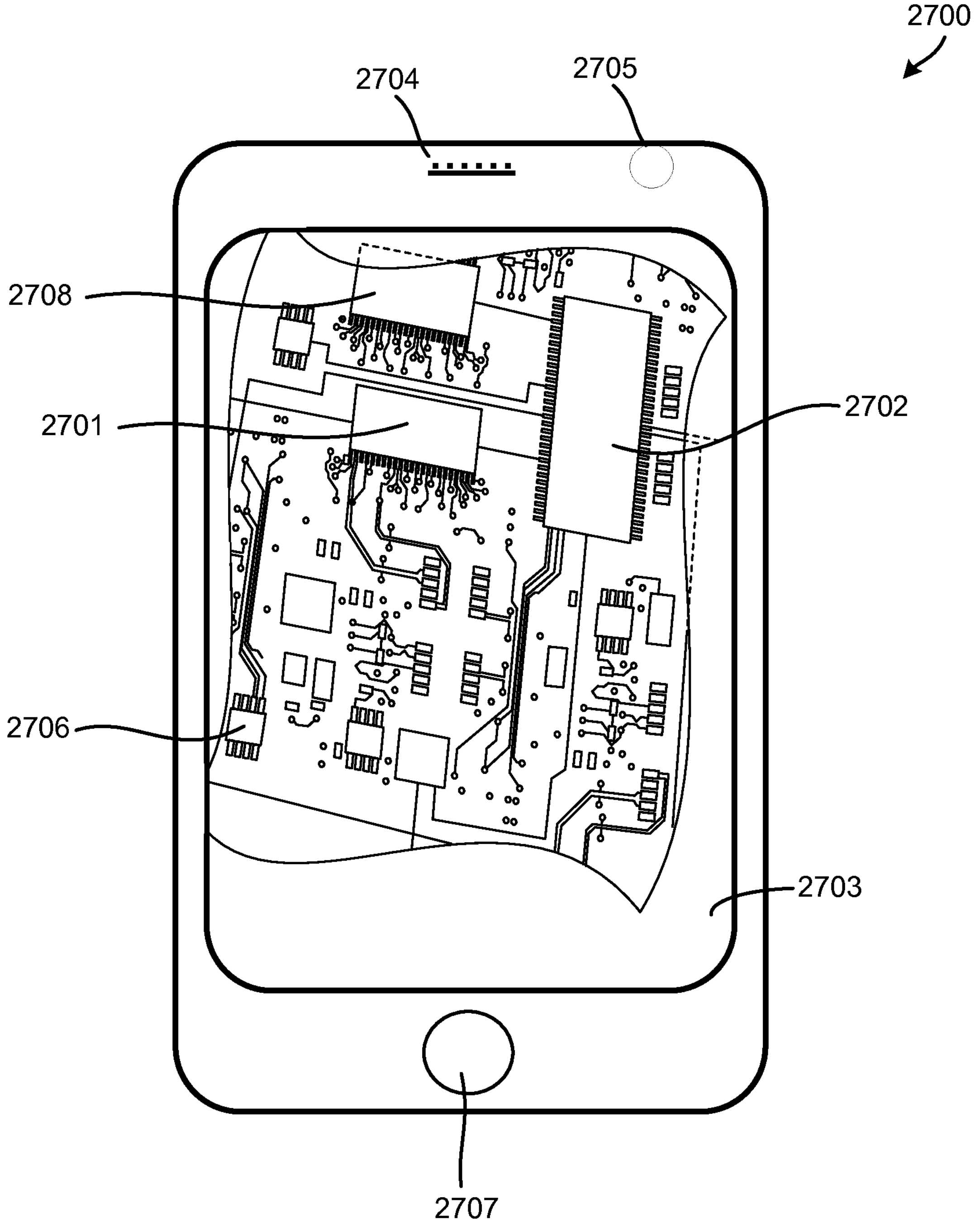


FIG. 27

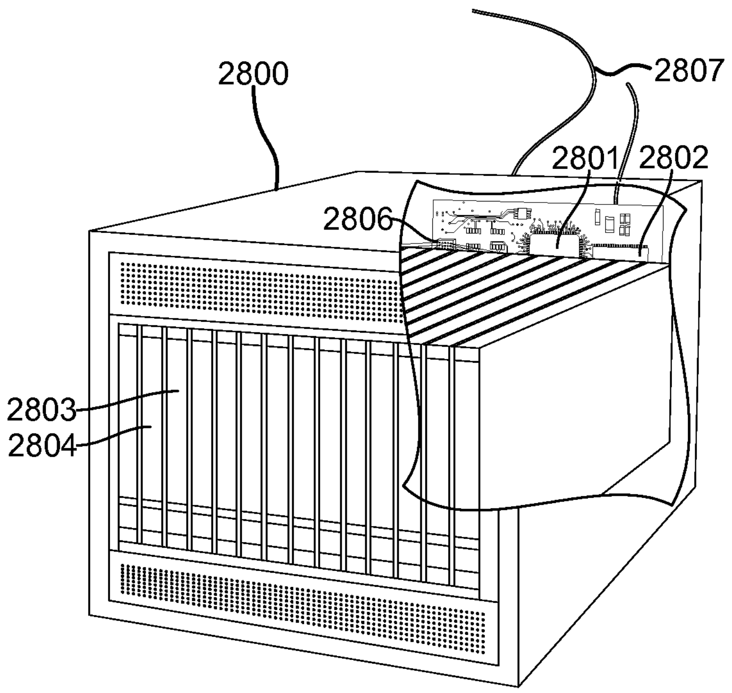


FIG. 28

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/039757

A. CLASSIFICATION OF SUBJECT MATTER

H04W 16/10(2009.01)i, H04W 16/14(2009.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04W 16/10; H04W 28/02; H04W 24/10; H04W 72/04; H04W 12/06; H04W 84/02; H04W 16/14

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & keywords: dynamic, spectrum, femtocell, home gateway, controller, policy, and similar terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2013-0095843 A1 (CLINT SMITH et al.) 18 April 2013 See paragraphs 344-357; and figures 36-40.	11,12
Y		1-4,6-9,14
A		5,10,13
Y	US 2012-0134328 A1 (JEAN-LOUIS GAUVREAU et al.) 31 May 2012 See paragraphs 39, 88, 113-119; and figures 1A, 5-8.	1-4,6-9,14
A		5,10-13
A	WO 2012-037236 A2 (INTER DIGITAL PATENT HOLDINGS, INC.) 22 March 2012 See paragraphs 87-89; and figure 17.	1-14
A	US 2012-0320741 A1 (MARTINO M. FREDA et al.) 20 December 2012 See paragraphs 81-87; and figure 6.	1-14
A	US 2011-0228750 A1 (JOHN L. TOMICI et al.) 22 September 2011 See paragraphs 269-272; and figures 67-69.	1-14

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
01 October 2014 (01.10.2014)	**01 October 2014 (01.10.2014)**

Name and mailing address of the ISA/KR
International Application Division
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea
Facsimile No. +82-42-472-7140

Authorized officer
YU, JAE CHON
Telephone No. +82-42-481-8647

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2013-0095843 A1	18/04/2013	AU 2011-279062 A1	07/03/2013
		CA 2805607 A1	19/01/2012
		CN 103370956 A	23/10/2013
		EA 201300143 A1	30/01/2014
		EP 2594097 A2	22/05/2013
		JP 2013-531446 A	01/08/2013
		KR 10-2014-0009966 A	23/01/2014
		MX 2013000570 A	22/07/2013
		US 2012-014332 A1	19/01/2012
		US 2012-264396 A1	18/10/2012
		US 2014-141794 A1	22/05/2014
		US 8279786 B1	02/10/2012
		US 8670403 B2	11/03/2014
		US 8711721 B2	29/04/2014
		WO 2012-009557 A2	19/01/2012
		WO 2012-009557 A3	05/04/2012
US 2012-0134328 A1	31/05/2012	CN 103155475 A	12/06/2013
		EP 2628269 A1	21/08/2013
		JP 2013-545364 A	19/12/2013
		KR 10-2013-0141523 A	26/12/2013
		TW 201230720 A	16/07/2012
		WO 2012-051151 A1	19/04/2012
WO 2012-037236 A2	22/03/2012	US 2012-063373 A1	15/03/2012
		WO 2012-037236 A3	02/08/2012
US 2012-0320741 A1	20/12/2012	CA 2781100 A1	19/05/2011
		CN 102612845 A	25/07/2012
		EP 2502437 A1	26/09/2012
		JP 2013-511240 A	28/03/2013
		KR 10-2012-0101454 A	13/09/2012
		WO 2011-060376 A1	19/05/2011
US 2011-0228750 A1	22/09/2011	None	

(19)中华人民共和国国家知识产权局

(12)发明专利申请

(10)申请公布号 CN 105264936 A
(43)申请公布日 2016.01.20

(21)申请号 201480030538.5
(22)申请日 2014.05.28
(30)优先权数据
61/828,238 2013.05.29 US
(85)PCT国际申请进入国家阶段日
2015.11.27
(86)PCT国际申请的申请数据
PCT/US2014/039757 2014.05.28
(87)PCT国际申请的公布数据
WO2014/193933 EN 2014.12.04
(71)申请人 里瓦达网络有限责任公司
地址 美国科罗拉多州
(72)发明人 C·史密斯 N·R·D·德维赛蒂
S·史密斯
(74)专利代理机构 北京律盟知识产权代理有限责任公司 11287
代理人 章蕾
(51)Int.Cl.
H04W 16/10(2006.01)
H04W 16/14(2006.01)

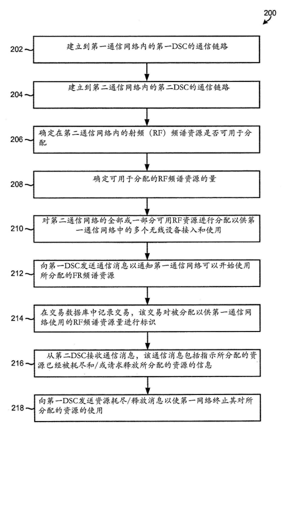
权利要求书2页 说明书45页 附图36页

(54)发明名称

具备家庭eNodeB的用于动态频谱仲裁的方法和系统

(57)摘要

一种动态频谱仲裁DSA系统包括多个毫微微小区、耦接至该多个毫微微小区中的每个毫微微小区的一个家庭eNodeB网关HGW、耦接至该HGW的一个动态频谱控制器DSC以及耦接至该DSC和多个其他DSC的一个动态频谱策略控制器DPC。这些毫微微小区中的每个毫微微小区都可以被配置成用于监测多种网络状况、基于该监测的结果生成多个拥塞报告以及向该HGW发送所生成的这些拥塞报告。该HGW可以被配置成用于从许多不同的毫微微小区接收多个拥塞报告、基于所接收到的这些拥塞报告生成拥塞状态信息以及向该DSC发送该拥塞状态信息。该DSC可以被配置成用于从一个或多个HGW接收该拥塞状态信息并且使用所接收的拥塞状态信息执行多个智能DSA操作(例如,分配资源、请求切入、执行退避操作等)。



CN 105264936 A

1. 一种动态频谱仲裁 DSA 系统，包括：

一个第一电信网络中的多个毫微微小区；

一个家庭 eNodeB 网关 HGW，该家庭 eNodeB 网关包括通过多个第一通信链路耦接至该多个毫微微小区中的每个毫微微小区的一个 HGW 处理器；

一个动态频谱控制器 DSC，该动态频谱控制器包括通过一个第二通信链路耦接至该 HGW 的 DSC 处理器；以及

一个动态频谱策略控制器 DPC，该动态频谱策略控制器包括通过一个第三通信链路耦接至该 DSC 的一个 DPC 处理器。

2. 如权利要求 1 所述的 DSA 系统，其中：

在一个 S1 接口上定义这些第一通信链路；

在一个 Xe 接口上定义该第二通信链路；以及

在一个 Xd 接口上定义该第三通信链路。

3. 如权利要求 1 所述的 DSA 系统，其中，该多个毫微微小区包括一个家庭 eNodeB HeNB，该家庭 eNodeB 包括配置有多条处理器可执行指令以执行多个操作的一个 HeNB 处理器，这些操作包括：

监测多种网络状况；

基于该监测的结果生成多个拥塞报告；以及

通过这些第一通信链路向该 HGW 发送所生成的这些拥塞报告。

4. 如权利要求 3 所述的 DSA 系统，其中，该 HeNB 处理器配置有多条处理器可执行指令以执行多个操作，从而使得监测多种网络状况包括监测网络拥塞、资源使用和资源可用性之一。

5. 如权利要求 3 所述的 DSA 系统，其中，该 HeNB 处理器配置有多条处理器可执行指令以执行多个操作，这些操作进一步包括：

确定该 HeNB 已经被移动；

确定该第一电信网络中是否存在多个合适的服务 HGW；

建立到所标识的这些服务 HGW 之一的一个通信链路；以及

终止到该 HGW 的这些第一通信链路之一。

6. 如权利要求 1 所述的 DSA 系统，其中，该 HGW 处理器配置有多条处理器可执行指令以执行多个操作，这些操作包括：

通过这些第一通信链路接收来自该多个毫微微小区的多个拥塞报告；

基于所接收到的这些拥塞报告生成拥塞状态信息；以及

通过该第二通信链路向该 DSC 发送所生成的该拥塞状态信息。

7. 如权利要求 6 所述的 DSA 系统，其中，该 DSC 处理器配置有多条处理器可执行指令以执行多个操作，这些操作包括：

通过该第二通信链路从该 HGW 接收该拥塞状态信息；以及

使用该接收到的拥塞状态信息确定在该第一电信网络中是否存在过剩网络资源可供一个第二电信网络分配和使用。

8. 如权利要求 6 所述的 DSA 系统，其中，该 DSC 处理器配置有多条处理器可执行指令以执行多个操作，这些操作包括：

通过该第二通信链路从该 HGW 接收该拥塞状态信息;以及

使用该接收到的拥塞状态信息确定是否执行多个切换操作以将所选择的多个无线设备转移至一个非拥塞的目标 eNodeB。

9. 如权利要求 8 所述的 DSA 系统,其中,该 DSC 处理器配置有多条处理器可执行指令以执行多个操作,这些操作进一步包括:

通过该第三通信链路与该 DPC 进行通信以使该 DPC 指示一个第二电信网络中的一个第二 DSC 限制向在该第一电信网络中的该多个毫微微小区中的一个或多个毫微微小区的进一步切换。

10. 如权利要求 1 所述的 DSA 系统,其中,该 DPC 处理器配置有多条处理器可执行指令以执行多个操作,这些操作进一步包括:

接收一个射频 RF 频谱资源请求;

确定在该第一电信网络之内可用于分配的 RF 频谱资源的量;以及

动态地分配该第一电信网络的一部分可用 RF 频谱资源以供在一个第二通信网络中的多个小区站点接入和使用。

11. 一种毫微微小区,包括:

一个处理器,该处理器配置有多条处理器可执行指令以执行多个操作,这些操作包括:

监测多种网络状况;

基于该监测的结果生成多个拥塞报告;以及

通过在一个 S1 接口上所定义的一个通信链路向一个家庭 eNodeB 网关 HGW 发送所生成的这些拥塞报告。

12. 如权利要求 11 所述的毫微微小区,其中,该处理器配置有多条处理器可执行指令以执行多个操作,从而使得监测多种网络状况包括监测网络拥塞、资源使用和资源可用性之一。

13. 如权利要求 12 所述的毫微微小区,其中,该处理器配置有多条处理器可执行指令以执行多个操作,这些操作进一步包括:

确定该毫微微小区已经被移动;

确定是否有一个合适的服务 HGW 可用;

响应于确定有一个合适的服务 HGW 可用,建立到一个标识的服务 HGW 的一个第二通信链路;以及

响应于建立到该服务 HGW 的该第二通信链路,终止到该 HGW 的该通信链路。

14. 一种家庭 eNodeB 网关 HGW,包括:

一个处理器,该处理器配置有多条处理器可执行指令以执行多个操作,这些操作包括:

建立到一个第一电信网络中的多个毫微微小区的多个第一通信链路;

建立到该第一电信网络中的一个动态频谱控制器 DSC 的一个第二通信链路;

通过这些第一通信链路接收来自该多个毫微微小区的多个拥塞报告;

基于所接收到的这些拥塞报告生成拥塞状态信息;以及

通过该第二通信链路向该 DSC 发送所生成的该拥塞状态信息。

具备家庭 eNodeB 的用于动态频谱仲裁的方法和系统

[0001] 相关申请

[0002] 本申请要求 2013 年 5 月 29 日提交的题为“Methods and Systems for Dynamic Spectrum Arbitrage with Home eNodeBs(具备家庭eNodeB的用于动态频谱仲裁的方法和系统)”的第 61/828,238 号美国临时申请的优先权的权益,该申请的全部内容通过引用结合于此。

背景技术

[0003] 近若干年来,可支持互联网的智能手机、平板计算机和游戏控制台已经成为必不可少的个人配件,将用户连接至好友、工作、休闲活动和娱乐。用户现在具有更多的选择,并且期望在任何地方、在任何时间都可以访问内容、数据和通信。随着更多的用户利用这些服务,电信网络必须满足用户需求的这些增加,并且支持新服务阵列且提供快速可靠的通信。因此,用于动态地分配第一电信网络的未被充分利用的电信资源(例如,RF 频谱等)以供订阅其他网络的无线设备接入和使用的改进的方法和系统将有益于电信网络、服务提供商以及电信服务的消费者。

发明内容

[0004] 各个实施例包括一种动态频谱仲裁(DSA)系统,该动态频谱仲裁系统包括:一个第一电信网络中的多个毫微微小区;家庭 eNodeB 网关(HGW),该家庭 eNodeB 网关具有通过多个第一通信链路耦接至该多个毫微微小区中的每个毫微微小区的 HGW 处理器;动态频谱控制器(DSC),该动态频谱控制器具有通过第二通信链路耦接至该 HGW 的 DSC 处理器;以及动态频谱策略控制器(DPC),该动态频谱策略控制器具有通过第三通信链路耦接至该 DSC 的 DPC 处理器。在一个实施例中,可以在 S1 接口上定义这些第一通信链路,可以在 Xe 接口上定义第二通信链路,并且可以在 Xd 接口上定义第三通信链路。

[0005] 在进一步的实施例中,该多个毫微微小区可以包括家庭 eNodeB(HeNB),该家庭 eNodeB 包括 HeNB 处理器。HeNB 处理器可以配置有多条处理器可执行指令以执行多个操作,这些操作包括:监测多种网络状况;基于该监测的结果生成多个拥塞报告;以及通过这些第一通信链路向该 HGW 发送所生成的这些拥塞报告。在一个进一步的实施例中,HeNB 处理器可以配置有多条处理器可执行指令以执行多个操作,从而使得监测多种网络状况包括监测网络拥塞、资源使用和资源可用性之一。在一个进一步的实施例中,HeNB 处理器可以配置有多条处理器可执行指令以执行多个操作,这些操作进一步包括:确定 HeNB 已经被移动;确定该第一电信网络中是否存在多个合适的服务 HGW;建立到所标识的这些服务 HGW 之一的通信链路;以及终止到该 HGW 的这些第一通信链路之一。

[0006] 在一个进一步的实施例中,HGW 处理器可以配置有多条处理器可执行指令以执行多个操作,这些操作包括:通过这些第一通信链路接收来自该多个毫微微小区的多个拥塞报告;基于所接收到的这些拥塞报告生成拥塞状态信息;以及通过该第二通信链路向该 DSC 发送所生成的该拥塞状态信息。

[0007] 在一个进一步的实施例中，DSC 处理器可以配置有多条处理器可执行指令以执行多个操作，这些操作包括：通过该第二通信链路从该 HGW 接收该拥塞状态信息；以及使用该接收到的拥塞状态信息确定在该第一电信网络中是否存在过剩网络资源可供第二电信网络分配和使用。

[0008] 在一个进一步的实施例中，DSC 处理器可以配置有多条处理器可执行指令以执行多个操作，这些操作包括：通过该第二通信链路从该 HGW 接收该拥塞状态信息；以及使用该接收到的拥塞状态信息确定是否执行多个切换操作以将所选择的多个无线设备转移至非拥塞的目标 eNodeB。

[0009] 在一个进一步的实施例中，DSC 处理器可以配置有多条处理器可执行指令以执行多个操作，这些操作进一步包括：通过该第三通信链路与该 DPC 进行通信以使该 DPC 指示在第二电信网络中的第二 DSC 限制向在该第一电信网络中的该多个毫微微小区中的一个或多个毫微微小区的进一步切换。

[0010] 在一个进一步的实施例中，DPC 处理器可以配置有多条处理器可执行指令以执行多个操作，这些操作进一步包括：接收射频（RF）频谱资源请求；确定在该第一电信网络之内可用于分配的 RF 频谱资源的量；以及动态地分配该第一电信网络的一部分可用 RF 频谱资源以供在第二通信网络中的多个小区站点接入和使用。

[0011] 进一步的实施例包括一种毫微微小区，该毫微微小区包括处理器，该处理器配置有多条处理器可执行指令以执行多个操作，这些操作包括：监测多种网络状况；基于该监测的结果生成多个拥塞报告；以及通过在 S1 接口上所定义的通信链路向家庭 eNodeB 网关（HGW）发送所生成的这些拥塞报告。在一个实施例中，毫微微小区处理器可以配置有多条处理器可执行指令以执行多个操作，从而使得监测多种网络状况包括监测网络拥塞、资源使用和资源可用性之一。在一个进一步的实施例中，毫微微小区处理器可以配置有多条处理器可执行指令以执行多个操作，这些操作进一步包括：确定该毫微微小区已经被移动；确定是否有合适的服务 HGW 可用；响应于确定有合适的服务 HGW 可用，建立到所标识的服务 HGW 的第二通信链路；以及响应于建立到该服务 HGW 的该第二通信链路，终止到该 HGW 的该通信链路。

[0012] 进一步的实施例包括一种家庭 eNodeB 网关（HGW），该家庭 eNodeB 网关包括处理器，该处理器配置有多条处理器可执行指令以执行多个操作，这些操作包括：建立到第一电信网络中的多个毫微微小区的多个第一通信链路；建立到该第一电信网络中的动态频谱控制器（DSC）的第二通信链路；通过这些第一通信链路接收来自该多个毫微微小区的多个拥塞报告；基于所接收到的这些拥塞报告生成拥塞状态信息；以及通过该第二通信链路向该 DSC 发送所生成的该拥塞状态信息。

[0013] 进一步的实施例可以包括具有处理器（或处理核）的计算设备，该处理器（或处理核）配置有多条处理器可执行指令以执行对应于上文所讨论的那些操作 / 方法的各个操作。

[0014] 进一步的实施例可以包括多个计算设备，这些计算设备包括用于执行对应于上文所讨论的那些操作 / 方法的功能的各种装置。

[0015] 进一步的实施例可以包括非瞬态处理器可读存储介质，该非瞬态处理器可读存储介质在其上存储有多条处理器可执行指令，这些指令被配置成用于使处理器 / 处理核执行

对应于上文所讨论的那些操作 / 方法的各个操作。

附图说明

[0016] 本文结合的并且构成此说明书的一部分的附图展示本发明的示例性实施例，并且连同以上给出的一般描述以及以下给出的详细描述来解释本发明的特征。

[0017] 图 1A 至 1F 是系统框图，展示了在可用于实现各个实施例的多个通信系统中的各个逻辑组件和功能组件以及通信链路。

[0018] 图 2A 是过程流程图，展示了根据一个实施例的一种从动态频谱策略控制器 (DPC) 的角度出发分配资源的动态频谱仲裁 (DSA) 方法。

[0019] 图 2B 是消息流图，展示了根据一个实施例在分配资源时 DSA 通信系统的组件之间的消息通信。

[0020] 图 3 至 7 是过程流程图，展示了一种在包括一个 DPC、两个动态频谱控制器 (DSC) 和一个无线设备的通信系统中分配和接入资源的实施例 DSA 方法。

[0021] 图 8A 至 8C 是消息流图，展示了一种实施例动态频谱仲裁应用部分 (DSAAP) 注册方法。

[0022] 图 9A 和 9B 是消息流图，展示了一种实施例 DSAAP 广告方法。

[0023] 图 10A 和 10B 是消息流图，展示了一种用于通信可用资源列表的实施例 DSAAP 方法。

[0024] 图 11A 和 11B 是消息流图，展示了一种实施例 DSAAP 竞标方法。

[0025] 图 12A 至 12D 是消息流图，展示了一种用于通知多个参与网络那些竞标操作的结果的实施例 DSAAP 通知方法。

[0026] 图 13A 和 13B 是消息流图，展示了一种用于立即 (或几乎立即) 购买资源的实施例 DSAAP 购买方法。

[0027] 图 14A 和 14B 是消息流图，展示了一种用于在出租者网络中分配资源以供承租者网络中的多个组件接入和使用的实施例 DSAAP 分配方法。

[0028] 图 15A 和 15B 是消息流图，展示了一种将无线设备从出租者网络选择性地切换回承租者的网络 (即，其归属 PLMN) 的实施例 DSAAP 退避方法。

[0029] 图 16A 是消息流图，展示了一种用于终止 DSA 操作的实施例 DSC 发起的 DSAAP 注销方法。

[0030] 图 16B 是消息流图，展示了一种用于终止 DSA 操作的实施例 DPC 发起的 DSAAP 注销方法。

[0031] 图 17A 是消息流图，展示了一种用于报告错误的 DSC 发起的 DSAAP 错误指示方法。

[0032] 图 17B 是消息流图，展示了一种用于报告错误的 DPC 发起的 DSAAP 错误指示方法。

[0033] 图 18 是组件框图，展示了在包括多个毫微微小区的实施例 DSA 系统中的各个通信链路。

[0034] 图 19 是图表，展示了根据一个实施例在源组件与目标组件之间的用于基于 X2 的切换 (HO) 支持的关系。

[0035] 图 20A 至 22 是框图，展示了根据各个实施例用于各个组件之间的用户平面通信和控制平面通信的协议栈。

[0036] 图23是过程流程图,展示了一种动态地确定最合适的服务家庭eNodeB网关(HGW)的实施例家庭eNodeB(HeNB)方法。

[0037] 图24是过程流程图,展示了根据一个实施例的一种生成拥塞报告的家庭eNodeB(HeNB)方法。

[0038] 图25是过程流程图,展示了根据一个实施例的一种基于从许多毫微微小区所接收的信息生成拥塞状态信息的家庭eNodeB网关(HGW)方法。

[0039] 图26是过程流程图,展示了根据一个实施例的一种管理电信网络中的拥塞的动态频谱控制器(DSC)方法。

[0040] 图27是适合于与各个实施例一起使用的示例无线设备的组件框图。

[0041] 图28是适合于与一个实施例一起使用的服务器的组件框图。

具体实施方式

[0042] 将参照附图详细地描述各种实施例。只要有可能,贯穿附图将使用的相同参考数字来指代相同或相似的部分。对特定示例和实现方式的引用是用于说明的目的,而不意在限制本发明或权利要求书的范围。

[0043] 如本文使用的,术语‘无线设备’、‘无线设备’和‘用户设备(UE)’可以互换使用,并且是指各种蜂窝电话、个人数据助理(PDA)、掌上计算机、具有无线调制解调器的笔记本计算机、无线电子邮件接收器(例如,黑莓(Blackberry)®和Treo®设备)、实现多媒体互联网的蜂窝电话(例如iPhone®)以及类似的个人电子设备中的任一者。无线设备可包括可编程处理器和存储器。在优选的实施例中,无线设备是可以经由蜂窝电话通信网络通信的蜂窝手持设备(例如无线设备)。

[0044] 如本申请中所使用的,术语‘组件’、‘模块’、‘引擎’、‘管理器’旨在包括计算机相关实体,如但不限于硬件、固件、硬件与软件的组合、软件、或执行中的软件,这些被配置成用于执行特定操作或功能。例如,组件可以是但不限于在处理器上运行的进程、处理器、对象、可执行文件、执行的线程、程序、计算机、服务器、网络硬件等。通过图示的方式,在计算设备上运行的应用和计算设备两者均可被称为组件。一个或多个组件可驻留在执行的进程和/或线程内,并且组件可位于一个处理器或核上和/或分布在两个或更多个处理器或核之间。另外,这些组件可从其上存储有各种指令和/或数据结构的各种非瞬态计算机可读介质执行。

[0045] 多个不同的蜂窝和移动通信服务和标准在未来是可用的或可预期的,所有这些都可以从各个实施例中实现并受益。这种服务和标准包括例如第三代合作伙伴计划(3GPP)、长期演进(LTE)系统、第三代无线移动通信技术(3G)、第四代无线移动通信技术(4G)、全球移动通信系统(GSM)、通用移动电信系统(UMTS)、3GSM、通用分组无线服务(GPRS)、码分多址接入(CDMA)系统(例如cdmaOne、CDMA2000TM)、GSM演进的增强型数据率(EDGE)、高级移动电话系统(AMPS)、数字AMPS(IS-136/TDMA)、演进数据最优化(EV-DO)、数字增强型无绳通信(DECT)、全球微波接入互操作性(WiMAX)、无线局域网(WLAN)、公共交换电话网(PSTN)、Wi-Fi保护接入I&II(WPA、WPA2)、蓝牙®、综合数字加强网络(iden)、地面移动无线电(LMR)以及演进的通用陆地无线接入网络(E-UTRAN)。这些技术中的每一种都涉及例如对语音消息、数据消息、信令消息和/或内容消息的传输和接收。应理解的是,对与单独

的电信标准或技术相关的术语和/或技术细节的任何引用都仅仅是出于说明的目的，而并非旨在将权利要求书的范围限制到特定的通信系统或技术，除非在权利要求语言中明确叙述。

[0046] 各种实施例包括一种动态频谱仲裁(DSA)系统，该动态频谱仲裁系统被配置成用于在两个或更多个电信网络之间动态地管理对电信资源(如射频(RF)频谱和RF频谱资源)的可用性、分配、接入和使用。在各个实施例中，DSA系统可以被配置成用于更好地支持小型小区架构，如毫微微小区架构。

[0047] 通常，毫微微小区是可以被配置成用于向在相对小区域内(例如，1米-50米的小区大小)的无线设备提供电信服务的小型的、低功率的和/或便携的设备(例如，基站)。电信网络可以采用许多这种毫微微小区以快速地减小覆盖间隙和/或将服务扩展到额外的用户或区域。然而，通常需要或使用大量的毫微微小区来为用户提供适当服务，并且执行DSA操作经常需要向和从每个毫微微小区发送和接收大量信息。进一步地，在网络之间分配资源时，需要执行程度控制来管理和协调这些DSA组件与那些不同的毫微微小区之间的通信和交互。为了这些和其他原因，使用现有的毫微微小区解决方案可能对DSA系统的性能具有显著的负面影响。因此，现有的毫微微小区解决方案不适用于DSA系统中。

[0048] 为了克服现有解决方案的限制，各个实施例提供了智能地并且高效地在动态频谱仲裁(DSA)系统和毫微微小区中的多个组件之间通信信息的多种方法以及被配置成用于实现这些方法的多个计算设备。也就是，各个实施例包括多个组件，这些组件被配置成用于管理和协调在多个毫微微小区与其他DSA组件之间的通信和交互，以便允许将毫微微小区包括在或用作一种综合DSA解决方案的一部分。

[0049] 一种实施例DSA系统可以包括动态频谱策略控制器(DPC)组件和动态频谱控制器(DSC)组件。DPC组件可以被配置成用于通过与在每一个参与网络中的DSC组件进行通信来管理DSA操作以及两个或更多个网络之间(例如，出租者网络与承租者网络之间)的交互。这些DSC组件中的每个DSC组件都可以包括到家庭eNodeB网关(HGW)、到eNodeB以及各种其他组件的有线或无线通信链路。家庭eNodeB网关可以被配置成用于促进在许多毫微微小区与该DSC组件之间的通信，从而使得DSC以与其与单个组件(即，单个eNodeB)进行通信相同的方式来与这些小区进行通信。这允许DSA系统高效地与许多不同的毫微微小区通信大量信息，而不会对DSA系统的操作或性能产生负面影响。

[0050] 在一个实施例中，DSA系统可以包括形式为家庭eNodeB(HeNB)的毫微微小区。该HeNB可以被配置成用于执行在本申请中所讨论的那些实施例eNodeB所执行的所有操作中的任何操作。例如，HeNB可以配备有DSC应用协议和拥塞监测(DAPCM)模块。DAPCM模块可以被配置成用于监测各种网络状况(例如，网络拥塞、资源使用、资源可用性等)、基于监测生成报告并且通过HGW将生成的报告发送至DSC组件。DSC可以被配置成用于接收和使用此类信息以做出更好或更明智的资源请求和/或更好地标识可用于分配的资源。

[0051] 在各个实施例中，可以通过动态频谱仲裁应用部分(DSAAP)协议或组件来促进或完成DSA组件之间的操作、通信和交互。

[0052] DSAAP组件可以被配置成用于允许、促进、支持或增加各个DSA组件之间的通信，以便提高DSA系统和电信网络的效率和速度。

[0053] DSAAP组件可以被配置成用于允许许多毫微微小区与DSC组件(例如，通过Xe接

口)、与其他 eNodeB(例如,通过 X2 接口)以及与各种其他组件(例如,通过 S1 接口)进行通信。DSAAP 组件可以被配置成用于允许 DSC 与许多不同的毫微微小区进行通信,如同它们是单个 eNodeB 一样(例如,通过 Xe 接口)和/或以便提高 DSA 系统的效率和速度。

[0054] 在各个实施例中,所有或部分 DSAAP 组件可以被包括在 DPC 组件、DSC 组件、eNodeB 组件、MME 组件、HGW 组件、独立的 DSA 组件或其任何组合中。DSAAP 组件可以在硬件、软件或硬件和软件的组合中实现。

[0055] 在一个实施例中,DSAAP 组件可以被配置成用于实现 DSAAP 协议,该协议可以在 Xe、Xd 和/或 X2 参考点上进行定义。在各个实施例中,HGW 与 DSC 之间的和/或 DSC 与 eNodeB 之间的 Xe 参考点可以使用 DSAAP 协议、TR-069 协议和/或 TR-192 数据模型扩展来支持列出 eNodeB 处的可用资源并且通知 eNodeB 竞标/购买确认。DSC 与 DPC 之间的 Xd 参考点可以使用 DSAAP 协议来进行动态频谱和资源仲裁操作。这些 eNodeB 之间的 X2 接口/参考点还可以使用 DSAAP 协议来通信信息。

[0056] DSAAP 组件可以允许各个 DSA 组件(例如,DSC、DPC、eNodeB 等)来使用 DSAAP 协议来进行通信和执行各种 DSA 和 DSAAP 方法。在一个实施例中,可以在 DSA 系统中执行这些方法,该 DSA 系统包括第一电信网络(例如,承租者网络)中的第一 DSC 服务器和 HGW 服务器、第二电信网络(例如,出租者网络)中的第二 DSC 服务器和 HGW 以及在第一电信网络和第二电信网络之外的 DPC 服务器。

[0057] 第一 DSC 可以包括通过第一通信链路(即,有线或无线链路)耦接至 DPC 的第一 DSC 处理器,并且第二 DSC 可以包括通过第二通信链路耦接至 DPC 的第二 DSC 处理器。此外,第一 DSC 和第二 DSC 可以通过第三通信链路和第四通信链路耦接至第一 HGW 和第二 HGW。可以在 Xd 接口上定义第一通信链路和第二通信链路,并且可以在 Xe 接口上定义第三通信链路和第四通信链路。这些 HGW 可以被配置成用于通过 S1 接口与许多不同的 HeNB 进行通信。

[0058] 第二 HeNB 可以被配置成用于监测各种网络状况(例如,网络拥塞、资源使用、资源可用性等)、基于监测的结果生成报告并且通过第二 HGW 将生成的报告发送至第二 DSC。这可以通过使用 DSAAP 协议(即,通过发送/接收 DSAAP 通信消息和/或执行在本披露中讨论的方法中的任何一种)来完成。第二 DSC 可以被配置成用于接收并使用此信息以便跟踪在其网络中的这些 eNodeB 和 HeNB 的拥塞状态、选择用于切换的目标节点和/或通过分流多个无线设备来管理这些 eNodeB 和 HeNB 上的流量。该 HGW 可以被配置成用于将来自许多不同的 HeNB 的信息如同它们来自单个 eNodeB 一样呈现给第二 DSC。因此,HGW 可以充当 DSC 与这些 HeNB 之间的网关,这允许系统添加或移除 HeNB 而不需要显著的网络规划并且不需要进一步修改网络中的 DSC 或其他组件。

[0059] 各个实施例可以在各种通信系统中实现,其示例展示在图 1A 至 1F 中。参照图 1A,无线设备 102 可以被配置成用于向和从基站 111 传输和接收语音信号、数据信号和控制信号,该基站可以是基站收发器 (BTS)、NodeB、eNodeB 等。基站 111 可以与接入网关 113 进行通信,该接入网关可以包括以下各项中的一项或多项:控制器、网关、服务网关 (SGW)、分组数据网络网关 (PGW)、演进分组数据网关 (ePDG)、分组数据服务节点 (PDSN)、服务 GPRS 支持节点 (SGSN) 或任何类似的组件或其所提供的特征/功能的组合。由于这些结构是众所周知的和/或以下进一步详细讨论的,为了集中说明最相关的特征,某些细节已经被从图 1A

省略。

[0060] 接入网关 113 可以是充当无线设备流量进出的主要点和 / 或将无线设备 102 连接至它们的即时服务提供商和 / 或分组数据网络 (PDN) 的任何逻辑组件和 / 或功能组件。接入网关 113 可以将语音信号、数据信号和控制信号作为用户数据分组转发至其他网络组件,提供至外部分组数据网络的连接性,管理和存储上下文 (例如,网络内部路由信息等) 并且充当不同技术 (例如,3GPP 系统和非 3GPP 系统) 之间的锚点。接入网关 113 可以协调向或从互联网 105 传输和接收数据以及向和从外部服务网络 104、互联网 105、其他基站 111 并向无线设备 102 传输和接收语音信息、数据信息和控制信息。

[0061] 在各个实施例中,基站 111 和 / 或接入网关 113 可以被耦接 (例如,通过有线或无线通信链路) 至动态频谱仲裁 (DSA) 系统,该动态频谱仲裁系统被配置成用于动态地管理各种网络资源 (例如,RF 频谱、RF 频谱资源等) 的可用性、分配、接入和使用。以下进一步地详细讨论 DSA 系统。

[0062] 图 1B 展示了无线设备 102 可以被配置成用于使用各种通信系统 / 技术 (例如,GPRS、UMTS、LTE、cdmaOne、CDMA2000TM) 向和从服务网络 104(以及最终互联网 105) 发送和接收语音信号、数据信号和控制信号,这些通信系统 / 技术中的任一种或全部都可以由各个实施例支持或者用于实现各个实施例。

[0063] 在图 1B 中所展示的示例中,从无线设备 102 所传输的长期演进 (LTE) 和 / 或演进的通用陆地无线接入网络 (E-UTRAN) 数据由 eNodeB 116 所接收并且被发送至位于核心网络 120 之内的服务网关 (SGW)118。eNodeB 116 可以将信令 / 控制信息 (例如,与呼叫建立、安全、认证等有关的信息) 发送至移动性管理实体 (MME)130。MME 130 可以从归属订户服务器 (HSS)132 请求用户 / 订阅信息、与其他 MME 组件进行通信、执行各种管理任务 (例如,用户认证、漫游限制的强制执行等)、选择 SGW 118 并且将授权和管理信息发送至 eNodeB 116 和 / 或 SGW 118。一旦从 MME 130 接收到授权信息 (例如,认证完成指示、所选择的 SGW 118 的标识符等),eNodeB 116 可以将从无线设备 102 所接收的数据发送至所选择的 SGW 118。SGW 118 可以存储关于所接收的数据 (例如,IP 承载服务的多个参数、网络内部路由信息等) 的信息,并且将多个用户数据分组转发至策略控制强制执行功能 (PCEF) 和 / 或分组数据网络网关 (PGW)128。

[0064] 图 1B 进一步展示了从无线设备 102 所传输的通用分组无线业务 (GPRS) 数据可以由基站收发器 (BTS)106 所接收并且被发送至基站控制器 (BSC) 和 / 或分组控制单元 (PCU) 组件 (BSC/PCU)108。从无线设备 102 所传输的码分多址接入 (CDMA) 数据可以由基站收发器 106 所接收并且被发送至基站控制器 (BSC) 和 / 或分组控制功能 (PCF) 组件 (BSC/PCF)110。从无线设备 102 所传输的通用移动电信系统 (UMTS) 数据可以由 NodeB 112 所接收并且被发送至无线网络控制器 (RNC)114。

[0065] BSC/PCU 108 组件、BSC/PCF 110 组件和 RNC 114 组件分别可以处理 GPRS 数据、CDMA 数据和 UMTS 数据,并且将所处理的数据发送至核心网络 120 之内的组件。更具体地,BSC/PCU 108 单元和 RNC 114 单元可以将所处理的数据发送至服务 GPRS 支持节点 (SGSN)122,并且 BSC/PCF 110 可以将所处理的数据发送至分组数据服务节点 (PDSN) 和 / 或高速分组数据服务网关 (HSGW) 组件 (PDSN/HSGW)126。PDSN/HSGW126 可以充当在无线接入网与基于 IP 的 PCEF/PGW 128 之间的连接点。SGSN 122 可以负责在具体地理服务区域内

路由数据并且将信令(控制平面)信息(例如,与呼叫建立、安全、认证等有关的信息)发送至 MME 130。MME 130 可以从归属订户服务器(HSS)132 请求用户和订阅信息、执行各种管理任务(例如,用户认证、漫游限制的强制执行等)、选择 SGW 118 并且将管理和/或授权信息发送至 SGSN 122。

[0066] 响应于从 MME 130 接收到授权信息,SGSN 122 可以将 GPRS/UMTS 数据发送至所选择的 SGW 118。SGW 118 可以存储关于数据(例如,IP 承载服务的多个参数、网络内部路由信息等)的信息,并且将多个用户数据分组转发至 PCEF 和/或 PGW 128。PCEF/PGW 128 可以将信令信息(控制平面)发送到策略控制规则功能(PCRF)134。PCRF 134 可以接入多个订户数据库、创建策略规则集并执行其他特定功能(例如,与在线/离线收费系统、应用功能等进行交互)。然后,PCRF 134 可以将这些策略规则发送至 PCEF/PGW 128 进行强制执行。PCEF/PGW 128 可以实现这些策略规则以控制带宽、服务质量(QoS)、数据特性以及正在服务网络 104 与最终用户之间进行通信的服务。

[0067] 在各个实施例中,以上所讨论的任何或全部组件(例如,组件 102-134)都可以耦接至被配置成用于动态地管理电信资源的可用性、分配、接入和使用的 DSA 系统或被包括于其内。

[0068] 图 1C 展示了实施例系统 100 中的各个逻辑组件和通信链路,该系统包括 DSA 系统 142 和演进的通用陆地无线接入网络(E-UTRAN)140。在图 1C 中所展示的示例中,DSA 系统 142 包括动态频谱控制器(DSC)144 组件和动态频谱策略控制器(DPC)146 组件。E-UTRAN 140 包括耦接至核心网络 120(例如,通过至 MME、SGW 等的连接)的多个互连的 eNodeB 116。

[0069] 在各个实施例中,DSC 144 可以被包括在或耦接至 E-UTRAN 140,或者作为其核心网络 120 的一部分或者在核心网络 120 之外。在一个实施例中,DSC 144 可以直接耦接(例如,通过有线或无线通信链路)至一个或多个 eNodeB 116。

[0070] 这些 eNodeB 116 可以被配置成用于通过 Xe 接口/参考点与 DSC 144 进行通信。在各个实施例中,DSC 与 eNodeB 116 之间的 Xe 参考点可以使用 DSAAP 协议、TR-069 协议和/或 TR-192 数据模型扩展来支持列出 eNodeB 116 处的可用资源并且通知 eNodeB116 竞标/购买确认。DSC 144 可以被配置成用于通过 Xd 接口/参考点与 DPC 146 进行通信。DSC 与 DPC 之间的 Xd 参考点可以使用 DSAAP 协议来进行动态频谱和资源仲裁操作。这些 eNodeB 116 可以是互连的,并且可以被配置成用于通过 X2 接口/参考点进行通信,其也可以使用 DSAAP 协议来通信数据。这些 eNodeB 116 可以被配置成用于通过 S1 接口与核心网络 120 中的多个组件进行通信。例如,这些 eNodeB 116 可以通过 S1-MME 接口连接至 MME 130 并且通过 S1-U 接口连接至 SGW 118。该 S1 接口可以支持这些 MME 130、SGW 118 与 eNodeB 116 之间的多对多关系。在实施例中,DPC 组件和/或 DSC 组件还可以被配置成用于与 HSS 132 组件进行通信。

[0071] 这些 eNodeB 116 可以被配置成用于提供朝向无线设备 102 的用户平面(例如,PDCP、RLC、MAC、PHY)和控制平面(RRC)协议终止。也就是,通过用作所有无线电协议朝向无线设备 102 的终止点并且将语音信号(例如,VoIP 等)、数据信号和控制信号中继到核心网 120 中的多个网络组件,eNodeB 116 可以充当无线设备 102 与核心网络 120 之间的桥(例如,第 2 层桥)。eNodeB 116 还可以被配置成用于执行各种无线电资源管理操作,比如控制无线电接口的使用、基于请求分配资源、根据各个服务质量(QoS)要求优先化并调度流量、

监测网络资源的使用等。此外，eNodeB 116 可以被配置成用于采集无线电信号电平测量结果、分析所采集的无线电信号电平测量结果并且基于分析的结果而将无线设备 102（或至移动设备的连接）切换至另一个基站（例如，第二 eNodeB）。

[0072] DSC 144 和 DPC 146 可以是被配置成用于管理用于在不同 E-UTRAN 140 之间共享射频和其他网络资源的动态频谱仲裁过程的功能组件。例如，DPC 146 组件可以被配置成用于通过与 E-UTRAN 网络中的多个 DSC 144 进行通信来管理 DSA 操作和多个 E-UTRAN 网络之间的交互。

[0073] 图 1D 展示了在被配置成用于支持小型小区架构的实施例系统 101 中的各个逻辑组件和通信链路。在图 1D 所展示的示例中，DSA 系统 142 和 E-UTRAN 140 包括上文参照图 1C 所讨论的所有组件。此外，对 E-UTRAN 140 进行升级以包括毫微微小区家庭 eNodeB(HeNB) 网关 (HGW 145)145，该毫微微小区家庭 eNodeB 网关耦接至多个互连的 HeNB 117、核心网络 120（例如，通过至 MME、SGW 等的连接）以及 DSC 144。这些 HeNB 117 可以通过 X2 接口互连，并且通过 S1 接口耦接至 HGW 145。图 1D 还展示了在本地 IP 接入 (LIPA) 模式下操作的 HeNB 117a 可以通过 S5 接口与核心网络 120 进行通信。

[0074] 系统 101 可以被配置成使得 S1 接口用于在 HGW 145 与核心网络 120 之间、在 HeNB117 与 HGW 145 之间、在 HeNB 117 与核心网络 120 之间和／或在 eNodeB 116 与核心网络 120 之间通信信息。系统 101 可以被配置成使得来自 HeNB 117 的 S1-U 接口在 HGW145 处终止。系统 101 还可以被配置成使得在 HeNB 177 与 SGW 118 之间存在直接的逻辑用户平面连接或通信链路。HGW 145 可以被配置成用于充当进行控制平面通信（如通过 S1-MME 接口）的集中器。

[0075] HGW 145 可以被配置成用于允许系统 101 支持任何或所有小小区或毫微微小区架构。这可以通过使用在这些 HeNB 117 与核心网络 120 之间的 S1 接口来以可缩放方式支持大量的 HeNB 117 而完成。

[0076] 在一个实施例中，系统 101 可以被配置成使得 HGW 145 对 MME 130 而言表现为 eNodeB 116。系统 101 还可以被配置成使得 HGW 145 对 HeNB 117 而言表现为 MME 130。在一个实施例中，HeNB 117 与核心网络 120 之间的 S1 接口可以是相同的，无论 HeNB 117 是否通过 HGW 145 连接至核心网络 120。

[0077] 在一个实施例中，HGW 145 可以被配置成用于建立到核心网络 120 中的组件的连接，从而使得到由 HGW 145 所服务的多个小区的入站移动性和出站移动性不一定需要 MME 间切换。在一个实施例中，系统 101 可以被配置成使得一个 HeNB 117 服务一个小区。

[0078] DSC 144 可以被配置成用于与 HGW 145 进行接口连接，与同大量 HeNB 117 进行接口连接相反。DSC 144 还可以被配置成用于通过 Xd 接口与 DPC 146 进行接口连接，如用于竞标管理和 DSC 间通信。

[0079] HeNB 117 可以被配置成用于支持与由 eNodeB 116 所支持的那些功能相同的功能和／或被配置成使得 HeNB 117 与核心网络 120 之间的操作与在那些 eNodeB 116 与核心网络 120 中的那些组件之间的操作相同。

[0080] 在一个实施例中，DSC 144 可以被配置成用于从在其网络中的多个 eNodeB 116 接收拥塞状态信息并且将该拥塞状态信息发送至 DPC 146 组件。DSC 144 还可以被配置成用于通过 HGW 145 组件从在其网络中的多个 HeNB 117 接收拥塞状态信息并且将该拥塞状态

信息发送至 DPC 146 组件。拥塞状态信息可以对一个 eNodeB、多个 eNodeB 和 / 或其他网络组件的当前拥塞状态（例如，正常、轻度、重度、严重等）进行标识。每种拥塞状态都可以与一个拥塞等级相关联。例如，“正常”拥塞状态可以指示网络组件（例如，eNodeB 等）正在正常负载（例如，用户流量在正常操作范围之内等）下运行。“轻度”拥塞状态可以指示网络组件正在经历拥塞和 / 或正在平均以上的负载下运行。“重度”拥塞状态可以指示网络组件正在经历显著拥塞和 / 或正在重负载下运行。“严重”拥塞状态可以指示网络组件正在经历严重拥塞、经历紧急情况或正在极重负载下运行。

[0081] 在各个实施例中，DSC 144 组件和 / 或 DPC 146 组件可以被配置成用于使用拥塞状态信息来智能地分配资源、管理这些 eNodeB 的用户流量、选择多个目标 eNodeB 进行切换、确定有待给予附接至这些 eNodeB 116 和 / 或 HeNB 117 的无线设备 102 的服务质量 (QoS) 等级和 / 或执行其他类似的操作以智能地管理各个网络对资源的分配和使用。

[0082] 在一个实施例中，动态频谱仲裁 (DSA) 系统可以包括 ：在第一电信网络中的多个毫微微小区（例如，HeNB 117）；家庭 eNodeB 网关 (HGW)145，该家庭 eNodeB 网关包括通过多个第一通信链路耦接至该多个毫微微小区中的每个毫微微小区的 HGW 处理器 ；动态频谱控制器 (DSC)144，该动态频谱控制器包括通过第二通信链路耦接至 HGW 145 的 DSC 处理器 ；以及动态频谱策略控制器 (DPC)146，该动态频谱策略控制器包括通过第三通信链路耦接至 DSC 144 的 DPC 处理器。可以在 S1 接口上定义这些第一通信链路，可以在 Xe 接口上定义第二通信链路，并且可以在 Xd 接口上定义第三通信链路。

[0083] 该多个毫微微小区可以包括家庭 eNodeB(HeNB)117，并且 HeNB 可以是毫微微小区（例如，小型的、便携式的或低功率的设备）。每个毫微微小区或 HeNB 可以包括处理器，该处理器被配置成用于监测多种网络状况、基于监测结果生成多个拥塞报告并且将所生成的这些拥塞报告通过这些第一通信链路（通过 S1 接口）发送至 HGW HGW。这些拥塞报告可以包括对毫微微小区或 HeNB 117 的当前拥塞状态（例如，正常、轻度、重度、严重等）进行标识的拥塞状态信息。

[0084] 在各个实施例中，毫微微小区处理器或 HeNB 处理器可以被配置成用于确定该毫微微小区 /HeNB 是否已经被移动 ；响应于确定该该毫微微小区 /HeNB 已经被移动，确定在该第一电信网络中是否存在多个合适的服务 HGW 145 ；建立到所标识的这些服务 HGW145 之一的通信链路 ；以及终止到该 HGW 145 的这些第一通信链路之一（即，在移动的毫微微小区与旧的 HGW 145 之间的通信链路）。在一个实施例中，毫微微小区处理器或 HeNB 处理器可以执行这些操作，从而使得其每次被连接至一个服务 HGW 145、与一个服务 HGW 145 进行通信或者向一个服务 HGW 145 发送拥塞报告或信息。

[0085] 服务 HGW 145 可以包括 HGW 处理器，该 HGW 处理器被配置成用于通过这些第一通信链路从许多毫微微小区 /HeNB 117 接收拥塞报告、分析包括在这些拥塞报告中的信息、编译这些报告、基于所接收到的拥塞报告生成拥塞状态信息并且通过第二通信链路（例如，通过 Xe 接口）向 DSC 144 发送所生成的拥塞状态信息。HGW 处理器可以被配置成用于生成该多个毫微微小区对 DSC 144 组件而言表现为单个 eNodeB 116 的拥塞状态信息。

[0086] DSC 144 可以包括 DSC 处理器，该 DSC 处理器被配置成用于通过第二通信链路从 HGW 145（以及许多其他 HGW 145 和 eNodeB 116) 接收拥塞状态信息 ；并且使用所接收的拥塞状态信息确定该第一电信网络中是否存在过剩网络资源可供第二电信网络分配和使用。

DSC 处理器还可以使用该接收到的拥塞状态信息确定是否执行多个切换操作以将所选择的多个无线设备 102 转移至非拥塞的目标 eNodeB 116 或 HGW 145。DSC 处理器可以通过该第三通信链路(例如,通过 Xd 接口)与 DPC 146 进行通信以使 DPC 144 指示第二电信网络中的第二 DSC 限制向在第一电信网络中的该多个毫微微小区中的一个或多个毫微微小区(或向管理该多个毫微微小区的 HGW 145) 的进一步切换。

[0087] 这些毫微微小区(例如,HeNB 117) 中的每个毫微微小区都可以包括发射器和毫微微小区处理器,该毫微微小区处理器被配置成用于监测多种网络状况(例如,网络拥塞、拥塞状态、资源使用、资源可用性等)、基于监测结果生成拥塞报告并且通过在 S1 接口之上所定义的通信链路向 HGW 145 发送所生成的拥塞报告。毫微微小区处理器还可以被配置成用于确定该毫微微小区已经被移动;确定是否有合适的服务 HGW 可用;响应于确定有合适的服务 HGW 可用,建立到所标识的服务 HGW 的第二通信链路;以及响应于建立到该服务 HGW 的该第二通信链路,终止到该 HGW 的该通信链路。

[0088] 在一个实施例中,HGW 可以包括 HGW 处理器,该 HGW 处理器被配置成用于建立到第一电信网络中的多个毫微微小区的多个通信链路(例如,通过 S1 接口)、建立到第一电信网络中的 DSC 144 的第二通信链路、接收来自该多个毫微微小区的拥塞报告、基于所接收的这些拥塞报告生成拥塞状态信息并且通过该第一通信链路向 DSC 发送所生成的拥塞状态信息。

[0089] 在实施例中,HGW 处理器可以被配置成用于执行多个负载均衡操作以管理用户流量,如通过在毫微微小区之间智能地转移设备以平衡跨多个毫微微小区的总负载。在一个实施例中,HGW 处理器可以被配置成用于响应于确定一个毫微微小区对网络资源的使用或在一个区域内对网络资源的使用超过使用阈值而使一个或多个无线设备 102 的本地服务质量 (QoS) 降级。HGW 处理器可以基于与这些无线设备被分组成的多个层相关联的优先级来使这些无线设备 102 的本地 QoS 降级。HGW 处理器可以继续监测这些毫微微小区对网络资源的使用来确定在毫微微小区处对网络资源的使用是否超过第二阈值,并且在确定对网络资源的使用超过第二阈值时将一个或多个无线设备切离到第二毫微微小区(或到另一个 HGW 或 eNodeB)。

[0090] 图 1E 展示了根据各个实施例的可以被包括在适用于执行 DSA 操作的通信系统 105 中的各个逻辑组件和功能组件。在图 1E 中所展示的示例中,通信系统 105 包括 eNodeB116、DSC 144、DPC 146、MME 130、SGW 118 和 PGW 128。

[0091] eNodeB 116 可以包括 DSC 应用协议和拥塞监测模块 150、小区间无线资源管理 (RRM) 模块 151、无线承载 (RB) 控制模块 152、连接移动性控制模块 153、无线准入控制模块 154、eNodeB 测量配置和供应模块 155 和动态资源分配模块 156。这些模块 150-156 中的每个模块都可以在硬件、软件或硬件和软件的组合中实现。

[0092] 此外,eNodeB 116 可以包括各种协议层,包括:无线资源控制 (RRC) 层 157、分组数据汇聚协议 (PDCP) 层 158、无线链路控制 (RLC) 层 159、媒体接入控制 (MAC) 层 160 和物理 (PHY) 层 161。在这些协议层中的每个协议层中,各种硬件组件和 / 或软件组件可以实现与指派给该层的责任相称的功能。例如,可以在物理层 161 中接收多个数据流,该物理层可以包括无线接收器、缓冲器以及多个处理组件,这些处理组件执行对射频 (RF) 信号中的多个符号进行解调、识别的操作并且执行用于从所接收的 RF 信号中提取原始数据的其他操作。

[0093] DSC 144 可以包括 eNodeB 地理边界管理模块 162、eNodeB 资源和拥塞管理模块 163、流控制传输协议（SCTP）模块 164、第 2 层（L2）缓冲器模块 165、第一层（L1）缓冲器模块 166。DPC 146 可以包括 eNodeB 资源竞标管理模块 167、DSC 间通信模块 168、SCTP/DIAMETER 模块 169、L2 缓冲器模块 170 和 L1 缓冲器模块 171。MME 130 可以包括非接入层（NAS）安全模块 172 和空闲状态移动性处理模块 173 和演进的分组系统（EPS）承载控制模块 174。SGW 118 可以包括移动性锚定模块 176。PGW 128 可以包括 UE IP 地址分配模块 178 和分组过滤模块 179。这些模块 162-179 中的每个模块都可以在硬件、软件或硬件和软件的组合中实现。

[0094] eNodeB 116 可以被配置成用于通过 S1 接口／协议与 SGW 118 和／或 MME 130 进行通信。eNodeB 116 还可以被配置成用于通过 Xe 接口／协议与 DSC 144 进行通信。DSC 144 可以被配置成用于通过 Xd 接口／协议与 DPC 146 进行通信。

[0095] eNodeB 116 可以被配置成用于执行各种操作（例如，通过模块／层 150-161）以提供各种功能，包括用于无线资源管理的功能，如无线承载控制、无线准入控制、连接移动性控制、在上行链路和下行链路（调度）中对无线设备 102 的动态资源分配等。这些功能还可以包括 IP 报头压缩和对用户数据流的加密、当无法从 UE 所提供的信息中确定到 MME 130 的路由时在 UE（或无线设备）附接时对 MME 的选择、朝向 SGW 118 的用户平面数据的路由、对寻呼信息（源自 MME）的调度和传输、对广播信息（源自 MME）的调度和传输、针对移动性和调度的测量和测量报告配置、对公共警报系统（例如，地震和海啸警报系统、商业移动提醒服务等）消息（源自 MME）的调度和传输、封闭订户群组（CSG）处理以及在上行链路中的传送等级分组标记。在一个实施例中，eNodeB116 可以是宿主 eNodeB（DeNB），该宿主 eNodeB 被配置成用于执行各种操作以提供多种附加功能，如 S1/X2 代理功能、S11 终止和／或用于支持中继节点（RN）的 SGW/PGW 功能。

[0096] MME 130 可以被配置成用于执行各种操作（例如，通过模块 172-175）以提供各种功能，包括非接入层（NAS）信令、NAS 信令安全、接入层（AS）安全控制、用于 3GPP 接入网络之间的移动性的 CN 间节点信令、空闲模式 UE 到达能力（包括对寻呼重传的控制和执行）、跟踪区列表管理（例如，针对在空闲模式和活跃模式下的无线设备）、PGW 和 SGW 选择、针对由于 MME 变化而导致的切换的 MME 选择、针对到 2G 或 3G3GPP 接入网络的切换的 SGSN 选择、漫游、认证、承载管理功能（包括专用承载建立）、对公共警报系统（例如，地震和海啸警报系统、商业移动提醒服务等）消息传输的支持以及执行寻呼优化。MME 模块还可以向 DSC 通信各种设备状态和附接／去附接状态信息。在一个实施例中，MME 130 可以被配置成用于不基于 CSG ID 对朝向宏 eNodeB 的寻呼消息进行过滤。

[0097] SGW 118 可以被配置成用于执行各种操作（例如，通过模块 176）以提供各种功能，包括移动性锚定（例如，针对 3GPP 间移动性）、充当用于 eNodeB 间切换的本地移动锚点、E-UTRAN 空闲模式下行分组缓冲、发起网络触发的服务请求过程、合法窃听、分组路由和转发、在上行链路（UL）和下行链路（DL）中的传送等级分组标记、用于运营商间收费的用户计费和 QoS 级别标识符（QCI）粒度、上行链路（UL）和下行链路（DL）收费（例如，每设备、PDN 和／或 QCI）等。

[0098] PGW 128 可以被配置成用于执行各种操作（例如，通过模块 178-179）以提供各种功能，包括基于每用户的分组过滤（通过例如深度分组检查）、合法窃听、UE IP 地址分配、

上行链路和下行链路中的传送等级分组标记、UL 和 DL 服务等级收费、选通和速率强制执行、基于 APN 聚合最大比特率(AMBR) 的 DL 速率强制执行等。

[0099] DSC 144 可以被配置成用于执行各种操作(例如,通过模块 162-166) 以提供各种功能,包括针对出租者网络中的承租者无线设备 102 的移动性管理来管理在网络(例如,PLMN) 内的资源仲裁操作、跟踪网络资源列表、跟踪当前正在进行中的竞标、跟踪被执行的竞标以及跟踪竞标特定的封闭订户群组(CSG) 标识符(CSG-ID)。DSC 144 可以被配置成用于将无线设备 102 从承租者网络切换至出租者网络(即,执行切入)、并且将无线设备 102 从出租者网络切换到承租者网络(即,执行退避)。

[0100] DSC 144 还可以被配置成用于跟踪 eNodeB 的拥塞状态、选择用于切换的目标 eNodeB 以及管理出租者 eNodeB 上的流量。DSC 144 可以被配置成用于基于所配置的策略(例如,分流较低优先级用户、分流较高优先级用户、分流具有特定 QoS 的用户等)来将用户从承租者网络分流至在出租者网络内的其他的负载较少的 eNodeB 116。DSC144 还可以执行退避操作以将无线设备 102 从出租者网络切换回承租者网络。DSC 144 还可以被配置成用于对从系统中的一个或多个 eNodeB 所采集或接收的历史拥塞信息进行监测、管理和/或维护。

[0101] DPC 146 可以被配置成用于执行各种操作(例如,通过模块 167-171) 以提供各种功能,包括作为出租者网络和承租者网络(例如,PLMN) 的 DSC 144 之间的资源仲裁经纪人起作用、列出来自各个出租者网络的资源以进行拍卖以及管理拍卖过程。DPC 146 可以被配置成用于向多个 DSC 144 发送出价过高、竞标获胜、竞标取消和竞标撤销以及竞标到期的通知,在承租者网络和出租者网络的在线和/或离线收费系统中安装竞标特定的收费规则,以及通过充当承租者 DSC 144 与出租者 DSC 144 之间的网关来协调 DSC144 之间的资源使用。

[0102] 图 1F 展示了示例通信系统 107 中的多个网络组件和信息流,该通信系统包括通过被配置成用于管理 DSA 操作和交互的 DPC 146 而互连的两个 E-UTRAN 140a、140b。在图 1F 中所展示的示例中,每个 E-UTRAN 140a、140b 包括在其核心网络 120a、120b 之外的 eNodeB 116a、116b 以及在核心网络 120a、120b 之内的 DSC 144a、144b。

[0103] DSC 144a、144b 可以被配置成用于通过 Xd 接口与 DPC 146 进行通信。DSC 144a、144b 还可以被直接或间接地连接至它们对应的核心网络 120a、120b 中的各个网络组件,如 PCRF 134、HSS 132 和 PCEF/PGW 128(图 1F 中未示出)。在一个实施例中,DSC 144a、144b 中的一个或多个可以直接连接至 eNodeB 116a、116b 中的一个或多个。

[0104] 除了上述连接和通信链路,系统 107 可以包括附加的连接/链路以容纳在不同的 E-UTRAN(例如,E-UTRAN 140a 与 140b) 中的组件之间的数据流和通信。例如,系统 107 可以包括第二 E-UTRAN 140b 中的 eNodeB 116b 到第一 E-UTRAN 140a 中的 SGW118 之间的连接/通信链路。作为另一个示例,系统 107 可以包括第二 E-UTRAN 140b 中的 SGW 118 到第一 E-UTRAN 140a 中的 PGW 128 之间的连接/通信链路。为集中讨论相关实施例,在图 1F 中未展示这些附加组件、连接和通信链路。

[0105] 如以下进一步详细讨论的,DSC 144a、144b 可以被配置成用于向 DPC 146 发送关于频谱资源的可用性的信息(例如,接收自 eNodeB、PCRF、PCEF、PGW 等的信息)。此信息可以包括与每个网络或子网络的当前使用和所预期的未来使用和/或能力相关的数据。

DPC 146 可以被配置成用于接收和使用这种信息来对第一 E-UTRAN 140a 的可用资源到第二 E-UTRAN 140b 进行智能分配、转移、管理、协调或租用，并且反之亦然。

[0106] 例如，作为动态频谱仲裁操作的一部分，DPC 146 可以被配置成用于对频谱资源从 E-UTRAN 140a（即，出租者网络）到第二 E-UTRAN 140b（即，承租者网络）的分配进行协调。此类操作可以允许将通过通信链路 143 无线地连接到第二 E-UTRAN 140b 中的 eNodeB 116b 的无线设备 102 切换到第一 E-UTRAN 140a 中的 eNodeB 116a，从而使得其可以使用第一 E-UTRAN 140a 的所分配的频谱资源。作为此切离过程的一部分，无线设备 102 可以建立到第一 E-UTRAN 140a 中的 eNodeB 116a 的新连接 141、终止到原始 eNodeB 116b 的无线连接 143 并且犹如第一 E-UTRAN 140a 的所分配的资源被包括在第二 E-UTRAN 140b 中那样来使用这些资源。可以执行这些 DSA 操作，使得第一 DSC144a 对于第一资源 / 时间段是出租者 DSC 并且对于第二资源或另一个时间段是承租者 DSC。

[0107] 在一个实施例中，可以执行 DSA 操作和 / 或切离操作，使得无线设备 102 在其被切离之后维持到原始网络的数据连接（或由其所管理的数据连接）。例如，可以执行 DSA 操作和 / 或切离操作，使得无线设备 102 在被切离到第一 E-UTRAN 140a 中的 eNodeB116a 之后维持到第二 E-UTRAN 140b 中的 PGW 128 的数据流连接。

[0108] 图 2A 展示了根据一个实施例的一种分配资源的示例 DSA 方法 200。方法 200 可以通过 DPC 146 组件（例如，服务器计算设备等）中的处理核来执行。

[0109] 在框 202 中，DPC 146 可以建立到第一通信网络（例如，E-UTRAN 等）中的第一 DSC 144a 的第一通信链路。在框 204 中，DPC 146 可以建立到第二通信网络中的第二 DSC 144b 的第二通信链路。在框 206 中，DPC 146 可以确定第二通信网络内的射频 (RF) 频谱资源是否可用于分配。这可以通过以下方式来完成：使用 DSAAP 协议通过第二通信链路来与第二通信网络中的 DSC 144 进行通信，该第二通信链路可以是有线或无线通信链路。在框 208 中，DPC 146 可以确定可用于分配的 RF 频谱资源的量。在框 210 中，DPC 146 可以执行各种操作以对第二通信网络的全部或一部分可用 RF 资源进行分配以供第一通信网络中的多个无线设备 102 接入和使用。

[0110] 在框 212 中，DPC 146 可以向第一 DSC 144a 发送通信消息（例如，通过使用 DSAAP 协议）以通知第一通信网络可以开始使用所分配的 FR 频谱资源。在框 214 中，DPC 146 可以在交易数据库中记录交易，该交易对被分配以供第一通信网络使用的 RF 频谱资源量进行标识。

[0111] 在框 216 中，DPC 146 可以从第二 DSC 144b 接收通信消息，该通信消息包括指示所分配的资源已经被耗尽和 / 或请求释放所分配的资源的信息。在框 218 中，DPC 146 可以向第一 DSC 144a 发送资源耗尽 / 释放消息以使第一网络终止其对所分配的资源的使用。

[0112] 图 2B 展示了在执行另一个实施例 DSA 方法 250 分配资源时 DPC 146 与多个 DSC144a-d 之间的示例信息流。在以下的描述中，从 DPC 146 组件的角度出发讨论 DSA 方法 250，并且该 DSA 方法可以通过 DPC 146 中的处理核来执行。然而，应当理解，DSA 方法 250 可以通过 DPC 146 组件中的多个处理核、DSC 144a-d 组件中的多个处理核或其组合来执行。此外，应当理解，DPC 146 与其他组件之间的所有交互和通信都可以通过多个 DSAAP 组件和 / 或使用 DSAAP 协议来完成。因此，所有这种交互和通信都可以被包括在 DSAAP 协议中。

[0113]　在操作 252 中，DPC 146 组件中的处理核可以从第一网络（例如，E-UTRAN 等）中的第一 DSC 144a 组件接收“资源请求”通信消息。应当理解，“资源请求”通信消息以及在本申请中所讨论的所有其他通信消息都可以是 DSAAP 消息。

[0114]　“资源请求”通信消息可以包括适合于通知DPC 146第一网络对购买、租用、接入和/或使用来自其他网络的资源感兴趣的信息。“资源请求”通信消息还可以包括适合于对第一网络所请求的资源（例如，RF 频谱资源等）的类型和/或量、所请求的资源将要被分配至的那些无线设备 102 的类型和能力进行标识的信息以及其他类似信息。

[0115]　在操作 254、256 和 258 中，DPC 146 可以生成“资源查询”通信消息并分别将其发送至第二网络中的第二 DSC 144b 组件、第三网络中的第三 DSC 144c 组件以及第四网络中的第四 DSC 144d 组件中的每一项。DPC 146 可以被配置成用于将这些“资源查询”通信消息生成为包括各种组件、设备和资源要求、标准和信息。例如，DPC 146 可以将“资源查询”通信消息生成为包括对第一网络（以及其他网络）中的资源将要被分配至的用户无线设备 102 的类型、能力和地理标准进行标识的信息。地理标准可以包括资源将要被分配至的用户无线设备 102 的地理位置、地理多边形和/或许可区域。

[0116]　在操作 260 和 262 中，DPC 146 可以从第二 DSC 144b 和第三 DSC 144c 接收“资源查询响应”通信消息。这些“资源查询响应”通信消息可以包括对符合被包括在资源查询消息中的要求/标准的过剩资源的可用性进行标识的信息。在操作 264 中，DPC 146 可以从第四 DSC 144d 接收另一条“资源查询响应”通信消息。此“资源查询响应”通信消息可以包括指示第四网络并不包括满足所请求的要求/标准的资源的信息。

[0117]　在一个实施例中，作为操作 260-264 的一部分，DPC 146 可以对数据库记录进行更新以便将第二网络和第三网络标识为具有可用于分配的资源和/或将第四网络标识为不包括这种资源。

[0118]　在操作 266 中，DPC 146 可以生成“资源可用性”通信消息并将其发送至多个网络中的多个 DSC（包括第一网络中的第一 DSC 144a）。DPC 146 可以被配置成用于将“资源可用性”通信消息生成为包括适合于通知这些网络多个资源可用于分配的信息。在一个实施例中，DPC 146 可以被配置成用于通过广播通信信号来通知这些网络多个资源可用于分配，该通信信号包括适合于通过拍卖和/或拍卖的拍卖开始时间来通知这些网络多个资源可用于分配的信息。

[0119]　在操作 268 中，DPC 146 可以从第一 DSC 144a 接收“资源预留请求”通信消息。所接收到的“资源预留请求”通信消息可以包括适合于通知 DPC 146 该第一网络想要参与拍卖和/或对至少一部分可用资源进行竞标的信息。

[0120]　在操作 270 和 272 中，DPC 146 可以分别向第二 DSC 144b 和第三 DSC 144c 发送“资源预留请求”通信消息。“资源预留请求”通信消息可以包括适合于使第二 DSC 144b 和第三 DSC 144c 预留它们的可用资源中的全部或一部分以供其他网络的分配和使用的信息。

[0121]　在操作 274 和 276 中，DPC 146 可以从第二 DSC 144b 和第三 DSC 144c 中的每一个接收“资源预留响应”通信消息。“资源预留响应”消息可以包括适合于通知 DPC 146 所请求的资源已经被预留的信息和/或适合于对所预留的资源进行标识的信息。

[0122]　可选地，在操作框 278 中，DPC 146 可以对所预留的资源进行汇聚以供其他网络（例如，第一网络）中的多个无线设备 102 的分配和使用。例如，DPC 146 可以将第二网络

中所预留的频谱块与第三网络中所预留的频谱块进行组合。作为另一个示例，DPC 146 可以对第二网络中所预留的频谱块的第一信道和第四信道中的可用资源进行汇聚。

[0123] 在操作 280 中，DPC 146 可以从多个网络（包括从第一网络中的第一 DSC 144a）接收“资源竞标”通信消息。每个“资源竞标”通信消息可以包括针对接入、使用、租用和 / 或购买资源的出价或报价以及其他相关竞标信息（例如，价格、所请求的分配 / 接入方法等）。作为操作 280 的一部分，DPC 146 可以确定所接收的资源竞标是否符合 DSA 系统的策略和规则和 / 或符合由提供用于分配的资源的网络所提出的要求（例如，满足最小要价等）。

[0124] 在操作 282 中，响应于确定接收自第一网络的资源竞标符合 DSA 系统的那些策略 / 规则并且符合由资源提供网络所提出的多个要求（例如，为使用可用资源池中的全部或一部分资源报出大于或等于第二网络所指定的最小量的货币量），DPC 146 可以接受来自第一网络的出价 / 报价。同样，在操作 282 中，DPC 146 可以生成“竞标接受”通信消息并且将其发送至第一 DSC 144a。

[0125] 在操作 284 中，DPC 146 可以通过向第二 DSC 144b 发送“指派资源请求”通信消息来分配第二网络的资源以供第一网络中的多个无线设备 102 接入和使用。也就是，在操作 284 中，DPC 可以确定（例如，在可用资源池中的）这些资源中由第一 DSC 144a 赢得的一部分资源通过第二网络是完全可用的，并且作为响应，仅向第二网络发送指派资源请求消息。

[0126] 在操作 286 中，DPC 146 可以从第二 DSC 144b 接收“资源已分配”通信消息。在操作 288 中，DPC 146 可以向第一 DSC 144a 发送“资源已分配”通信消息以通知第一网络这些资源已经被分配以供其无线设备 102 接入和使用和 / 或可以开始使用所分配的资源。在操作框 290 中，DPC 146 可以在交易数据库中记录交易，该交易将这些资源标识为已经被分配以供第一网络接入和使用。

[0127] 在操作 292 中，DPC 146 可以从第二 DSC 144b 接收“释放资源”通信消息，该通信消息包括指示所分配的资源已经被耗尽的信息和 / 或适合于请求释放所分配的资源的信息。在操作 294 中，DPC 146 可以向第一 DSC 144a 发送资源耗尽 / 释放消息以使第一网络终止其对所分配的资源的使用。

[0128] 图 3 至 7 展示了一种用于在通信系统中分配和接入资源的实施例 DSA 方法 300，该通信系统包括一个 DPC 146 组件、两个 DSC 144a、144b 组件和多个无线设备 102。DSA 方法 300 的全部或部分可以通过 DPC 146、DSC 144a 至 144b 和 / 或无线设备 102 中的多个处理核来执行。在各个实施例中，组件 146、144a、144b 和 102 之间的所有交互和通信中的任一项都可以通过多个 DSAAP 组件和 / 或使用 DSAAP 协议来完成或促进。因此，所有这种交互和通信都可以被包括在 DSAAP 协议中。

[0129] 参照图 3，在框 302 中，第一网络中的第一 DSC 144a 可监测相比于可用于第一网络的总频谱资源的用户流量（例如，呼叫流量和数据流量等）。在框 304 中，第一 DSC 144a 可以基于其监测的结果生成资源状态报告、在存储器中记录 / 存储资源状态报告并且通过资源状态报告通信消息向 DPC 146 发送资源状态报告。在确定框 306 中，第一 DSC 144a 可以基于所接收到的资源状态报告确定是否需要额外的资源（和 / 或是否有较高的可能性在不远的将来将需要额外的资源）来向第一网络中的现有无线设备 102 提供适当服务。响应于确定需要额外的资源（即，确定框 306 =“是”），在框 308 中，第一 DSC 144a 可以向 DPC 146 发送“资源请求”通信消息。响应于确定不需要额外的资源（即，确定框 306 =“否”），

在框 302 中，第一 DSC 144a 可以继续监测用户流量和 / 或执行其他 DSC 操作。

[0130] 在框 310 中，第二网络中的第二 DSC 144b 可以监测相比于可用于第二网络的总频谱资源的用户流量、生成资源状态报告和 / 或执行在本申请中所讨论的任何或全部 DSC 操作。在确定框 312 中，第二 DSC 144b 可以确定第二网络中是否有可用的过剩资源量。响应于确定第二网络中没有可用的过剩资源（即，确定框 312 ＝“否”），在框 310 中，第二 DSC 144b 可以继续监测用户流量和 / 或执行其他 DSC 操作。

[0131] 响应于确定在第二网络中存在可用的过剩资源量（即，确定框 312 ＝“是”），在框 314 中，第二 DSC 144b 可以标记、指定或分配其过剩资源的全部或部分以供其他网络（例如，第一网络等）接入和使用。在框 316 中，第二 DSC 144b 可以生成资源分配报告并将所生成的资源分配报告发送至 DPC 146（例如，通过资源通信消息）。DSC 144b 可以被配置成用于将资源分配报告生成为包括对可用于分配和 / 或已经由第二网络标记、指定或分配的资源（或资源的部分或量）进行标识的信息。

[0132] 在框 320 中，DPC 146 可以从许多不同网络中的 DSC 144（包括在第一网络和第二网络中的第一 DSC 144a 和第二 DSC 144b）接收各种资源状态和分配报告。这些报告可以包括对这些网络及它们的组件的各种特性、标准、要求和情况进行标识的信息（如所检测到的用户流量与总可用频谱资源之比）、网络所需要的资源量、网络中可用于分配的资源量、将要使用所分配的资源的无线设备 102 的类型和能力、在无线设备 102 接入所分配的资源之前必须满足的系统要求、关于对资源的接入和使用的网络规则和策略以及其他类似信息。

[0133] 在框 322 中，DPC 146 可以在存储器（例如，非易失性存储器）中存储所接收的报告（例如，资源状态报告、资源分配报告等）。在框 324 中，DPC 146 可以从不同网络中的 DSC 144（包括第一网络中的第一 DSC 144a）接收资源请求。在框 326 中，DPC 146 可以使用所接收 / 存储的信息（例如，在资源请求、资源分配报告、资源状态报告等中所接收的信息）以标识和选择第一网络可以从中租用或购买额外的资源的最合适的 / 最佳可用网络。在图 3 中所展示的示例中，DPC 146 将第二网络标识和选择为向第一网络提供资源的最合适的网络。

[0134] 在框 328 中，DPC 146 可以向第二 DSC 1144b 发送资源查询通信消息。在框 330 中，第二 DSC 1144b 可以接收资源查询通信消息。在框 332 中，第二 DSC 1144b 可以确定由第二网络所标记、指定或分配的过剩资源的可用性、量和 / 或数量。在框 334 中，第二 DSC 1144b 可以生成“资源查询响应”通信消息并且将其发送至 DPC 146。第二 DSC1144b 可以将资源查询响应生成为包括适用于对被标识、指定或分配以供其他网络（例如，第一网络）接入和使用的资源的可用性和数量进行标识的信息。在框 336 中，DPC146 可以从第二 DSC 1144b 接收“资源查询响应”通信消息，并且作为响应，执行图 4 中所展示的确定框 400 的操作。

[0135] 参照图 4，在确定框 400 中，DPC 146 可以基于从第二网络中的第二 DSC 144b 所接收的数据（例如，资源查询响应消息）确定资源是否可用。例如，响应于确定所有或一部分资源在被预留之前由其他竞标者购买或赢得，DPC 146 可以确定所标识的资源不可用。

[0136] 响应于确定资源不可用（即，确定框 400 ＝“否”），在框 402 中，DPC 146 可以向第一网络中的第一 DSC 144a 发送“无资源可用”通信消息。在框 404 中，第一 DSC 144a 可

以接收该“无资源可用”通信消息。在框406中，第一DSC 144a可以搜索(例如，通过DPC 146)其他可用资源、从不同的网络请求资源、请求不同的资源、终止与用户的连接或通信会话以腾出资源或执行其他类似的操作以管理第一网络中的网络流量和拥塞。

[0137] 响应于确定资源可用(即，确定框400＝“是”)，在框408中，DPC 146可以向第一DSC 144a发送“资源可用”通信消息。该资源可用消息可以包括可由第一DSC 144a用于确定在第二网络中可由第一网络中的无线设备102使用的资源的质量和数量的信息。

[0138] 在框410中，第一DSC 144a可以接收从DPC 146发送的资源可用通信消息。在框412中，第一DSC 144a可以确定第一网络需要的和/或将试图获取的资源的量/数量，并且在“请求资源”通信消息中将此资源信息和其他资源信息发送至DPC 146。

[0139] 在框414中，DPC 146可以从第一DSC 144a接收“请求资源”消息。在框416中，DPC 146可以使用被包括在所接收的消息中的信息来生成“预留资源请求”通信消息并且将其发送至第二网络中的第二DSC 144b。

[0140] 在框418中，第二DSC 144b可以从DPC 146接收“预留资源请求”消息。在框420中，第二DSC 144b可以使用被包括在所接收的“预留资源请求”消息中的信息来预留所请求的数量的所分配的资源以供其他网络中的多个组件接入和使用。在框422中，第二DSC 144b可以向DPC 146发送“资源已预留”通信消息以便确认已经预留所请求的数量的资源和/或对所预留的资源进行标识。

[0141] 在框424中，DPC 146可以从第二DSC 144b接收“资源已预留”通信消息。在框426中，DPC 146可以针对拍卖提供所预留的资源和/或开始接受对所预留的资源的资源竞标。

[0142] 图5展示了DSA方法300的可以在DPC 146针对拍卖提供所预留的资源和/或开始接受对所预留的资源的资源竞标之后(例如，在执行图4中所展示的框426的那些操作之后)执行的竞标过程。

[0143] 参照图5，在框500中，第一网络中的第一DSC 144a可以通过向DPC 146发送资源竞标(例如，通过通信消息)来协商对第二网络的所预留的资源的接入。在框502中，DPC 146可以从第一DSC 144a接收资源竞标。

[0144] 在确定框504中，DPC 146可以确定是否接受所接收的资源竞标，这可以通过确定该资源竞标是否符合DSA系统的策略和规则以及第二网络的要求(例如，大于最小量等)来完成。响应于确定接受从第一DSC 144a所接收的资源竞标(即，确定框504＝“是”)，在框506中，DPC 146可以向第一DSC 144a发送“接受竞标”通信消息。在框508中，第一DSC 144a可以接收“接受竞标”消息并且等待接收资源接入指令。在框510中，DPC 146可以向第二网络中的第二DSC 144b发送“指派资源”通信消息。

[0145] 在框512中，第二DSC 144b可以从DPC 146接收“指派资源”通信消息。在框514中，第二DSC 144b可以使用被包括在所接收的“指派资源”消息中的信息来指派其预留的资源的全部或部分以供第一网络中的多个组件接入和使用。在框516中，第二DSC144b可以生成“资源接入”通信消息并且将该“资源接入”消息发送至DPC 146，该资源接入通信消息包括可以由无线设备102(即，在第一网络中)用来接入所指派的资源的信息(例如，接入参数等)。在框518中，第二DSC 144b可以执行各种操作以准备建立对第一网络中的无线设备102的通信会话/链路，如通过配置或准备接收语音呼叫或数据呼叫。

[0146] 在框522中，DPC 146可以从第二DSC 144b接收“资源接入”通信消息，并且将资源接入消息中继到第一DSC 144a。在框524中，第一DSC 144a可以从DPC 146接收“资源接入”消息。所接收的“资源接入”消息可以包括可由无线设备102用来接入第二网络的所分配的资源的多个接入参数。在框526中，第一DSC 144a可以向具有与第一网络的通信会话的无线设备102和/或向第一网络为迁移至其他网络已经指定/标记的无线设备102发送接入参数。

[0147] 在框528中，无线设备102可以从第一DSC 144a接收第二网络的接入参数。在框530和520中，无线设备102和/或第二DSC 142b可以执行各种操作以建立无线设备102与第二网络之间的通信会话/链路。然后，第二DSC 144b可以执行图7中所展示并且在以下进一步讨论的框700的那些操作。

[0148] 如上所述，在确定框504中，DPC 146可以确定是否接受从第一DSC 144a所接收的资源竞标。响应于确定不接受从第一DSC 144a所接收的资源竞标(即，确定框504＝“否”)，DPC 146可以执行在图6中所展示的框600的那些操作。

[0149] 参照图6，在框600中，DPC 146可以向第一DSC 144a发送“拒绝竞标”通信消息。在框602中，第一DSC 144a可以从DPC 146接收该“拒绝竞标”消息。在确定框604中，第一DSC 144a可以确定第一网络是否将/应该对这些资源进行重新竞标。响应于确定第一网络将/应该对资源进行重新竞标(即，确定框604＝“是”)，在框606中，第一DSC 144a可以向DPC 146发送新的资源竞标(例如，在资源竞标通信消息中)。

[0150] 在框608中，DPC 146可以从第一DSC 144a接收该新的资源竞标(或重新竞标)。在确定框610中，DPC 146可以确定是否接受该新的资源竞标，如通过确定该新的资源竞标是否符合DSA系统的策略和规则以及第二网络的要求。响应于确定接受该新的资源竞标(即，确定框610＝“是”)，DPC 146可以执行在图5中所展示的框506的那些操作。响应于确定不接受该新的资源竞标(即，确定框610＝“否”)，DPC 146可以执行框600的那些操作。

[0151] 响应于确定第一网络应该对资源进行重新竞标(即，确定框604＝“否”)，在框612中，第一DSC 144a可以向DPC 146发送“取消资源请求”通信消息。在框614中，DPC 146可以从第一DSC 144a接收“取消资源请求”消息。在框616中，DPC 146可以向第二DSC 144b发送“资源释放”通信消息。

[0152] 在框618中，第二DSC 144b可以从DPC 146接收该“资源释放”消息。在框620中，第二DSC 144b可以释放所预留的资源，从而使得它们可以由其他网络使用。然后，第二DSC 144b可以向DPC 146报告所分配的资源的状态，这可以通过执行在图3中所展示的并且在上文讨论的框316的那些操作来完成。

[0153] 图7展示了DSA方法300的结算过程，可以在第二网络提供对第一网络中的次要用户无线设备102的接入之后(即，在执行图5中所展示的框520的操作之后)执行该结算过程。

[0154] 在框700中，第二DSC 144b可以向DPC 146发送与第一网络对所分配的资源的使用相关的发票和支付指令。在框704中，DPC 146可以将所接收到的发票和支付指令中继至第一DSC 144a。在框706中，第一DSC 144a可以接收这些发票和支付指令并且在框718中对第二网络的收费进行结算。

[0155] 可选地或者可替代地，在框 708 中，第二 DSC 144b 可以向 DPC 146 发送多个使用参数和多条支付指令。在框 710 中，DPC 146 可以从第二 DSC 144b 接收这些使用参数和支付指令。在框 712 中，DPC 146 可以针对资源的接入和使用创建发票。在框 714 中，DPC 146 可以向第一网络中的第一 DSC 144a 发送发票。在框 716 中，第一 DSC 144a 可以接收这些发票和支付指令并且在框 718 中执行各种操作以对第二网络的收费进行结算。

[0156] 在各个实施例中，DPC 146 和 DSC 144 组件可以被配置成用于通过接口进行通信，这可以在以上在 Xe 参考点和／或 Xd 参考点上所定义的动态频谱仲裁应用部分（DSAAP）协议／模块／组件中实现或者通过其来提供。DSAAP 可以允许、促进、支持或增加 DPC 146 与 DSC 144 之间的通信，以便提高 DSA 系统和电信网络的效率和速度。在各个实施例中，所有或部分 DSAAP 模块／组件可以被包括在 DPC 146 组件、DSC 144 组件、独立于 DPC 146 和 DSC 144 组件的组件或其任何组合中。DSAAP 模块／组件可以允许这些和其他 DSA 组件使用 DSAAP 协议来通信信息。

[0157] 例如，DSAAP 可以允许 DPC 146 组件和 DSC 144 组件通信特定信息和／或执行多种操作，这些操作一起提供各种功能，包括：DSC 注册功能、资源可用性广告功能、资源的竞标和分配功能、将承租者用户切出到出租者网络功能、从出租者网络退避功能、错误处理功能（例如，对未针对其定义特定错误消息的一般错误情况的报告功能等）、DSC 注销功能、错误指示功能、DSC 竞标成功和失败指示功能以及 DSC 资源分配撤销功能。在各个实施例中，可以通过配置 DPC 146 组件和／或 DSC 144 组件来执行以下参照图 8A 至 17B 所讨论的 DSAAP 方法中的一种或其组合来提供、实现或完成这些功能。使用 DSAAP 协议并执行这些 DSAAP 方法可以包括通过一个或多个 DSAAP 消息来进行通信。

[0158] 在各个实施例中，用于在 DSC 144 与 DPC 146 之间通信信息的 DSAAP 消息可以包括 DSC 注册请求消息、DSC 注册接受消息、DSC 注册拒绝消息、DSC 注销消息、DSC 资源注册请求消息、DSC 资源注册接受消息、DSC 资源注册拒绝消息、可用竞标请求消息、可用竞标响应消息、可用竞标拒绝消息、DSC 竞标请求消息、DSC 竞标接受消息、DSC 竞标拒绝消息、DSC 竞标出价过高消息、DSC 竞标获胜消息、DSC 竞标失败消息、DSC 竞标取消消息、DSC 购买请求消息、DSC 购买接受消息、DSC 购买拒绝消息、DSC 资源已分配消息、DSC 资源撤消消息和／或 DSC 退避命令消息。这些消息中的每条消息都可以包括关键性信息、存在信息、范围信息和所指派的关键性信息或可以与其相关联。以下进一步对这些消息以及它们的内容进行详细讨论。

[0159] 在各个实施例中，可以在 DSA 系统中执行这些 DSAAP 方法，该 DSA 系统包括第一电信网络（例如，承租者网络）中的第一 DSC 服务器、第二电信网络（例如，出租者网络）中的第二 DSC 服务器以及在第一电信网络和第二电信网络之外的 DPC 服务器。第一 DSC 可以包括通过第一通信链路耦接至 DPC 的第一 DSC 处理器，并且第二 DSC 可以包括通过第二通信链路耦接至 DPC 的第二 DSC 处理器。第二 DSC 可以通过第三通信链路耦接至第二电信网络中的 eNodeB。可以在 Xd 接口上定义第一通信链路和第二通信链路，并且在 Xe 接口上定义第三通信链路。

[0160] 图 8A 至 8C 展示了一种用于向 DPC 146 注册 DSC 144 组件以便允许 DPC 146 向 DSC 144 提供各种服务（例如，广告出租者 DSC 144 的用于竞标的资源、允许承租者 DSC 144 对由其他网络所提供的资源进行竞标等）的实施例 DSAAP 注册方法 800。在图 8A 至 8C 中所

展示的示例中,DSAAP 注册方法 800 通过 DPC 146 组件和 DSC 144 组件中的处理核来执行,这些组件中的每个组件都可以包括 DSAAP 模块 / 组件的全部或部分。可以在 DSC 144 或 DPC 146 检测到已经建立 XE 信令传送或通信链路之后或者响应于其而执行 DSAAP 注册方法 800 的操作。

[0161] 在图 8A 至 8C 所展示的操作 802 中,DSC 144 可以通过生成 DSC 注册请求消息并且将其发送至 DPC 146 来发起 DSAAP 注册方法 800。在一个实施例中,响应于确定其要求来自 DPC 146 的服务,DSC 144 可以被配置成用于生成和 / 或发送 DSC 注册请求消息。例如,响应于确定其相应的网络(即,DSC 所表示的网络)包括可以被分配给其他网络的过剩资源,DSC 144 可以被配置成用于生成 DSC 注册请求消息。作为另一个示例,响应于确定鉴于当前或所预期的未来用户流量、网络拥塞等其网络要求额外的资源来向其现有的无线设备 102 提供适当服务,DSC 144 可以被配置成用于生成 DSC 注册请求消息。

[0162] 在各个实施例中,DSC 144 可以被配置成用于将 DSC 注册请求消息生成为包括以下各项中的任一项或全部 :消息类型信元 (IE)、消息 ID IE、DSC 标识 IE、DSC 互联网协议 (IP) 地址 IE、DSC 类型 IE、DSC PLMN-ID IE、PLMN 类型 IE 和 DSC 资源更新定时器 IE。DSC PLMN-ID IE 可以包括适用于对与 DSC 144 相关联或由其表示的网络(例如,E-UTRAN) 进行标识的 PLMN ID。PLMN 类型 IE 可以包括适用于确定由 DSC 144 所表示的网络的类型(例如,公共安全、商业广告等)的信息。DSC IP 地址 IE 可以包括负责管理、维护或提供 DSAAP 的 XE 接口的 DSC 144 的 IP 地址。

[0163] 在图 8A 和 8B 中所展示的操作框 804 中,DPC 146 可以执行各种注册操作(即,认证 DSC、在存储器中存储 DSC 标识符信息等)以便向 DPC 146 注册 DSC 144。在一个实施例中,作为这些注册操作的一部分,如响应于接收重复的 DSC 注册请求消息(即,对于由相同的唯一 DSC 标识所标识的已经注册的 DSC),DPC 146 可以用新的注册来盖写 / 覆写现有的注册。

[0164] 在图 8A 中所展示的操作框 806 中,DPC 146 可以确定这些注册操作是成功的。在操作 808 中,DPC 146 可以生成 DSC 注册接受消息并且将其发送至 DSC 144 以指示对 DSC 144 的接受和注册。在各个实施例中,DPC 146 可以将 DSC 注册接受消息生成为包括以下各项中的任一项或全部 :消息类型信元 (IE)、消息 ID IE、DPC ID IE、XEh 信令传送网络层 (TNL) 地址 IE 和隧穿信息 IE。XEh 信令 TNL 地址 IE 可以包括适用于建立传送层会话的地址值。隧穿信息 IE 可以包括可用于封装不同的净荷协议、通过不可信的或未验证的网络建立安全的通信、在不兼容的传递网络上携带净荷和 / 或执行其他类似的隧穿操作的信息。

[0165] 为支持通过 / 向 DPC 146 的 XEh 连接性,在操作框 810 中,DSC 144 可以使用被包括在 DSC 注册接受消息中的 XEh 信令 TNL 地址 IE 来建立传送层会话。在一个实施例中,响应于确定 DSC 注册接受消息在 XEh 信令 TNL 地址信元中包括地址值,DSC 144 可以被配置成用于建立传送层会话。在一个实施例中,响应于确定 XEh 信令 TNL 地址信元不存在、为零、为空或无效,DSC 144 可以被配置成用于确定不支持或不需要通过 / 到 DPC 146 的 XEh 连接性。

[0166] 现在参照图 8B,在操作框 812 中,DPC 146 可以确定作为操作 804 的一部分所执行的那些注册操作失败。响应于检测到各种情况 / 事件(包括无法认证或授权 DSC、网络或组件过载、DSC 参数失配等)中的任何一种,DPC 146 可以确定注册失败。在操作 814 中,DPC

146 可以生成 DSC 注册拒绝消息并且将其发送至 DSC 144 以通知 DSC 144 注册失败和 / 或 DPC 146 无法注册 DSC 144。在各个实施例中，DPC 146 可以将 DSC 注册拒绝消息生成为包括以下各项中的任一项或全部：消息类型信元 (IE)、消息 ID IE、原因 IE、关键性诊断 IE 和退避定时器 IE。原因 IE 可以包括适合于对失败的特定原因（例如，过载等）进行标识或适合于指示失败的原因未知或未指明的信息。

[0167] 在操作框 816 中，DSC 144 可以基于被包括在所接收的注册拒绝消息中的信息执行各种注册失败响应操作。例如，响应于确定将所接收到的注册拒绝消息中的原因 IE 的值设为“过载”，DSC 144 可以在重新尝试注册同一个 DPC 146 之前等待在所接收的注册拒绝消息中的退避定时器 IE 中所指示的持续时间。

[0168] 参照图 8C，在操作框 852 中，响应于向 DPC 146 发送 DSC 注册请求消息（例如，作为操作 802 的一部分），DSC 144 可以启动注册响应定时器。在操作框 854 中，DSC 144 可以确定注册响应定时器在 DSC 144 接收到 DSC 注册响应消息之前到期。在操作 856 中，响应于确定在其接收到相应的 DSC 注册响应消息之前定时器到期，DSC 144 可以向 DPC 146 重新发送 DSC 注册请求消息。在操作框 858 中，DSC 144 可以重启或重置注册响应定时器。在操作 860 中，DPC 可以向 DSC 144 发送 DSC 注册响应消息。在操作框 862 中，响应于接收到 DSC 注册响应消息，DSC 144 可以停止注册响应定时器。

[0169] 图 9A 和 9B 展示了一种 DSAAP 广告方法 900，该 DSAAP 广告方法用于对可用于竞标 / 购买的资源进行广告以便允许 DPC 146 通过金融经纪平台存储、组织那些资源和 / 或使其可用于竞标 / 分配。在图 9A 和 9B 中所展示的示例中，DSAAP 广告方法 900 通过 DPC 146 组件和 DSC 144 组件中的处理核来执行，这些组件中的每个组件都可以包括 DSAAP 模块 / 组件的全部或部分。

[0170] 在图 9A 和 9B 所展示的操作框 902 中，DSC 144 可以确定在由那个 DSC 144 所服务的多个小区之内存在可用于分配的资源。在操作框 904 中，DPC 144 可以生成 DSC 资源注册请求消息并且将其发送至 DPC 146。在各个实施例中，DSC 144 可以将 DSC 资源注册请求消息生成为包括以下各项中的任一项或全部：消息类型信元 (IE)、消息 ID IE、DSC 标识 IE、DSC 类型 IE、PLMN-ID 列表 IE、资源可用性 IE、资源可用性开始时间 IE、数据带宽 IE、网格列表 IE、竞标或购买 IE、最小竞标量 IE、资源可用性结束时间 IE、时间 IE、持续时间 IE、兆比特每秒 (MBPS)IE 和小区标识 IE。

[0171] DSC 标识 IE 可以包括可由 DPC 146 用来确定 DSC 144 的标识的信息。例如，DSC 标识 IE 可以包括 DSC 池 ID、DSC 实例信息以及 DSC 正在管理或表示的网络的 PLMN ID。DSC 池 ID 可以是可用资源池的唯一标识符和 / 或可以与 3GPP EPC 架构中的 MME 池 ID 和 MME ID 相同或类似。

[0172] 消息 ID IE 可以包括用于从 DSC 144 发送的特定 DSC 资源注册请求消息的消息标识符。DSC 144 和 DPC 146 可以被配置成用于将消息 ID IE 用作序号以便对 DSC 资源注册请求消息、DSC 资源注册接受消息和 / 或 DSC 资源注册拒绝消息进行标识和关联。

[0173] 资源可用性 IE 可以包括适合于由 DPC 146 用来确定正在对资源进行广告以供其他网络分配和使用的网络的 PLMN ID 的信息。DPC 146 可以被配置成用于针对多个 DSC 和 / 或针对多个不同的网络（即，不同的 PLMN ID）来接收、存储和 / 或维护资源可用性 IE。因此，每个资源可用性 IE 可以包括适合于对正在广告资源的那些网络中的一个或多个网络

进行标识的信息。

[0174]　时间 IE 可以包括适合于由 DPC 146 用来确定 DSC 144 传输 DSC 资源注册请求消息的时间的信息。持续时间 IE 可以包括适用于确定将要使资源可用于竞标或购买的时间段的信息。

[0175]　数据带宽 IE 可以包括适用于确定在可选的持续时间 IE 中所指定的持续时间的可用带宽（即,以 MBPS 表示）的信息。响应于确定持续时间 IE 没有被包括在所接收的 DSC 资源注册请求消息中（或响应于确定持续时间 IE 并不包括有效值），DPC 146 可以确定使在 MBPS IE 中所指定的带宽是可用的直至该带宽被获胜的竞标者或购买者耗尽。

[0176]　网格列表 IE 可以包括适用于确定将要可用于竞标或购买的网络带宽的位置的多个网格标识符的信息。小区标识 IE 可以包括适用于确定每个网格内的各个小区（由网格 ID 和小区 ID 所标识）的信息,这些小区具有作为 DSC 资源注册请求消息中的报价的一部分的被提供用于竞标或购买的可用资源。最小竞标量 IE 可以包括以面额或纸币（如以美国美元 (USD)）表示的货币量。

[0177]　在图 9A 中所展示的操作框 906 中,DPC 146 可以接受 DSC 144 的用于竞标的资源。在操作 908 中，DPC 146 可以生成 DSC 资源注册响应消息或 DSC 资源注册接受消息并且将其发送至 DSC 144 以确认这些资源被接受。在各个实施例中，DPC 146 可以将 DSC 资源注册消息生成为包括以下各项中的任一项或全部 :消息类型信元 (IE)、竞标 ID IE 和消息 ID IE。消息 ID IE 可以包括在所接收的 DSC 资源注册请求消息中包括的同一个消息标识符值。DPC 146 和 / 或 DSC 可以被配置成用于使用消息 ID IE 的值来对 DSC 资源注册请求消息和 DSC 资源注册接受消息进行标识和关联。在操作框 910 中,DPC 146 可以通过金融经纪平台存储、组织网络资源和 / 或使其可用于竞标或购买。

[0178]　在图 9B 中所展示的操作 912 中,DPC 146 可以拒绝 DSC 资源注册请求消息和 / 或拒绝对在所接收的 DSC 资源注册请求消息中所标识的资源进行竞标。DPC 146 可以因为多种原因和 / 或响应于检测到多种事件或情况中的任何一种而拒绝消息 / 资源。例如,响应于确定 DPC 146 没有从任何运营商处接受资源、没有接受用于在所接收的消息中标识的特定运营商的资源、没有接受在消息中所标识的资源、DPC 过载、存储器不足以对可用于竞标的资源进行的存储和服务等，DPC 146 可以拒绝资源。响应于确定 DPC 146 的管理员已经禁用了来自 DSC 资源注册请求消息中所包括的特定 PLMN ID、来自所有网络（例如,所有的 PLMN ID) 的进一步的竞标等,DPC 146 也可以拒绝资源可用消息。

[0179]　在图 9B 中所展示的操作 914 中,DPC 146 可以生成 DSC 资源注册拒绝消息并且将其发送至 DSC 144。在各个实施例中,DPC 146 可以将 DSC 资源注册拒绝消息生成为包括以下各项中的任一项或全部 :消息类型信元 (IE)、消息 ID IE、原因 IE 和关键性诊断 IE。DPC 146 还可以将 DSC 资源注册拒绝消息生成为包括消息 ID IE,该消息 ID IE 包括与从 DSC 144 接收的 DSC 资源注册请求消息中所包括的消息标识符相同的值。DPC146 和 / 或 DSC 144 可以被配置成用于使用消息 ID IE 的值来对 DSC 资源注册请求消息和 DSC 资源注册拒绝消息进行标识和关联。

[0180]　在操作框 916 中,DSC 144 可以基于被包括在所接收的 DSC 资源注册拒绝消息中的信息而执行各种资源注册失败响应操作。例如，DSC 144 可以使用在 DSC 资源注册拒绝消息中所包括的信息来确定是否重新尝试向 DPC 146 注册资源、尝试向另一个 DPC 注册资源、

重新尝试注册不同的资源、或执行在本申请中所讨论的其他DSC操作中的任何DSC操作。

[0181] 图10A和10B展示了根据一个实施例的一种用于通信可用资源列表的DSAAP方法1000。可以执行DSAAP方法1000以通知多个承租者网络可用于竞标/购买的资源竞标或资源。在图10A和10B中所展示的示例中，DSAAP方法1000通过DPC 146组件和DSC 144组件中的处理核来执行，这些组件中的每个组件都可以包括DSAAP模块/组件的全部或部分。在一个实施例中，承租者DSC 144可以被配置成用于执行DSAAP方法1000以便在该DSC 144竞标、或请求租用或购买来自DPC 146的资源之前检索/接收可用资源列表。

[0182] 在图10A和10B中所展示的操作1002中，承租者DSC 144可以生成可用竞标请求消息并将其发送至DPC 146以请求来自出租者网络的可用于分配的资源竞标的信息以便进行竞标或购买。在各个实施例中，承租者DSC 144可以将可用竞标请求消息生成为包括以下各项中的任一项或全部:序号信元(IE)、消息类型IE、包括一个或多个PLMN ID IE的PLMN列表IE、包括一个或多个网格ID IE的网格ID列表IE。

[0183] 在一个实施例中，承租者DSC 144可以被配置成用于通过将可用竞标请求消息生成为包括特定网络的PLMN ID来从所期望的网络请求特定资源，该PLMN ID可以被包括在可用竞标请求消息中的PLMN列表IE的PLMN ID IE中。

[0184] 在一个实施例中，承租者DSC 144可以被配置成用于通过不对所生成的可用竞标请求消息中的PLMN列表IE进行填充和/或通过将可用竞标请求消息生成为不包括PLMN列表IE和/或PLMN ID值来从任何可用网络请求资源。

[0185] 在一个实施例中，承租者DSC 144可以被配置成用于通过将可用竞标请求消息生成为包括特定网格的网格ID来从所期望的网格请求资源，该网格ID可以被包括在可用竞标请求消息中的网格ID列表IE的网格ID IE中。

[0186] 在一个实施例中，承租者DSC 144可以被配置成用于通过不对所生成的可用竞标请求消息中的网格ID列表IE进行填充和/或通过将可用竞标请求消息生成为不包括网格ID来从PLMN ID IE网格中的指定PLMN ID内的任何或全部网格请求资源。

[0187] 在图10A和10B中所展示的操作框1004中，DPC 146可以确定在所接收的可用竞标请求消息中所包括的PLMN ID和网格ID是否有效。如果PLMN ID和网格ID是不正确的，在操作框1005中，DPC 146可以确定用于错误/不正确的值的原因代码。在操作框1006中，DPC 146可以确定是否存在可用于在所接收的可用竞标请求消息中所标识的每个网格或可用于所有可用网格的资源/竞标(例如，当在所接收的可用竞标请求消息中的网格ID列表IE不包括有效值时)。

[0188] 在图10A中所展示的操作1008中，DPC 146可以生成可用竞标响应消息并且将其发送至DSC 144。DPC 146可以被配置成用于将可用竞标响应消息生成为包括以下各项中的任一项或全部:消息类型信元(IE)、消息ID IE、DSC标识IE、PLMN-ID网格小区竞标信息列表IE、序号IE、包括一个或多个PLMN ID IE的PLMN列表IE以及网格列表IE。在一个实施例中，PLMN列表IE和网格列表IE可以被包括在PLMN-ID网格小区竞标信息列表IE中。在一个实施例中，网格列表IE可以包括包含一个或多个小区ID IE的一个或多个小区ID列表IE。

[0189] 在各个实施例中，DPC 146可以将可用竞标响应消息生成为还包括以下各项中的任一项或全部:绝对射频信道号(ARFCN)IE、信道带宽IE、用于标识总可用带宽的兆位或兆

字节 IE、用于标识资源的峰值数据速率的 MBPS IE、资源可用时间 IE、资源到期时间 IE、竞标/购买 IE、竞标/购买到期时间 IE、最小竞标量 IE 以及购买价格 IE。DPC146 可以将可用竞标响应消息生成为包括用于该消息中所标识的每个 PMLN、每个资源、每个网格和/或每个小区的这种信息。

[0190] 在一个实施例中，响应于确定存在针对可用于拍卖的资源的竞标，DPC 146 可以被配置成用于将可用竞标响应消息生成为包括 PLMN ID 列表、在每个 PLMN 内的多个网格 ID 列表以及在每个网格内的可用资源/竞标。

[0191] 在一个实施例中，响应于确定没有用于可用于由 DPC 146 针对相关网络/PLMN ID 进行的拍卖的资源的资源/竞标，该 DPC 146 可以被配置成用于将可用竞标响应消息生成为包括消息类型 IE 和序号 IE（或这些 IE 的有效值）。在一个实施例中，DPC 146 可以被配置成用于将可用竞标响应消息生成为包括具有与在所接收的可用竞标请求消息中所包括的序号 IE 中相同的值的序号 IE。在一个实施例中，DSC 144 可以被配置成用于使用这些请求消息和响应消息中的序号 IE 来使这些消息相关联。

[0192] 在一个实施例中，DPC 146 可以被配置成用于将可用竞标响应消息生成为包括包含 PLMN ID 的 PLMN 列表 IE 以及网格 ID 列表 IE。该网格 ID 列表 IE 可以包括在网格内可用于拍卖的小区列表。该小区 ID 列表 IE 可以包括小区 ID，以及针对每个小区的 ARFCN、信道带宽、总可用带宽、所允许的峰值数据速率、资源可用以及它们到期/结束的时间（例如，以 UTC 表示）、是否是竞标或购买类型的拍卖、最小竞标量或购买价格、竞标到期时间（例如，以 UTC 表示）以及其他类似的信息。

[0193] 在操作框 1010 中，DSC 144 可以使用可用竞标响应消息中所包括的信息来对可用于竞标的资源进行标识、确定 DSC 144 是否将提交针对可用资源的竞标、确定 DSC 144 将要提交竞标所针对的资源和/或执行其他类似的操作。

[0194] 参照图 10B，在操作 1012 中，DPC 146 可以通过生成可用竞标拒绝消息并将其发送至 DSC 144 来拒绝接收自承租者 DSC 144 的可用竞标请求消息。响应于确定（例如，作为操作 1004 或 1006 的一部分）请求消息中所提供的 PLMN ID 中的一个或多个 PLMN ID 不是来自任何已知网络、请求消息中所提供的网格 ID 中的一个或多个网格 ID 相对于所提供的 PLMN ID 不是有效的和/或在相关网格内没有可用的资源/竞标，DPC 146 可以被配置成用于拒绝可用竞标请求消息。

[0195] 在一个实施例中，DPC 146 可以被配置成用于将可用竞标拒绝消息生成为包括消息类型信元(IE)、消息 ID IE、原因 IE、关键性诊断 IE 和序号 IE。原因 IE 可以包括对可用竞标请求的拒绝的原因代码（例如，无效 PLMN ID、无效网格 ID 等），该原因代码可以在操作框 1005 中确定。序号 IE 可以包括与接收自承租者 DSC 144 的可用竞标请求消息中所包括的序号值相同的序号值。因此，DPC 146 和/或 DSC 144 可以被配置成用于使用请求消息和响应消息中的序号 IE 来使那些消息互关联。

[0196] 在操作框 1014 中，DSC 144 可以使用在所接收的可用竞标拒绝消息中所包括的信息来执行各种失败响应操作。例如，DSC 144 可以确定是否向 DPC 146 发送可用竞标请求消息、确定是否向不同的 DPC 发送另一个可用竞标请求消息等。

[0197] 图 11A 和 11B 展示了一种对 DSC 资源进行竞标的 DSAAP 竞标方法 1100，该方法允许不同的承租者网络对可从多个出租者网络获得的资源进行竞标。在图 11A 和 11B 中所展

示的示例中，DSAAP 方法 1100 通过 DPC 146 组件和 DSC 144 组件中的处理核来执行，这些组件中的每个组件都可以包括 DSAAP 模块 / 组件的全部或部分。

[0198] 在一个实施例中，DSC 144 和 / 或 DPC 146 可以被配置成用于在 DSC 144 检索到可用于竞标的资源列表之后（例如，执行 DSAAP 方法 1000 之后）执行 DSAAP 方法 1100。在各个实施例中，DSC 144 和 / 或 DPC 146 可以被配置成用于连续地或重复地执行 DSAAP 方法 1100，直至竞标时间到期。在一个实施例中，DPC 146 可以被配置成用于在竞标时间到期时选择获胜竞标（即，出价最高竞标值）。

[0199] 在图 11A 和 11B 中所展示的方法 1100 的操作 1102 中，承租者 DSC 144 可以生成 DSC 竞标请求消息并将其发送至 DPC 146 以对被确定为可从出租者网络获得的资源中的一个或多个资源（即，通过方法 1000 的执行获得的资源列表中所包括的一个或多个资源）进行竞标。承租者 DSC 144 可以被配置成用于将 DSC 竞标请求消息生成为包括以下各项中的任一项或全部：消息类型信元 (IE)、消息 ID IE、DSC 标识 IE、DSC 类型 IE、竞标 ID IE、PLMN ID IE 和竞标量 IE。竞标 ID IE 可以包括适合于对承租者 DSC144 进行出价所针对的特定资源进行标识的信息。PLMN ID IE 可以包括适用于对与在竞标 ID IE 中所标识的资源相关联的网络的 PLMN ID 进行标识的信息。竞标量 IE 可以包括以纸币（例如，USD）表示的货币量或竞标值。

[0200] 在一个实施例中，承租者 DSC 144 可以被配置成用于将 DSC 竞标请求消息生成为包括竞标量 IE 值，该竞标量 IE 值大于在竞标列表中针对于特定资源 / 竞标 ID 所指定的最小竞标量。在一个实施例中，承租者 DSC 144 可以被配置成用于从所接收的可用竞标响应消息（例如，作为在图 10A 中所展示的操作 1008 的一部分而发送的消息）中获得最小竞标量和 / 或竞标列表。

[0201] 在图 11A 中所展示的操作框 1104 中，DPC 146 可以使用所接收的 DSC 竞标请求消息中所包括的信息来确定竞标（资源竞标）是否有效并且是否将被接受，如通过确定竞标是否符合 DSA 系统的策略和规则以及出租者网络的要求。在操作 1106 中，响应于确定竞标是有效的和 / 或将要被接受，DPC 146 可以生成 DSC 竞标接受消息并将其发送至 DSC。DPC 146 可以被配置成用于将 DSC 竞标接受消息生成为包括以下各项中的任一项或全部：消息类型信元 (IE)、消息 ID IE、竞标 ID IE 以及适合于通知 DSC 144 该竞标已经被确定为有效和 / 或已经被接受的其他信息。

[0202] 应指出的是，在以上所讨论的示例中，DSC 竞标接受消息通知 DSC 144 该竞标有效 / 被接受而不是承租者 DSC144 已经赢得竞标。当 DPC 146 确定竞标时间已经到期并且承租者 DSC 是在竞标到期时的最高竞标者，可以通过 DSC 竞标获胜消息来通知获胜的承租者 DSC。类似地，DPC 146 可以通过 DSC 竞标失败消息通知参与竞标过程但是提交了失败的竞标的一个或多个承租者 DSC 它们没有提交获胜竞标。以下进一步对 DSC 竞标获胜消息和 DSC 竞标失败消息进行更详细的讨论。

[0203] 参照图 11B，在操作框 1108 中，DPC 146 可以使用在所接收到的 DSC 竞标请求消息中所包括的信息来确定竞标无效并且将不被接受。例如，DPC 146 可以使用所接收的信息来确定竞标不符合 DSA 系统的策略 / 规则和 / 或不符合出租者网络的要求（例如，不满足最小要价等）。作为进一步的示例，响应于确定竞标请求消息中的竞标量 IE 中特定的竞标量不高于最小竞标、竞标量不是当前报价竞标中的最高量、竞标 ID IE 中所包括的竞标 id

是无效的或竞标 / 资源不再可用于竞标(例如,由于到期、拍卖结束、竞标撤销或无效竞标 id),DPC 146 可以被配置成用于确定竞标无效或不被接受。

[0204] 在操作 1110 中,DPC 146 可以生成 DSC 竞标拒绝消息并且将其发送至 DSC 144。DPC 146 可以被配置成用于将 DSC 竞标拒绝消息生成为包括以下各项中的任一项或全部:消息类型信元 (IE)、消息 ID IE、竞标 ID IE、原因 IE 和关键性诊断 IE。DSC 竞标拒绝消息中的竞标 ID IE 可以包括与所接收的 DSC 竞标请求消息中所包括的竞标标识符相同的值。原因 IE 可以包括对拒绝竞标的原因进行标识的原因代码(例如,未满足最小竞标、出价过高、未发现竞标等)。在操作框 1112 中,DSC 144 可以使用在所接收的 DSC 竞标拒绝消息中所包括的信息来执行各种竞标请求失败响应操作,如确定是否对资源进行重新竞标、生成包括有效竞标 ID 的新的 DSC 竞标请求消息的操作等。

[0205] 图 12A 至 12D 展示了一种通知多个参与网络这些竞标操作的结果的 DSAAP 通知方法 1200。也就是,可以执行 DSAAP 通知方法 1200 来通知多个 DSC 144 拍卖结果(例如,它们提交了获胜竞标、它们已经被击败、它们提交了失败的竞标、拍卖被取消等)。在图 12A 至 12D 中所展示的示例中,DSAAP 通知方法 1200 通过 DPC 146 组件和 DSC 144 组件中的处理核来执行,这些组件中的每个组件都可以包括 DSAAP 模块 / 组件的全部或部分。

[0206] 可以在 DPC 146 通知 DSC 144 竞标已经被接受之后(例如,在图 11 中所展示的操作 1106 之后)执行 DSAAP 通知方法 1200。还可以在竞标时间到期之后和 / 或响应于 DPC146 检测到事件或情况(例如,新竞标被接收、出价过高等)执行 DSAAP 通知方法 1200。

[0207] 在图 12A 中所展示的操作框 1202 中,DPC 146 可以确定在从 DSC 144 所接受的最后、最近或最当前竞标请求消息中的竞标量 IE 中特定的竞标量不是当前竞标中的最高量。在操作 1204 中,DPC 146 可以生成 DSC 竞标出价过高消息并将其发送至 DSC 144 以通知承租者 DSC 144 其早前的竞标被来自其他承租者 DSC 的更高竞标所击败和 / 或它们的早前竞标不再有效。在各个实施例中,DPC 146 可以将 DSC 竞标出价过高消息生成为包括以下各项中的任一项或全部:消息类型信元 (IE)、消息 ID IE、原因 IE、竞标消息 IE、关键性诊断 IE、DSC ID IE 和竞标 ID IE。

[0208] DSC ID IE 可以包括适用于对特定承租者 DSC 144 进行标识的信息。竞标 ID IE 可以包括适用于对已经被击败的所提交的竞标进行标识的竞标 ID。在操作框 1206 中,承租者 DSC 144 可以执行各种竞标出价过高失败响应操作,如通过确定是否向该 DPC 146 提交针对资源的更高竞标、是否向不同的 DPC 146 提交竞标、是否挂断现有通话以释放带宽等。

[0209] 参照图 12B,在操作框 1210 中,DPC 146 可以确定竞标时间已经到期并且在从 DSC144 所接受的最后、最近或最当前竞标请求消息中的竞标量 IE 中特定的竞标量是当前竞标中的最高量。在操作 1212 中,DPC 146 可以生成 DSC 竞标获胜消息并将其发送至 DSC144 以通知承租者 DSC 144 它们早前的竞标是获胜竞标。在各个实施例中,DPC 146 可以将 DSC 竞标获胜消息生成为包括以下各项中的任一项或全部:消息类型信元 (IE)、消息 ID IE、竞标 ID IE、竞标信息 IE、DSC ID IE 以及原始竞标细节(如,带宽、MBPS、持续时间和获胜竞标量等)。DSC ID IE 可以包括适用于对特定承租者 DSC 144 进行标识的信息。竞标 ID IE 可以包括适合于对赢得资源拍卖 / 竞标操作的竞标进行标识的竞标标识符。

[0210] 在操作框 1214 中,在调度其网络装置和设备(例如,无线设备)来开始使用资源和 / 或使资源可供使用之前(即,对资源将准备好可供获胜的承租者网络使用的时间进行

调度），获胜的承租者 DSC 144 可以等待从 DPC 146 接收 DSC 资源已分配消息。在操作框 1216 中，DPC 146 可以关闭拍卖，如通过拒绝来自其他网络的针对由承租者 DSC 144 所提交的竞标赢得的资源的进一步竞标。

[0211] 参照图 12C，在操作框 1220 中，DPC 146 可以确定竞标时间已经到期并且在从 DSC144 所接受的最后、最近或最当前竞标请求消息中的竞标量 IE 中特定的竞标量不是当前竞标中的最高量。在操作 1222 中，DPC 146 可以生成 DSC 竞标失败消息并将其发送至 DSC 144 以通知承租者 DSC 144 其早前的竞标未赢得竞标并且由于另一个承租者 DSC 赢得拍卖导致拍卖 / 竞标被关闭。在各个实施例中，DPC 146 可以将 DSC 竞标失败消息生成为包括以下各项中的任一项或全部：消息类型信元 (IE)、消息 ID IE、竞标 ID IE 和 DSC ID IE。DSC ID IE 可以包括适用于对提交了失败的竞标和 / 或 DSC 竞标失败消息被发送至的的特定承租者 DSC 144 进行标识的信息。竞标 ID IE 可以包括适用于对所提交的竞标进行标识的竞标标识符。

[0212] 在操作框 1224 中，承租者 DSC 144 可以执行各种失败响应操作，如确定是否针对其他可用资源提交竞标、是否挂断现有呼叫以腾出资源等。在操作框 1226 中，DPC 146 可以关闭拍卖和 / 或允许失败的承租者 DSC 对其他可用资源进行竞标。

[0213] 参照图 12D，在操作框 1230 中，DPC 146 可以确定已经取消了 DSC 144 先前所提交的针对网络资源的拍卖。例如，DPC 146 可以确定出租者网络运营商已经撤消拍卖或者 DPC 运营商因为管理原因已经取消拍卖。在操作 1232 中，DPC 146 可以生成 DSC 竞标取消消息并将其发送至 DSC 144 以通知承租者 DSC 144 拍卖已经被取消。在各个实施例中，DPC 146 可以将 DSC 竞标取消消息生成为包括以下各项中的任一项或全部：消息类型信元 (IE)、消息 ID IE、竞标 ID IE、DSC ID IE 和原因 IE。DSC ID IE 可以包括适用于对特定承租者 DSC 144 进行标识的信息。竞标 ID IE 可以包括适用于对拍卖已经被取消所针对的资源 / 竞标进行标识的竞标标识符。原因 IE 可以包括竞标的取消的原因代码（例如，竞标撤销、竞标取消等）。在操作框 1234 中，承租者 DSC 144 可以执行各种失败响应操作，如通过确定是否向不同的 DPC 146 提交竞标、是否挂断呼叫等。

[0214] 图 13A 和 13B 展示了允许承租者网络进行立即（或几乎立即）的购买和 / 或要求对可用于由出租者网络分配的资源的使用的 DSAAP 购买方法 1300。在图 13A 和 13B 中所展示的示例中，DSAAP 购买方法 1300 通过 DPC 146 组件和 DSC 144 组件中的处理核来执行，这些组件中的每个组件都可以包括 DSAAP 模块 / 组件的全部或部分。在一个实施例中，DSC 144 和 DPC 146 可以被配置成用于在 DSC 144 检索 / 接收可供购买的资源列表之后（例如，在执行以上关于图 10 所讨论的 DSAAP 方法 1000 之后）执行 DSAAP 方法 1300。

[0215] 在图 13A 和 13B 所展示的操作框 1302 中，承租者 DSC 144 可以从资源列表（例如，从执行以上所讨论的 DSAAP 方法 1000 所获得的资源列表）中标识并选择用于立即购买的特定资源。在各个实施例中，承租者 DSC 144 可以选择针对竞标所调度的、当前正在被拍卖的、仅可用于立即购买等的资源。在操作 1304 中，DSC 144 可以生成 DSC 购买请求消息并将其发送至 DPC 146 以请求从出租者网络购买所标识的 / 所选择的资源。

[0216] 在各个实施例中，DSC 144 可以将 DSC 购买请求消息生成为包括以下各项中的任一项或全部：消息类型信元 (IE)、消息 ID IE、DSC 标识 IE、DSC 类型 IE、竞标 ID IE、购买量 IE 和 PLMN ID IE。PLMN ID IE 可以包括适用于对与可以由竞标 ID IE 标识的竞标相关联

的网络的PLMN ID进行标识的信息。购买量IE可以包括由承租者DSC 144所提交的竞标的量(例如,以USD表示)(即竞标值)。
[0217] 在一个实施例中,DSC 144可以被配置成用于将DSC购买请求消息生成为包括购买量值,该购买量值等于通过包括在所接收的可用竞标响应消息(以上参照图10所讨论的)中所包括的竞标ID的列表中的购买量IE进行标识的量。
[0218] 在图13A中所展示的操作框1306中,DPC 146可以使用在所接收的DSC购买请求消息中所包括的信息来标识以下各项:所请求的资源、与请求资源相关联的网络、所请求的资源是否当前正在被拍卖、所请求的资源是否已经可用于立即购买、针对该资源的立即购买所请求的最小购买量和/或在所接收的DSC购买请求消息中所包括的购买量是否等于(或大于)所请求的购买量。在图13A中所展示的示例中,作为操作框1306的一部分,DPC 146确定在所接收的DSC购买请求消息中所包括的购买量大于或等于所请求的购买量。
[0219] 在操作1308中,DPC 146可以生成DSC购买接受消息并将其发送至DSC 144以通知承租者DSC 144它已经成功地购买/租用资源进行使用。在各个实施例中,DPC 146可以将DSC购买接受消息生成为包括以下各项中的任一项或全部:消息类型信元(IE)、消息ID IE和竞标ID IE。在操作框1310中,DPC 146可以终止、停止或关闭针对该资源的活跃拍卖和/或执行类似的操作,从而使得该资源不再可用于竞标或由其他承租者DSC购买。
[0220] 参照图13B,在操作框1312中,DPC 146可以使用在所接收到的DSC购买请求消息(例如,作为操作1304的一部分)中所包括的信息来确定竞标(购买请求)将被拒绝。例如,DPC 146可以确定在所接收到的DSC购买请求消息中的购买量IE中特定的购买量小于所请求的购买量。作为另一个示例,DPC 146可以确定在竞标ID IE中所包括的竞标ID值是无效的、或者资源/竞标不再可用于竞标(由于到期、拍卖结束、竞标撤销、无效竞标ID等)。
[0221] 在操作1314中,DPC 146可以生成DSC购买拒绝消息并且将其发送至DSC 144。在各个实施例中,DPC 146可以将DSC购买拒绝消息生成为包括以下各项中的任一项或全部:消息类型信元(IE)、消息ID IE、竞标ID IE和原因IE。竞标ID IE的值可以与在作为操作1304的一部分所接收的DSC购买请求消息中所包括的竞标标识符相同。原因IE可以包括拒绝购买请求的原因代码(例如,未满足所请求的购买价格、未发现竞标等)。在操作框1316中,DSC 1316可以执行各种失败响应操作,如确定是否提交具有更高竞标量的新的购买请求。在操作框1318中,DPC 146执行各种操作,以便使得该资源可供其他承租者DSC竞标或购买。
[0222] 图14A和14B展示了一种用于在出租者网络中分配资源以供承租者网络中的多个组件接入和使用的DSAAP资源分配方法1400。在图14A和14B中所展示的示例中,DSAAP资源分配方法1400通过DPC 146组件、承租者DSC 144a组件和出租者DSC 144b组件中的处理核来执行,这些组件中的每个组件都可以包括DSAAP模块/组件的全部或部分。
[0223] 在图14A和14B中所展示的操作框1402中,DPC 146可以确定承租者DSC 144a已经成功地购买或赢得对由出租者DSC 144b所表示的出租者网络中的资源的拍卖。在图14A中所展示的操作1404中,DPC 146可以生成DSC竞标成功消息并将其发送至出租者DSC 144b以通知出租者网络其所分配的资源/竞标中的一个或多个已经被承租者DSC 144a所赢得。

[0224] 在各个实施例中，DPC 146 可以将 DSC 竞标成功消息生成为包括以下各项中的任一项或全部：消息类型信元(IE)、消息 ID IE、原因 IE 和关键性诊断 IE。在进一步的实施例中，DPC 146 可以被配置成用于将 DSC 竞标成功消息生成为还包括以下各项中的任一项或全部：竞标 ID IE、DSC ID IE 和竞标值 IE。这些额外信元可以用于通信关于获胜竞标的信息。例如，竞标 ID IE 可以包括竞标 ID，该竞标 ID 对应于成功地参与并赢得针对资源的拍卖的竞标。DSC ID IE 可以包括拍卖赢家（即，承租者 DSC 144a）的 DSC ID。竞标值 IE 可以包括获胜竞标量和／或资源的购买价格。

[0225] 在操作 1404 中，出租者 DSC 144b 可以生成 DSC 资源已分配消息并将其发送至 DPC146 以分配／提交资源以供承租者网络中的多个组件接入和使用。出租者 DSC 144b 可以被配置成用于将 DSC 资源已分配消息生成为包括以下各项中的任一项或全部：消息类型信元(IE)、消息 ID IE、竞标 iD、PLMN-ID 网格 ID 小区 ID 列表 IE、PLMN ID IE、网格 ID IE、小区 ID 列表 IE 以及各种拍卖／资源细节（例如，带宽、MBPS、持续时间等）。在一个实施例中，PLMN ID IE、网格 ID IE 和小区 ID 列表 IE 可以被包括在 PLMN-ID 网格 ID 小区 ID 列表 IE 中。PLMN ID IE 可以包括分配资源的出租者网络的 PLMN ID，该 PLMN ID 可以是在获胜竞标中所标识的同一个 PLMN ID/ 网络。网格 ID IE 和小区 ID 列表 IE 可以包括适合于对与这些资源相关联的网格／小区进行标识的信息。这些值可以与获胜竞标中所包括的网格／小区值相同。

[0226] 在操作 1406 中，DPC 146 可以向获胜的承租者 DSC 144a 转发所接收到的 DSC 资源已分配消息以便使得承租者 DSC 144a 开始使用出租者网络资源中的已分配资源。在操作框 1408 中，承租者 DSC 144a 可以调度其自身的网络装置从作为竞标的一部分而指定的和／或在所接收的 DSC 资源已分配消息中所包括的时间开始使用出租者网络资源。

[0227] 参照图 14B，在操作框 1410 中，出租者 DSC 144b 可以确定针对拍卖所提交的资源应当被撤销和／或放弃向拍卖的赢家分配所提交的资源。在 DPC 146 确定承租者网络购买或赢得针对资源的拍卖之后和／或为了各种原因中的任何一种原因（例如，无法预料的原因或管理原因等），出租者 DSC 144b 可以确定撤销这些资源。

[0228] 在操作 1412 中，出租者 DSC 144b 可以生成 DSC 资源撤消消息并且将其发送至 DPC146 以撤销资源。出租者 DSC 144b 可以将 DSC 资源撤消消息生成为包括以下各项中的任一项或全部：消息类型信元(IE)、消息 ID IE、竞标 ID IE、原因 IE 和 PLMN-ID 网格 ID 小区 ID 列表 IE。竞标 ID IE 可以包括适用于对竞标进行标识的信息。原因 IE 可以包括描述撤销资源分配的原因的原因代码（例如，资源不可用、资源撤销、管理等）。

[0229] 在操作 1414 中，DPC 146 可以将所接收到的 DSC 资源撤消消息转发至可能已经针对所撤销的资源提交获胜竞标的承租者 DSC 144a。在操作框 1416 中，承租者 DSC 144a 可以执行各种失败响应操作，如确定是否参与另一个拍卖、是否对不同的资源进行竞标、确定是否挂断呼叫以腾出资源等。

[0230] 图 15A 和 15B 展示了一种将无线设备从出租者网络选择性地切换回无线设备所订阅的承租者的网络（即，其归属 PLMN）的实施例 DSAAP 退避方法 1500。在图 15A 和 15B 中所展示的示例中，DSAAP 退避方法 1500 通过 DPC 146 组件、承租者 DSC 144a 组件和出租者 DSC 144b 组件中的处理核来执行，这些组件中的每个组件都可以包括 DSAAP 模块／组件的全部或部分。

[0231] 在图 15A 和 15B 中所展示的操作框 1502 中，出租者 DSC 144b 可以确定其来自作为前一次拍卖的一部分的小区的网络资源处于拥塞。也就是，出租者 DSC 144b 可以确定其需要对其所分配的资源的接入或使用。在操作 1504 中，出租者 DSC 144b 可以生成 DSC 退避命令消息并将其发送至 DPC 146 以将正在使用出租者网络的所分配的资源的一个或多个无线设备选择性地切换回到承租者网络（即，其归属 PLMN）。

[0232] 出租者 DSC 144b 可以被配置成用于将 DSC 退避命令消息生成为包括以下各项中的任一项或全部：消息类型信元 (IE)、消息 ID IE、竞标 ID IE、UE 标识 IE、测量报告 IE、切离小区信息 IE、原因 IE 和 DSC 退避响应定时器 IE。

[0233] UE 标识 IE 可以包括适用于确定用于无线设备（或 UE）的标识相关的信息，如无线设备或其网络的国际移动订户标识 (IMSI)。

[0234] 测量报告 IE 可以包括出租者网络针对所标识的无线设备（即，被要求退避到承租者网络的无线设备）接收到的最新、最后或最近的测量报告 E-UTRAN RRC 消息。

[0235] 竞标 ID IE 可以包括竞标 ID 值，该竞标 ID 值对应于成功地参与并完成 / 赢得拍卖的竞标。竞标 ID 可以用于对与这些退避操作相关联的拍卖 / 合同（即，分配资源所针对的拍卖 / 合同）进行标识。

[0236] 在一个实施例中，出租者 DSC 144b 可以被配置成用于确定是否存在多个对应于拥塞小区的竞标 ID。在一个实施例中，响应于确定存在多个对应于拥塞小区的竞标 ID，出租者 DSC 144b 可以被配置成用于从多个竞标 ID 中选择竞标 ID 值。在各个实施例中，出租者 DSC 144b 可以被配置成用于基于在出租者 DSC 144b 处所供应的运营商策略、基于之前的约定、基于出租者网络与承租者网络之前协商的策略 / 规则等来选择竞标 ID 值。

[0237] 在操作 1506 中，DPC 146 可以将所接收到的 DSC 退避命令消息转发至承租者 DSC144a。在操作框 1508 中，承租者 DSC 144a 可以使用所接收的 DSC 退避命令消息的 UE 标识 IE 中的信息来对将要经受退避操作的一个或多个无线设备（即，将要被切换回的无线设备）进行标识。

[0238] 在操作框 1510 中，承租者 DSC 144a 可以使用所接收的 DSC 退避命令消息的测量报告 IE 中所包括的信息来确定、标识和 / 或选择所标识的一个或多个无线设备将要切换至的（在承租者网络之内）目标小区（出租者网络可以具有来自无线设备的之前（如当它们被附接或被切换至出租者网络时）被使能的测量报告）。

[0239] 在操作 1512 中，承租者 DSC 144a 可以生成 DSC 退避响应消息并且将其发送至 DPC146。承租者 DSC 144a 可以被配置成用于将 DSC 退避响应消息生成为包括以下各项中的任一项或全部：消息类型信元 (IE)、消息 ID IE、竞标 ID IE、UE 标识 IE、切离小区信息 IE 和原因 IE。在一个实施例中，响应于确定无法针对切换而标识或选择（在承租者网络内的）合适的目标小区，承租者 DSC 144a 可以被配置成用于将 DSC 退避响应消息生成为包括原因 IE（或原因 IE 的值）。原因 IE 的值可以标识失败的原因，如网络过载、没有找到适当的目标小区或未知无线设备 /UE。在一个实施例中，响应于成功地对无线设备可以被切换至的（在承租者网络内的）目标小区进行标识，承租者 DSC 144a 可以被配置成用于将 DSC 退避响应消息生成为包括切离小区信息 IE 的值（例如，目标小区信息）。

[0240] 在操作 1514 中，DPC 146 可以基于在所接收的 DSC 退避响应消息中所包括的竞标 id IE 来标识出租者 DSC 144a 并且将所接收的 DSC 退避响应消息转发至出租者 DSC144b。

在操作框 1516 中，出租者 DSC 144b 可以确定所接收的 DSC 退避响应消息是否包括切离小区信息 IE（或切离小区信息 IE 的有效值）。响应于确定所接收的 DSC 退避响应消息包括切离小区信息 IE（或切离小区信息 IE 的有效值），在操作框 1518 中，出租者 DSC 144b 可以使用在切离小区信息 IE 中所包括的目标小区信息来对要求切换消息进行编码。在操作框 1520 中，出租者 DSC 144b 可以并且发起基于 S1 的切换过程以将无线设备从出租者网络切换至承租者网络。

[0241] 参照图 15B，在操作框 1552 中，出租者 DSC 144b 可以确定 DPC 146 在 DSC 退避命令消息中所包括的 DSC 退避响应定时器 IE 中所标识的时间段内尚未对（作为操作 1504 的一部分而被发送的）DSC 退避命令消息做出响应。可替代地或此外，在操作框 1554 中，出租者 DSC 144b 可以确定：存在显著的或严重的网络拥塞或者需要撤销对与在 DSC 退避命令消息中所包括或标识的资源 / 竞标 id 有关的所有剩余网络资源的分配的管理原因。

[0242] 在操作 1556 中，承租者 DSC 144b 可以生成 DSC 资源撤消消息并将其发送至 DPC146。在操作 1558 中，DPC 146 可以将所接收到的 DSC 资源撤消消息转发至承租者 DSC144a 以撤销对剩余网络资源的分配。在操作框 1560 中，承租者 DSC 144a 可以执行各种资源撤销失败响应操作，如挂断呼叫、确定是否针对新资源进行竞标等。

[0243] 图 16A 展示了一种用于终止操作的实施例 DSC 发起的 DSAAP 注销方法 1600。在图 16A 中所展示的示例中，DSC 发起的 DSAAP 注销方法 1600 通过 DPC 146 组件和 DSC144 组件中的处理核来执行，这些组件中的每个组件都可以包括 DSAAP 模块 / 组件的全部或部分。

[0244] 在操作框 1602 中，DSC 144 可以确定其需要终止 DSA 操作。在操作 1604 中，DSC144 可以生成 DSC 注销消息并且将其发送 DPC 146。DSC 144 可以被配置成用于将 DSC 注销消息生成为包括以下各项中的任一项或全部：消息类型信元 (IE)、消息 ID IE、退避定时器 IE 以及对终止这些操作的原因进行标识的原因 IE。在操作框 1606 中，响应于接收到 DSC 注销消息，DPC 146 可以清除所有与 DSC 144 相关联的相关资源和 / 或执行其他类似的操作以注销 DSC 144。

[0245] 图 16B 展示了一种用于终止操作的实施例 DPC 发起的 DSAAP 注销方法 1650。在图 16B 中所展示的示例中，DPC 发起的 DSAAP 注销方法 1650 通过 DPC 146 组件和 DSC144 组件中的处理核来执行，这些组件中的每个组件都可以包括 DSAAP 模块 / 组件的全部或部分。

[0246] 在操作框 1652 中，DPC 146 可以确定其需要终止与 DSC 144 的 DSA 操作。在操作 1654 中，DPC 146 可以生成 DSC 注销消息并且将其发送至 DSC 144。DPC 146 可以被配置成用于将 DSC 注销消息生成为包括以下各项中的任一项或全部：消息类型信元 (IE)、消息 ID IE、退避定时器 IE 以及对终止这些操作的原因进行标识的原因 IE（例如，过载、未指定等）。在操作框 1656 中，DPC 146 可以清除所有与 DSC 144 相关联的相关资源和 / 或执行其他类似的操作以注销 DSC 144。

[0247] 在操作框 1658 中，DSC 144 可以基于被包括在所接收的 DSC 注销消息中的信息执行各种注销失败响应操作。例如，当 DSC 注销消息中的原因 IE 的值被设为“过载”时，DSC 144 可以被配置成用于至少在被包括于所接收的 DSC 注销消息中的退避定时器 IE 中所指示的持续时间内不重试向同一个 DPC 146 进行注册。

[0248] 图 17A 展示了根据一个实施例的一种用于报告错误的 DSC 发起的 DSAAP 错误指示方法 1700。在图 17A 中所展示的示例中，方法 1700 通过 DPC 146 组件和 DSC 144 组件中的

处理核来执行，这些组件中的每个组件都可以包括 DSAAP 模块 / 组件的全部或部分。

[0249] 在操作框 1702 中，DSC 144 可以检测错误或错误情况（例如，协议错误等）。在操作 1704 中，DSC 144 可以生成错误指示消息并且将其发送至 DPC 146。DSC 144 可以被配置成用于将错误指示消息生成为包括以下各项中的任一项或全部：消息类型信元（IE）、消息 ID IE、原因 IE 和关键性诊断 IE。原因 IE 可以包括适用于对错误（例如，转移语法错误、抽象语法错误、逻辑错误等）的原因或类型进行标识的信息。关键性诊断 IE 可以包括过程代码 IE、触发消息 IE 和过程关键性 IE。在操作框 1706 中，DSC 144 和 / 或 DPC 146 可以基于所检测到的错误或在所接收的错误指示消息中所包括的信息来执行各种错误响应操作。以下进一步对错误检测和响应操作进行详细讨论。

[0250] 图 17B 展示了根据另一个实施例的一种用于报告错误的 DPC 发起的 DSAAP 错误指示方法 1750。在图 17B 中所展示的示例中，方法 1750 通过 DPC 146 组件和 DSC 144 组件中的处理核来执行，这些组件中的每个组件都可以包括 DSAAP 模块 / 组件的全部或部分。

[0251] 在操作框 1752 中，DPC 146 可以检测错误情况。在操作 1754 中，DPC 146 可以生成错误指示消息并且将其发送至 DSC 144。DPC 146 可以被配置成用于将错误指示消息生成为包括对错误的原因进行标识的原因信元（IE）。在操作框 1756 中，DSC 144 和 / 或 DPC 146 可以基于在所接收的错误指示消息中所包括的信息来执行各种错误响应操作。

[0252] 如上所述，响应于检测到错误情况或失败情况，DSC 144 和 DPC 146 可以被配置为用于执行各种错误响应操作或失败响应操作。作为这些操作的一部分，DSC 144 和 / 或 DPC 146 可以对错误 / 失败情况的类型或原因进行标识并且基于所标识的类型或原因来定制它们的响应。例如，DSC 144 和 / 或 DPC 146 可以被配置成用于确定所检测到的错误是否是协议错误并且相应地定制它们的响应。

[0253] 协议错误包括转移语法错误、抽象语法错误和逻辑错误。转移语法错误可以在接收功能 DSAAP 实体（例如，DSC、DPC 等）无法对所接收到的物理消息进行解码时发生。例如，在对所接收的消息中的 ASN.1 信息进行解码时可以检测到转移语法错误。在一个实施例中，响应于确定所检测到的错误是转移语法错误，DSC 144 组件和 DPC 146 组件可以被配置成用于传输或重新请求 DSAAP 消息（例如，作为那些错误响应操作的一部分）。

[0254] 抽象语法错误可以在接收功能 DSAAP 实体（例如，DSC、DPC 等）接收无法被理解或认识的信元（IE）或 IE 组（即，未知 IE id）时发生。抽象语法错误还可以在该实体接收逻辑范围（例如，所允许的副本数量）被违反的信元（IE）时发生。DSC 144 组件和 DPC 146 组件可以被配置成用于检测或标识这些类型的抽象语法错误（即，无法理解抽象语法错误），并且作为响应，基于在相应的 DSAAP 消息中所包括的关键性信息来执行多个错误响应操作。以下进一步提供关于这些操作和关键性信息的附加细节。

[0255] 抽象语法错误还可以在以下情况下发生：该接收功能 DSAAP 实体没有接收 IE 或 IE 组，但是根据对目标的指定存在，这些 IE 或 IE 组应该已经存在于所接收的消息中。DSC144 组件和 DPC 146 组件可以被配置成用于检测或标识这些具体类型的抽象语法错误（即，丢失 IE 或 IE 组），并且作为响应，基于丢失的 IE/IE 组的关键性信息和存在信息来执行多个错误响应操作。以下进一步提供关于这些操作、关键性信息和存在信息的附加细节。

[0256] 抽象语法错误还可以在该接收实体接收到 IE 或 IE 组时发生，这些 IE 或 IE 组以错误的顺序被定义为该消息的一部分或相同的 IE 或 IE 组出现太多次。此外，抽象语法错

误还可以在以下情况下发生：该接收实体接收到 IE 或 IE 组，但是根据相关对象的有条件的存在以及所指定的条件，这些 IE 或 IE 组不应该已经存在于所接收的消息中。DSC144 组件和 DPC 146 组件可以被配置成用于对此类抽象语法错误（即，错误顺序、太多出现、错误地存在等）进行检测或标识，并且作为响应，拒绝或终止与该错误相关联的过程或方法（例如，造成该错误的方法）。作为错误响应操作的一部分，DSC 144 组件和 DPC 146 组件可以拒绝或终止该过程 / 方法。

[0257] 在各个实施例中，DSC 144 组件和 DPC 146 组件可以被配置成用于在检测、标识或确定针对 DSAAP 消息发生抽象语法错误之后继续解码、读取或处理该消息。例如，DSC144 组件和 DPC 146 组件可以跳过该消息的包括错误的部分，并且继续处理该消息的其他部分。作为此继续的处理的一部分，DSC 144 组件和 DPC 146 组件可以检测或标识附加的抽象语法错误。

[0258] 在一个实施例中，DSC 144 组件和 DPC 146 组件可以被配置成用于针对每个检测到的抽象语法错误和 / 或基于与抽象语法错误相关联的 IE/IE 组的关键性信息和存在信息来执行多个错误响应操作。

[0259] 如上所述，每条 DSAAP 消息都可以包括关键性信息、存在信息、范围信息和所指派的关键性信息或可以与其相关联。在各个实施例中，在检测错误、标识错误类型或将要被执行的特定错误响应时，接收功能 DSAAP 实体（例如，DSC、DPC 等）可以被配置成用于使用此类信息（例如，关键性信息、存在信息等）中的任一项或全部。也就是，根据关键性信息、存在信息、范围信息和 / 或所指派的关键性信息的值，该实体可以执行不同的操作。

[0260] 在一个实施例中，在标识错误类型以及将要针对所标识的错误类型执行的特定错误响应操作时，该接收功能 DSAAP 实体（例如，DSC、DPC 等）可以被配置成用于使用在 DSAAP 消息中所包括的存在信息。例如，该实体可以使用该存在信息来针对该消息或通信确定信元 (IE) 的存在是否是可选的、有条件的或强制性的（例如，相对于 RNS 应用）。当所接收的消息丢失了被确定为是强制性的（或当条件为真时是有条件的）一个或多个信元时，该实体可以确定抽象语法错误已经发生。

[0261] 在一个实施例中，在标识将要被执行的特定错误响应操作时，该接收功能 DSAAP 实体（例如，DSC、DPC 等）可以被配置成用于使用关键性信息。也就是，每条 DSAAP 消息都可以包括在该消息中所包括的每个信元 (IE) 或 IE 组的关键性信息。每个 IE 或 IE 组的关键性信息的值可以包括“拒绝 IE”、“忽略 IE 并通知发送方”以及“忽略 IE”。该接收实体（例如，DSC、DPC 等）可以使用此关键性信息来确定 IE、IE 组或 EP 是不可理解的，将该情况标识为抽象语法错误（即，无法理解的抽象语法错误）和 / 或标识将要被执行的那些错误响应操作（例如，拒绝、忽略、通知等）。

[0262] 在一个实施例中，响应于确定在一种方法 / 过程执行期间所接收的消息中所包括的信元 (IE) 是不可理解的并且针对该 IE 的关键性信息的值被设为“拒绝 IE”，接收实体（例如，DSC、DPC 等）可以被配置成用于拒绝该方法 / 过程并发起 DSAAP 错误指示方法（以上参照图 17A 至 B 所讨论的）。

[0263] 例如，当接收到发起一种方法 / 过程（例如，DSC 注册请求消息等）的消息并确定该消息包括不可理解的并被标记为“拒绝 IE”的一个或多个 IE/IE 组时，接收实体可以通过不执行该消息中所包括的功能请求中的任一条功能请求来拒绝该方法 / 过程。接收实体还

可以使用通常用来报告过程的不成功结果的消息来报告对一个或多个IE/IE组的拒绝。当在所接收到的发起消息中的信息是不足的并且无法用来确定在用于报告过程的不成功结果的消息中需要存在的所有IE的值时，该接收实体可以终止该过程并发起DSAAP错误指示方法／过程。

[0264] 作为进一步的示例，当接收到发起一种方法／过程（其不具有消息来报告不成功结果）的消息并且该消息包括接收实体不理解的以“拒绝IE”标记的一个或多个IE/IE组时，该接收实体可以终止该方法／过程并发起DSAAP错误指示方法／过程。

[0265] 作为又另一个示例，当接收到包括接收实体不理解的以“拒绝IE”标记的一个或多个IE的响应消息（例如，DSC注册响应消息等）时，该接收实体可以认为该方法／过程未被成功地终止并且发起局部错误处理方法。

[0266] 在一个实施例中，响应于确定在一种方法／过程的执行期间所接收的消息中所包括的信元(IE)是不可理解的并且针对该IE的关键性信息的值被设为“忽略IE并通知发送方”，接收实体（例如，DSC、DPC等）可以被配置成用于忽略或跳过该方法／过程并发起DSAAP错误指示方法（以上参照图17A至B所讨论的）。

[0267] 作为示例，当接收到包含该接收实体不理解的以“忽略IE并通知发送方”标记的一个或多个IE/IE组的发起一种方法／过程的消息时，该接收实体可以忽略这些不可理解的IE/IE组的内容、如同没有接收到这些不可理解的IE/IE组一样（除了进行报告之外）继续使用被理解的IE/IE组进行该方法／过程并且在该方法／过程的响应消息中报告已经忽略一个或多个IE/IE组。当在发起消息中接收的信息不足以确定在响应消息中需要存在的所有IE的值，该接收实体可以终止该方法／过程并发起DSAAP错误指示方法／过程。

[0268] 作为进一步的示例，当接收到包含该接收实体不理解的以“忽略IE并通知发送方”标记的一个或多个IE/IE组的发起一种方法／过程（其不具有消息来报告该方法／过程的结果）的消息时，该接收实体可以忽略这些未被理解的IE/IE组的内容、如同没有接收到这些未被理解的IE/IE组一样（除了进行报告之外）继续使用被理解的IE/IE组进行该方法／过程并且发起DSAAP错误指示方法／过程来报告已经忽略了一个或多个IE/IE组。

[0269] 作为又另一个示例，当接收到包含该接收实体不理解的以“忽略IE并通知发送方”标记的一个或多个IE/IE组的响应消息时，该接收实体可以忽略这些未被理解的IE/IE组的内容、如同没有接收到这些未被理解的IE/IE组一样（除了进行报告之外）继续使用被理解的IE/IE组进行该方法／过程并且发起DSAAP错误指示方法／过程。

[0270] 在一个实施例中，响应于确定在一种方法／过程的执行期间所接收的消息中所包括的信元(IE)是不可理解的并且针对该IE的关键性信息的值被设为“忽略IE”，接收实体（例如，DSC、DPC等）可以被配置成用于忽略或跳过该方法／过程。

[0271] 作为一个示例，当接收到包含该接收实体不理解的以“忽略IE”标记的一个或多个IE/IE组的发起一种方法／过程的消息时，该接收实体可以忽略这些未被理解的IE/IE组的内容并且如同没有接收到这些未被理解的IE/IE组一样继续仅使用被理解的IE/IE组进行该方法／过程。

[0272] 作为进一步的示例，当接收到包含该接收实体不理解的以“忽略IE”标记的一个或多个IE/IE组的响应消息时，该接收实体可以忽略这些未被理解的IE/IE组的内容并且如同没有接收到这些未被理解的IE/IE组一样继续使用被理解的IE/IE组进行该方法／过

程。

[0273] 当使用针对该方法／过程所定义的响应消息来报告以“拒绝 IE”或“忽略 IE 并通知发送方”标记的多个未被理解的 IE/IE 组时，针对每个报告的 IE/IE 组，可以将信元关键性诊断 IE 包括在关键性诊断 IE 中。

[0274] 在一个实施例中，响应于确定接收实体无法对所接收到的消息中的消息类型 IE 进行解码，接收实体（例如，DSC、DPC 等）可以被配置成用于发起 DSAAP 错误指示方法（以上关于图 17A 至 B 所讨论的）。在一个实施例中，在确定消息中所包括的 IE 的正确顺序时，该实体可以被配置成用于仅考虑在组件所使用的规范版本中所指定的那些 IE。

[0275] 在一个实施例中，接收实体（例如，DSC、DPC 等）可以被配置成用于根据所接收到的消息中的由在接收方所使用的本文件的版本中所指定的丢失的 IE/IE 组的关键性信息来处理该丢失的 IE/IE 组。

[0276] 作为示例，响应于确定所接收到的发起消息中丢失一个或多个带有指定的关键性“拒绝 IE”的 IE/IE 组，接收实体（例如，DSC、DPC 等）可以被配置成用于不执行所接收到的该消息的那些功能请求中的任何功能请求。接收实体可以拒绝该方法／过程并使用通常用来报告该方法／过程的不成功结果的消息来报告丢失的 IE/IE 组。当确定在发起消息中所接收的信息不足以确定在用于报告该方法／过程的不成功结果的消息中需要存在的所有 IE 的值时，该接收实体可以终止该方法／过程并发起 DSAAP 错误指示方法／过程。

[0277] 作为进一步的示例，当所接收的发起一种方法／过程（其不具有消息来报告不成功结果）的消息丢失一个或多个带有指定的关键性“拒绝 IE”的 IE/IE 组时，该接收实体可以终止该方法／过程并发起 DSAAP 错误指示方法／过程。

[0278] 作为又另一个示例，当所接收到的响应消息丢失一个或多个带有指定的关键性“拒绝 IE”的 IE/IE 组时，该接收实体可以认为该方法／过程未被成功地终止的并且发起局部错误处理方法／过程。

[0279] 作为另一个示例，当所接收到的发起一种方法／过程的消息丢失一个或多个带有指定的关键性“忽略 IE 并通知发送方”的 IE/IE 组时，接收实体可以忽略那些 IE 丢失并且基于在该消息中存在的其他 IE/IE 组继续进行该方法／过程，并在该方法／过程的响应消息中报告丢失了一个或多个 IE/IE 组。当在发起消息中接收的信息不足以确定在响应消息中需要存在的所有 IE 的值，该接收实体可以终止该方法／过程并发起 DSAAP 错误指示方法／过程。

[0280] 作为另一个示例，当所接收到的发起一种方法／过程（其不具有消息来报告该方法／过程的结果）的消息丢失一个或多个带有指定的关键性“忽略 IE 并通知发送方”的 IE/IE 组时，该接收实体可以忽略那些 IE 丢失并且基于在该消息中存在的其他 IE/IE 组继续进行该方法／过程，并发起 DSAAP 错误指示方法／过程以报告丢失了一个或多个 IE/IE 组。

[0281] 作为另一个示例，当所接收的消息所接收的响应消息丢失一个或多个带有指定的关键性“忽略 IE 并通知发送方”的 IE/IE 组时，该接收实体可以忽略那些 IE 丢失并且基于在该消息中存在的其他 IE/IE 组继续进行该方法／过程，并发起 DSAAP 错误指示方法／过程以报告丢失了一个或多个 IE/IE 组。

[0282] 作为另一个示例，当所接收到的发起一种方法／过程的消息丢失一个或多个带有指定的关键性“忽略 IE”的 IE/IE 组时，该接收实体可以忽略那些 IE 丢失并且基于在该消

息中存在的其他 IE/IE 组继续进行该方法 / 过程。

[0283] 作为另一个示例，当所接收的响应消息丢失一个或多个带有指定的关键性“忽略 IE”的 IE/IE 组时，该接收实体可以忽略那些 IE/IE 组丢失并且基于在该消息中存在的其他 IE/IE 组继续进行该方法 / 过程。

[0284] 该接收实体（例如，DSC、DPC 等）可以被配置成用于响应于多条消息，这些消息包括以错误顺序接收的 IE 或 IE 组、包括太多出现、或以各种方式错误地存在（即，在未满足条件时被包括并被标记为“有条件的”）。例如，响应于确定所接收到的消息包括具有错误顺序的 IE 或 IE 组、包括 IE 的太多出现、或包括错误地存在的 IE，该接收实体（例如，DSC、DPC 等）可以被配置成用于不执行所接收到的消息的那些功能请求中的任何功能请求。该接收实体可以拒绝该方法 / 过程并使用通常用来报告该方法 / 过程的不成功结果的消息来报告原因值“抽象语法错误”（错误地构建的消息）。当在发起消息中所接收的信息不足以确定在用于报告该方法 / 过程的不成功结果的消息中需要存在的所有 IE 的值时，该接收实体可以终止该方法 / 过程并发起 DSAAP 错误指示方法 / 过程。

[0285] 作为另一个示例，当接收到包含具有错误顺序或具有太多出现或错误地存在的一个或多个 IE 或 IE 组的发起一种方法 / 过程（其不具有消息来报告该方法 / 过程的结果）的消息时，该接收实体可以终止该方法 / 过程并使用原因值“抽象语法错误”（错误地构建的消息）来发起 DSAAP 错误指示方法 / 过程。

[0286] 作为另一个示例，当接收到包含具有错误顺序或具有太多出现或错误地存在的一个或多个 IE 或 IE 组的响应消息时，该接收实体可以认为该方法 / 过程未被成功地终止并且发起局部错误处理。

[0287] 如上所述，协议错误包括转移语法错误、抽象语法错误和逻辑错误。逻辑错误在以下情况下发生：消息被正确地理解，但是该消息内所包含的信息无效（即，语义错误）、或描述了一种与该接收实体的状态不兼容的方法 / 过程。

[0288] 在一个实施例中，响应于确定 / 检测到逻辑错误，接收实体（例如，DSC、DPC 等）可以被配置成用于基于该方法 / 过程的类别而不考虑包含错误值的那些 IE/IE 组的关键性信息来执行多种错误响应操作。

[0289] 例如，当在类别 1 方法 / 过程的请求消息中检测到逻辑错误并且该方法 / 过程具有消息来报告此不成功结果时，此消息可以与适当的原因值（即，在原因 IE 中）（如“语义错误”或“消息与接收方状态不兼容”）一起被发送。当在类别 1 方法 / 过程的请求消息中检测到逻辑错误并且该方法 / 过程不具有消息以报告此不成功结果时，可以终止该方法 / 过程并且以适当的原因值发起 DSAAP 错误指示方法 / 过程。当逻辑错误存在于类别 1 过程的响应消息中时，可以认为该过程未被成功地终止，并且可以发起局部错误处理。

[0290] 当在类别 2 过程的消息中检测到逻辑错误时，可以终止该过程并且可以以适当的原因值发起 DSAAP 错误指示过程。

[0291] 在各个实施例中，当在错误指示消息中检测到协议错误时，该接收实体（例如，DSC、DPC 等）可以被配置成用于执行局部错误处理方法 / 过程（与 DSAAP 错误指示方法 / 过程相反）。假如需要返回响应消息或错误指示消息，但是确定该消息的接收方所需要的信息丢失，可以认为该过程未被成功地终止，并且可以发起局部错误处理。当发生终止过程的错误时，所返回的原因值可以反映导致该过程终止的错误，即使一个或多个带有关键性“忽

略并通知”的抽象语法错误较早在同一个过程内已经发生。

[0292] 如上文所讨论的，在各个实施例中，动态频谱仲裁应用部分（DSAAP）协议或组件可以被配置成用于允许、促进、支持更小型的小区架构（如毫微微小区架构）。在一个实施例中，所有或部分 DSAAP 协议 / 组件可以包括在 HeNB 117 和 / 或 HGW 145 中。

[0293] 图 18 展示了在包括多个毫微微小区的实施例 DSA 系统 1800 中的各个通信链路。在图 18 所展示的示例中，DSA 系统 1800 包括多个 HeNB 117、一个 HGW 145、一个 DSC 144 和一个 DPC 146。DSA 系统 1800 还可以可选地包括一个 SGW 118、一个 MME130、一个 HeNB 管理系统 1802。

[0294] 每个 HeNB 117 都可以被配置成用于主控与 eNodeB 相同的功能。进一步地，每个 HeNB 117 对于单个小区或对于小地理区域而言可以充当 eNodeB 或作为 eNodeB 而操作。因此，每个 HeNB 117 都可以是毫微微小区。

[0295] 这些 HeNB 117 可以被配置成用于通过一组 S1 接口（即，所展示的 S1-U 接口和 S1-MME 接口）建立与核心网络 120 中的多个组件的通信链路和 / 或与其进行通信。S1-U 数据平面可以通过 HeNB 117、HGW 145 和 SGW 118 建立（或在其之间建立）。可以通过 HGW 145 来建立、促进或提供 HeNB 117 与核心网络 120 之间的基于 S1-MME 的通信。在一个实施例中，HGW 145 可以被配置成用于建立到核心网络 120 中的多个组件的多个连接，从而使得到由 HGW 145 所服务的多个小区的入站移动性和出站移动性不需求 MME 间切换。

[0296] 在各个实施例中，HGW 145 可以被配置成用于对 MME 130 而言作为 eNodeB 116 而操作、通信和 / 或表现，并且对 eNodeB 116 而言作为 MME 130 而操作、通信和 / 或表现。从而，eNodeB 116 可以以与其将与 MME 130 进行通信相同的方式（并且使用相同的通信链路 / 协议）与 HGW 145 进行通信。同样，MME 130 可以以与其将与 eNodeB 116 进行通信相同的方式与 HGW 145 进行通信。这允许系统（或控制器）动态地添加或移除组件（例如，HeNB、eNodeB、MME 等）而不会对系统 1800 的性能或响应性产生负面影响。这还允许将大量额外的 HeNB 117 部署到网络或系统 1800 中，而无需显著的准备或网络规划。

[0297] HGW 145 可以被配置成用于作为 HeNB 117（或几十、几百或几千个 HeNB 117）、DSC 144 和核心网络 120 之间的网关而进行操作。进一步地，HGW 145 可以被配置成用于表示许多不同的 HeNB 117，从而使得它们对 DSC 144 而言表现为单个 eNodeB 116。这允许 DSC 144 与管理或表示大量不同的 HeNB 117 的单个 HGW 145（即，而不是与大量单独的 HeNB 进行通信的 DSC）进行接口连接或通信。

[0298] 在一个实施例中，这些 HeNB 117 中的一个或多个 HeNB 可以被配置成用于在本地 IP 接入（LIPA）模式下操作。在图 18 所展示的示例中，HeNB 117a 包括 LIPA 本地网关（HeNB LIPA LGW）1804 模块，其可以被配置成用于允许、促进或支持在 LIPA 模式下操作时 HeNB 117a 与核心网络 120 之间通过 S5 接口的通信。因此，HeNB 117a 可以支持 LIPA 功能系统，而不考虑 HGW 145 连接。

[0299] HeNB LIPA LGW 1804 模块可以设置并维护到核心网络 120 的 S5 连接，从而使得建立 S5 接口不需要或不使用 HGW 145。HeNB LIPA LGW 1804 模块可以针对 S5 接口 / 连接重新使用用于 S1 接口 / 连接的 IP 地址。这允许系统重新使用 S1 安全接口。HeNB LIPA LGW 1804 模块还可以使用另一个 IP 地址，这可能导致另一个安全接口。可以在切出时释放 S5LIPA 连接，在这种情况下，HeNB LIPA LGW 1804 可以触发在 S5 接口上的释放。

[0300] 此外，HeNB LIPA LGW 1804模块可以被配置成用于执行各个操作以支持各种附加功能，不依赖于HGW 145在系统1800中的存在。例如，HeNB LIPA LGW 1804模块可以被配置成用于在每次空闲－活跃转变时在S1-MME之上将HeNB 117的并置LGW IP地址转移到核心网络120、针对上行NAS传送过程在S1-MME之上将HeNB 117的并置LGW IP地址转移到核心网络120并且在并置LGW功能中支持多种基本PGW 128功能。HeNB LIPA LGW 1804模块可以支持对应于LIPA的SGi接口、提供对发送多个第一分组的附加支持、缓冲后续分组、提供内部直接LGW到HeNB用户路径管理、依次向无线设备102的提供分组传递等。进一步地，HeNB LIPA LGW 1804模块可以被配置成用于支持受限制的S5过程(例如，对应于对LIPA功能的严格支持)、向核心网络120发送多个通知以便进行并置的LGW功能。HeNB LIPA LGW 1804模块可以被配置成用于在有待在S1-MME之上被转发的受限制的过程集之内在S5接口之上上行传输用于LIPA承载的多个TEID，并且进一步地由HeNB 117出于并置的L-GW功能与HeNB 117之间的相关联目的而用作“相关id”。在切出触发LGW功能释放LIPA PDN连接的情况下，HeNB LIPA LGW 1804模块可以切换这些非LIPA E-RAB。

[0301] 在LIPA支持的情况下，MME 130可以支持以下附加功能：对UE授权进行验证以请求在此CSG处针对所请求的APN的LIPA激活以及对所接收到的并置L-GW IP地址的转移；在UE上下文设置过程和E-RAB设置过程内将“相关id”(即，并置L-GW上行TEID)转移至HeNB 117；验证在切换过程期间LIPA PDN连接是否已经被释放；如果检测到UE已经移出与LGW功能并置的HeNB 117的覆盖范围，对空闲模式UE的LIPA PDN连接的去激活。

[0302] 各个实施例可以支持多个HeNB 117之间的直接X2连接性，不依赖于所涉及的HeNB 117中的任何HeNB 117是否连接至HGW 145。在一个实施例中，系统和/或其组件可以被配置成使得HeNB 117所使用的跟踪区域码(TAC)和PLMN ID也受到HGW145的支持。

[0303] 如上所述，HeNB 117可以被配置成用于主控与eNodeB 116相同的功能。除了这些功能之外，HeNB 117可以被配置成用于发现合适的服务HGW145。HeNB 117可以被配置成用于每次连接至单个HGW 145(例如，在HeNB处不使用S1Flex功能)。HeNB 117可以被配置成用于不同时连接至第二HGW 145或MME 130。

[0304] 在一个实施例中，系统1800和/或其组件可以被配置成使得HeNB 117可以被从一个地理区域移动到另一个地理区域。在这种系统中，HeNB 117可以被配置成用于自动地发现合适的服务HGW 145、建立到所发现的HGW 145的通信链路并且终止到之前的HGW 145的通信链路。

[0305] 在一个实施例中，HGW 145可以被配置成用于主控对MME 130的选择。从而，系统1800和/或其组件可以被配置成使得对MME 130的选择(例如，当无线设备102附接时)由HGW 145(与HeNB相反)来主控。

[0306] 在一个实施例中，HeNB 117可以被配置成用于支持固定宽带接入网络交互功能以通过初始UE消息、路径切换请求消息和切换通知消息来向MME 130用信号发送隧道信息。在一个实施例中，隧道信息可以包括HeNB IP地址(以及如果检测到NAT/NAPT的话，UDP端口)。

[0307] 在一个实施例中，HeNB 117可以被配置成用于接收来自无线设备102的全局唯一移动性管理实体标识符(GUMMEI)并且将所接收的GUMMEI包括在初始UE通信消息中。HeNB 117可以被进一步配置成为初始UE通信消息中的GUMMEI类型。在一个实施例中，系统和/

或其组件可以被配置成用于支持在 S1 路径切换请求消息中将源 MME 130 的 GUMMEI 用信号发送至 HGW 145。

[0308] 在一个实施例中，HGW 145 可以被配置成用于在 MME 130 与服务无线设备 102 的 HeNB 117 之间中继多条 S1 应用部分消息。

[0309] 在一个实施例中，响应于接收到来自 HeNB 117 的 UE 上下文释放请求消息（如当该消息包括明确的网关上下文释放指示时）和／或响应于确定附接的 HeNB 117 不再服务由所接收的消息标识的无线设备，HGW 145 可以被配置成用于终止 S1 上下文释放请求过程并且释放 S1 上下文。

[0310] 在一个实施例中，响应于接收到 S1 初始上下文设置请求消息和 S1 切换请求消息，HGW 145 可以被配置成用于通知 HeNB 117 对应于服务 MME 130 的 GUMMEI、由 MME130 所指派的 MME UE S1AP ID 以及由 HGW 145 为无线设备 102 所指派的 MME UE S1AP ID。

[0311] 在一个实施例中，响应于接收到 S1 路径切换请求确认消息，HGW 145 可以被配置成用于通知 HeNB 117 由 MME 130 所指派的 MME UE S1AP ID 以及由 HGW 145 为无线设备所指派的 MME UE S1AP ID。

[0312] 在一个实施例中，响应于接收到 S1 初始 UE 消息、S1 路径切换请求和／或 S1 切换请求确认消息，HGW 145 可以被配置成用于验证所指示的小区接入模式对 HeNB 117 来说有效。当接入模式是封闭式的时（即，是封闭式接入 HeNB），HGW 145 可以被进一步配置成用于验证 CSG ID 对该 HeNB 117 来说也是有效的。

[0313] 在各个实施例中，系统和／或其组件可以被配置成使得组件可以终止朝向 HeNB 117 和朝向 MME 130 的非 UE 相关联的 S1 应用部分过程。

[0314] 在一个实施例中，响应于接收到 S1 设置请求消息，HGW 145 可以被配置成用于验证 HeNB 所使用的标识是有效的。在一个实施例中，HGW 145 可以被配置成使得，一旦接收到过载消息，HGW 145 可以朝向 HeNB 发送该过载消息，包括在该消息中的受到影响的 MME 模式的那些标识。在一个实施例中，如果 HGW 145 被部署，可以在多个 HeNB 与 HGW 145 之间以及在 HGW 145 与 MME 130 之间执行非 UE 相关联的过程。

[0315] 在各个实施例中，系统和／或其组件可以被配置成使得组件可以可选地终止与 HeNB117 以及与 SGW 118 的 S1-U 接口连接。在各个实施例中，系统和／或其组件可以被配置成用于支持 HeNB 117 所使用的 TAC 和 PLMN ID。在各个实施例中，系统和／或其组件可以被配置成使得不在 HGW 145 与其他节点之间建立 X2 接口。

[0316] 在各个实施例中，系统和／或其组件可以被配置成用于基于从 HeNB 117 所接收的 GUMMEI 而朝向 MME 130 路由 S1 路径切换请求消息。在一个实施例中，CSG ID 列表可以被包括在寻呼消息中，并且 HGW 145 可以被配置成用于使用该 CSG ID 列表进行寻呼优化。

[0317] 在一个实施例中，MME 130 可以被配置成用于为作为封闭订户群组 (CSG) 的成员的多个无线设备 102 提供接入控制功能。在切换到多个 CSG 小区的情况下，接入控制可以基于由服务网络提供给 MME 130 的所选择的目标 PLMN 的目标 CSG ID。

[0318] 在一个实施例中，MME 130 可以被配置成用于为被切换到多个混合小区的多个无线设备提供成员验证。在切换到多个混合小区的情况下，MME 130 可以基于无线设备的选择的目标 PLMN、小区接入模式相关信息以及在 S1 切换中由源网络提供（或在 X2 切换中由目标网络提供）的目标小区的 CSG ID 执行成员验证。

[0319] 在一个实施例中,MME 130 可以被配置成用于向网络提供 CSG 成员状态信令,如在附接/切换到多个混合小区的情况下以及在无线设备由 CSG 小区或混合小区所服务时改变成员状态的情况下。在一个实施例中，MME 130 可以被配置成用于监管在无线设备的成员状态变化之后的网络操作/动作。

[0320] 在一个实施例中,MME 130 可以被配置成使得,当 HeNB 117 被直接连接时,MME130 验证 HeNB 117 所使用的标识是有效的。MME 130 可以响应于接收到 S1 设置请求消息而验证该标识。此外,MME 130 可以验证所指定的小区接入模式是有效的、并且当该接入模式为封闭式时所提供的 CSG ID 在接收到初始 UE 消息消息、路径切换请求和切换请求确认消息时是有效的。

[0321] 在一个实施例中,MME 130 可以被配置成用于路由多条切换消息,可以通过朝向多个 HGW 145 的 MME 配置转移消息和 MME 直接信息转移消息基于这些消息中所包含的 TAI 来完成这些切换消息。在一个实施例中,MME 130 可以被配置成用于确定将避免路由模糊。响应于确定将避免路由模糊，MME 130 可以被配置成用于在一个 HGW 145 中不重新使用另一个 HGW 145 中所使用的系统 TAI。

[0322] 在各个实施例中，MME 130 和/或 HGW 145 可以被配置成用于在直接向不信任的 HeNB 117 或 eNodeB 116 发送寻呼消息时不包括 CSG ID 列表。在一个实施例中,MME130 可以被配置成用于用 HeNB 117 来支持 LIPA 功能。在一个实施例中，MME 130 可以被配置成用于与 HeNB 117 进行固定宽带接入网络互通。

[0323] 图 19 展示了根据一个实施例用于基于 X2 的切换 (HO) 支持的在源组件与目标组件之间的关系。具体地,图 19 展示了当目标节点是 eNodeB 时,源可以是任何 HeNB。当源是 eNodeB 或系统中的任何 HeNB 时,目标可以是开放式接入 HeNB 或混合接入 HeNB。当源是混合接入 HeNB 或封闭式接入 HeNB 时,目标可以是封闭式接入 HeNB。当将要被切换的无线设备是 CSG 小区的成员并且源节点/目标节点包括相同的 CSG Id 和 PLMN 时,这种情况是尤其相关的。

[0324] 图 20A 展示了用于通过在 HeNB 117 组件与 SGW 118 组件之间的 S1-U 接口进行的用户平面通信的协议栈。图 20B 展示了用于通过 HGW 145 组件针对在 HeNB 117 组件与 SGW 118 组件之间的 S1-U 接口的用户平面通信的协议栈。这些附图展示了 HGW 145 可以可选地终止朝向 HeNB 117 以及朝向 SGW 118 的用户平面并且在 HeNB 117 与 SGW118 之间中继用户平面数据。

[0325] 图 21A 展示了用于通过在 HeNB 117 组件与 MME 130 组件之间的 S1-MME 接口的控制平面通信的协议栈。图 21B 展示了用于通过 HGW 145 组件通过在 HeNB 117 组件与 MME 130 组件之间的 S1-MME 接口的控制平面通信的协议栈。这些附图展示了当 HGW 145 不存在时 (例如,图 21A) 所有的 S1-AP 过程都可以被终止于 HeNB 117 和 MME 130 处。当 HGW 145 存在时 (图 21B),HGW 145 可以终止与 HeNB 117 以及与 MME 130 的非 UE 指定的过程。

[0326] HGW 145 可以在 HeNB 117 与 MME 之间中继控制平面数据。关联到非 UE 指定的过程的的任何协议功能的范围可以在 HeNB 117 与 HGW 145 之间和/或在 HGW 145 与 MME 130 之间。关联到 UE 指定的过程的任何协议功能都可以位于 HeNB 117 与 MME130 之间。

[0327] 图 22 展示了用于通过在 HeNB 117 与 HGW 145 之间的 S1-MME 接口以及通过在 HGW 145 与 DSC 144 之间的 Xe 接口的控制平面通信的协议栈。

[0328] 图 23 展示了一种动态地确定最合适的服务家庭 eNodeB 网关 (HGW) 的实施例家庭 eNodeB(HeNB) 方法 2300，通过该服务家庭 eNodeB 网关连接至核心网络和 / 或 DSA 系统。可以由毫微微小区或 HeNB 的处理核执行方法 2300。

[0329] 在框 2302 中，处理核可以在毫微微小区 /HeNB 与第一家庭 eNodeB 网关 (HGW) 之间建立在 S1 接口之上所定义的第一通信链路。在框 2304 中，处理核可以监测各种状况（例如，GPS 信息、信号强度等）以确定该 HeNB 是否已经被移动。在框 2306 中，处理核可以确定 HeNB 已经被移动。在框 2308 中，处理核可以确定在同一个电信网络中是否存在合适的服务 HGW。在框 2310 中，响应于确定在该电信网络中存在合适的服务 HGW，处理核可以在 HeNB 与新的服务 HGW 之间建立第二通信链路。在框 2312 中，处理核可以终止到第一 HGW 的第一通信链路。

[0330] 图 24 展示了一种生成拥塞报告的家庭 eNodeB(HeNB) 方法 2400。可以在 HeNB 组件的处理核中执行方法 2400。在框 2402 中，处理核可以监测各种网络状况（网络拥塞、资源使用、资源可用性等）。在框 2404 中，处理核可以基于监测的结果（例如，基于所检测到的网络状况）生成拥塞报告。在框 2406 中，处理核可以通过在 S1 接口上所定义的第一通信链路向家庭 eNodeB 网关 (HGW) 发送所生成的拥塞报告。

[0331] 图 25 展示了一种基于从许多毫微微小区所接收的信息生成拥塞状态信息的家庭 eNodeB 网关 (HGW) 方法 2500。可以在 HGW 组件的处理核中执行方法 2500。在框 2502 中，处理核可以通过在 S1 接口上所定义的多个第一通信链路从多个毫微微小区接收拥塞报告。在框 2504 中，处理核可以基于所接收的拥塞报告生成拥塞状态信息。在框 2506 中，处理核可以通过在 Xe 接口上所定义的第二通信链路向 DSC 发送所生成的拥塞状态信息。

[0332] 图 26 展示了一种管理电信网络中的拥塞的 DSC 方法 2600。可以在 DSC 组件的处理核中执行方法 2600。在框 2602 中，处理核可以通过在 Xe 接口上所定义的第二通信链路接收拥塞状态信息。在框 2602 中，处理核可以使用所接收到的拥塞状态信息确定是否执行多个切换操作以将所选择的多个无线设备转移至非拥塞的目标 eNodeB。在框 2602 中，处理核可以通过在 Xd 接口之上所定义的第三通信链路与 DPC 组件进行通信以使该 DPC 指示在第二电信网络中的第二 DSC 限制向在第一电信网络中的那些毫微微小区的进一步切换。

[0333] 各个实施例可以包括或使用被配置成用于允许、促进、支持或增强在两个或更多个 DSA 组件（例如，DPC、DSC、eNodeB、MME、HSS 等）之间的通信的动态频谱仲裁应用部分 (DSAAP) 协议和 / 或组件以便提高 DSA 系统的效率和速度。DSA 组件可以是在本申请中所讨论的任何组件和 / 或参与到在本申请中所讨论任何 DSA 操作、通信或方法中的任何组件。因此，一个或多个 DSAAP 组件可以被配置成用于允许、促进、支持或增强在本申请中所讨论的任何组件之间的通信，包括 DPC 组件与 DSC 组件之间、DSC 组件与 eNodeB 组件之间、DSC 组件与 MME 组件之间、DSC 组件与 HSS 组件之间、MME 组件与 HSS 组件、eNodeB 组件与无线设备之间的通信等。

[0334] 为促进两个或更多个 DSA 组件之间的通信，DSAAP 组件可以发布应用编程接口 (API) 和 / 或包括促进这些 DSA 组件之间的通信的多个客户端模块。此外，DSAAP 组件可以被配置成用于允许这些 DSA 组件通信特定信息、使用特定通信消息和 / 或执行特定操作，这些特定操作一起提供进一步提高 DSA 系统和参与网络的效率和速度的各种 DSA 功能。

[0335] 作为一个示例，DSAAP 组件可以被配置成用于允许 eNodeB 与 DSC 组件（例如，通

过 Xe 接口）、与其他 eNodeB（例如，通过 X2 接口）以及与各种其他组件（例如，通过 S1 接口）进行通信。作为进一步的示例，DSAAP 组件可以被配置成用于允许、促进、支持或增强在 DSC 组件与 DPC 组件之间的通信以便允许 DPC 组件和 / 或 DSC 组件跨不同的更好地网络汇聚资源、更好地监测各个网络中的流量和资源使用、更高效地对竞标和竞标信息进行通信、快速地且高效地注册和注销组件以及更好地执行退避操作。DSAAP 组件还可以通过提高竞标、生成发票、广告资源、请求资源、购买资源、证实竞标凭证等过程的性能和效率来改进 DSA 资源拍卖操作。

[0336] 在各个实施例中，DSAAP 组件的全部或部分可以被包括在一个或多个 DSA 组件中，如 DPC 组件、DSC 组件、eNodeB 组件、MME 组件和 HSS 组件。DSAAP 组件可以在硬件、软件或硬件和软件的组合中实现。在一个实施例中，DSAAP 组件可以被配置成用于实现 DSAAP 协议，该协议可以在 Xe、Xd 和 / 或 X2 参考点上进行定义。在各个实施例中，DSC 与 eNodeB 之间的 Xe 参考点可以使用 DSAAP 协议、TR-069 协议和 / 或 TR-192 数据模型扩展来支持列出 eNodeB 处的可用资源并且通知 eNodeB 竞标 / 购买确认。DSC 与 DPC 之间的 Xd 参考点可以使用 DSAAP 协议来进行动态频谱和资源仲裁操作。这些 eNodeB 之间的 X2 接口 / 参考点还可以使用 DSAAP 协议来通信信息。

[0337] 在各个实施例中，DSAAP 组件可以被配置成用于允许各个 DSA 组件（例如，DSC、DPC、eNodeB 等）来使用 DSAAP 协议来进行通信和 / 或执行各种 DSAAP 方法。DSAAP 方法可以在本申请中所讨论的任何 DSA 系统中执行，如包括第一电信网络（例如，承租者网络）中的第一 DSC 服务器、第二电信网络（例如，出租者网络）中的第二 DSC 服务器以及在第一电信网络和第二电信网络之外的 DPC 服务器的系统。

[0338] 各个实施例可在各种移动无线计算设备上实现，其中的一个示例展示在图 27 中。具体来说，图 27 是形式为适用于与任何实施例一起使用的智能电话 / 蜂窝电话 2700 的移动收发设备的系统框图。蜂窝电话 2700 可以包括处理器 2701，该处理器耦接到内部存储器 2702、显示器 2703、以及扬声器 2704。另外，蜂窝电话 2700 可包括用于发送和接收电磁辐射的天线 2705，该天线可连接至无线数据链路和 / 或耦合至处理器 2701 的蜂窝电话收发机 2706。蜂窝电话 2700 通常还包括用于接收用户输入的菜单选择按钮或拨动开关 2707。

[0339] 典型的蜂窝电话 2700 还包括声音编码 / 解码 (CODEC) 电路 2708，该声音编码 / 解码电路将接收自麦克风的声音数字化为适用于无线通信的数据分组并且解码所接收的声音数据分组以生成模拟信号，这些模拟信号被提供给扬声器 2704 以生成声音。同样，处理器 2701、无线收发机 2706 和 CODEC 2708 中的一个或多个可以包括数字信号处理器 (DSP) 电路（未单独示出）。蜂窝电话 2700 可以进一步包括用于无线设备之间的低功率短程通信的 ZigBee 接收机（即，IEEE 802.15.4 接收机）、或其他类似的通信电路（例如，实现蓝牙®或 WiFi 协议的电路等）。

[0340] 可在广播系统之内的多种可商购的服务器设备如图 28 中所示的服务器 2800 上实现包括频谱仲裁功能的上述实施例。此类服务器 2800 通常包括连接到易失性存储器 2802 和大容量非易性失存储器（如盘驱动器 2803）的处理器 2801。服务器 2800 还可包括耦接到处理器 2801 的软盘驱动器、致密盘 (CD) 或 DVD 盘驱动器 2804。服务器 2800 还可包括耦接到处理器 2801 的用于与网络 2807 建立数据连接的网络接入端口 2806，比如耦接到其他通信系统计算机和服务器的局域网。

[0341] 处理器 2701、2801 可以是可由软件指令（应用）配置成执行包括以下描述的各个实施例的功能的多种功能的任何可编程微处理器、微处理器或多个处理器芯片。在一些无线设备中，可提供多个处理器 2801，诸如专用于无线通信功能的处理器和专用于运行其他应用的处理器。通常，在软件应用被访问并被加载到处理器 2701、2801 中之前，这些软件应用可被存储在内部存储器 2702、2802 中。处理器 2701、2801 可包括足以存储应用软件指令的内部存储器。在一些服务器中，处理器 2801 可包括足以存储应用软件指令的内部存储器。在一些接收器设备中，安全存储器可以是耦接到处理器 2701 的分离的存储器芯片。内部存储器 2702、2802 可以是易失性或非易失性存储器（如闪存），或两者的混合。为此描述的目的，对存储器的一般引用是指处理器 2701、2801 可访问的所有存储器，包括内部存储器 2702、2802；插入到设备中的可移除存储器；以及处理器 2701、2801 本身内的存储器。

[0342] 提供前述的方法描述和过程流程图作为说明性示例而不意在要求或暗示必须以呈现的顺序执行各种实施例的步骤。如本领域普通技术人员将认识到的，可以按照任何顺序执行前述实施例中的步骤的顺序。如‘其后’、‘然后’、‘接下来’等词并不意在限制步骤的顺序；这些词仅用于贯穿方法的描述引导读者。而且，以单数形式声明元件的任何引用（例如使用冠词‘一个’、‘一种’或‘该’）不应被解释为将该元件限制于单数。

[0343] 可将结合本文披露的实施例描述的各种说明性逻辑框、模块、电路和算法步骤实现为电子硬件、计算机软件或两者的组合。为了清楚地说明硬件和软件的此可互换性，已在以上一般地在它们的功能性方面描述了各种说明性的组件、块、模块、电路、和步骤。将这样的功能性实现为硬件还是软件取决于在整体系统上强加的具体应用和设计约束。熟练的业内人士可以针对每个具体应用以不同的方式实现所描述的功能性，但不应将这种实现方式决定解释为引起背离本发明的范围。

[0344] 可用设计成执行本文描述的功能的通用处理器、数字信号处理器 (DPC)、专用集成电路 (ASIC)、现场可编程门阵列 (FPGA) 或其他可编程逻辑器件、分立门或晶体管逻辑、分立硬件组件或其任何组合来实现或执行用于实现结合本文披露的实施例描述的各种说明性逻辑、逻辑框、模块和电路的硬件。通用处理器可以是微处理器，但可替代地，处理器可以是任何常规处理器、控制器、微处理器或状态机。还可将处理器实现为计算设备的组合，例如，DPC 和微处理器、多个微处理器、一个或多个微处理器连同 DPC 核或任何其他此类配置的组合。可替代地，可通过专用于给定功能的电路来执行一些步骤或方法。

[0345] 在一个或多个示例性方面中，可在硬件、软件、固件或其任何组合中实现所描述的功能。当在软件中实现时，可以将功能存储成非瞬态计算机可读介质或非瞬态处理器可读介质上的一个或多个指令或代码。可在处理器可执行软件模块中实施本文披露的方法或算法的步骤，该软件模块可存在于非瞬态计算机可读或处理器可读存储介质上。非瞬态计算机可读或处理器可读存储介质可以是计算机或处理器可访问的任何存储介质。通过示例，而非限制，如非瞬态计算机可读或处理器可读介质可包括 RAM、ROM、EEPROM、闪存、CD-ROM、或其他光盘存储、磁盘存储或其他磁存储设备或可用来以指令或数据结构的形式存储期望的程序代码并且计算机可访问的任何其他介质。本文使用的盘和碟，包括致密碟 (CD)、激光碟、光碟、数字通用碟 (DVD)、软磁碟和蓝光碟，这里盘通常磁再生数据，而碟用激光光再生数据。以上介质的组合也被包括在非瞬态计算机可读和存储器可读介质的范围内。此外，方法或算法的操作可作为非瞬态的存储器可读介质和 / 或计算机可读介质上的一个或任

何组合或集合的代码和 / 或指令存在，其可结合在计算机程序产品中。

[0346] 提供披露的实施例的前述描述以使任何本领域普通技术人员能够进制造使用本发明。本领域技术人员将容易理解这些实施例的各种修改，并且在此所定义的一般原理可以在不背离本披露的范围的情况下应用到其他实施例。因此，本披露不旨在限于在此所描述的实施例，但符合与在此所披露的原理一致的最广泛范围。

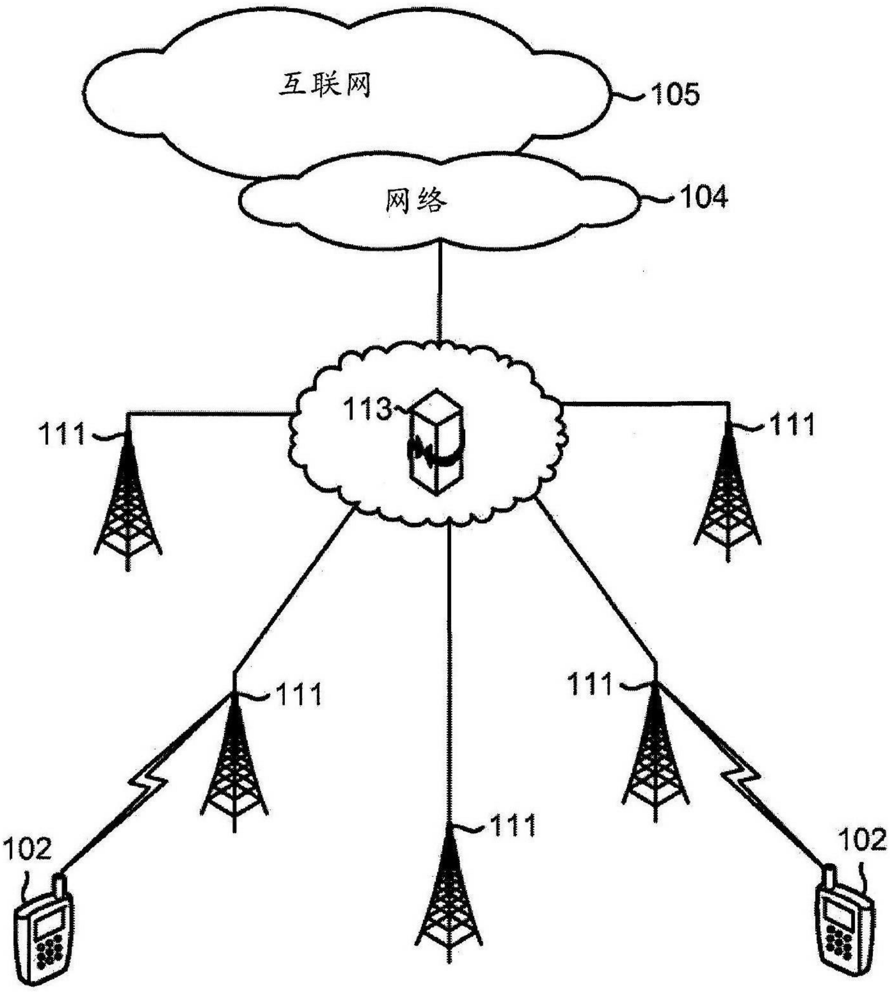
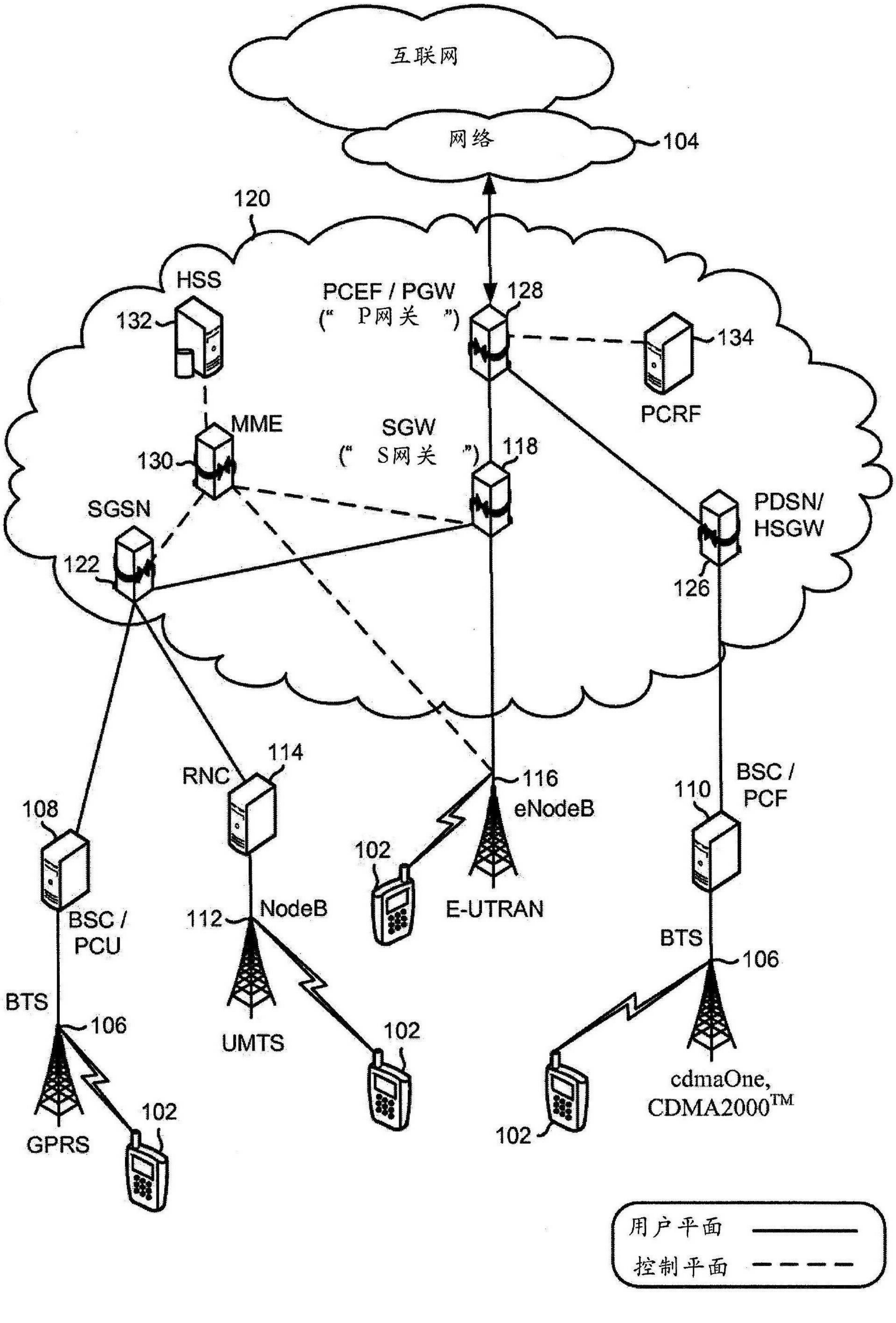


图 1A



互联网
网络
104
120
HSS
132
PCEF / PGW
("P网关")
128
134
PCRF
MME
130
SGW
("S网关")
118
SGSN
122
PDSN/
HSGW
126
RNC
114
116
eNodeB
108
110
BSC /
PCF
102
E-UTRAN
BSC /
PCU
112
NodeB
BTS
106
UMTS
GPRS
cdmaOne,
CDMA2000™
用户平面
控制平面

图 1B

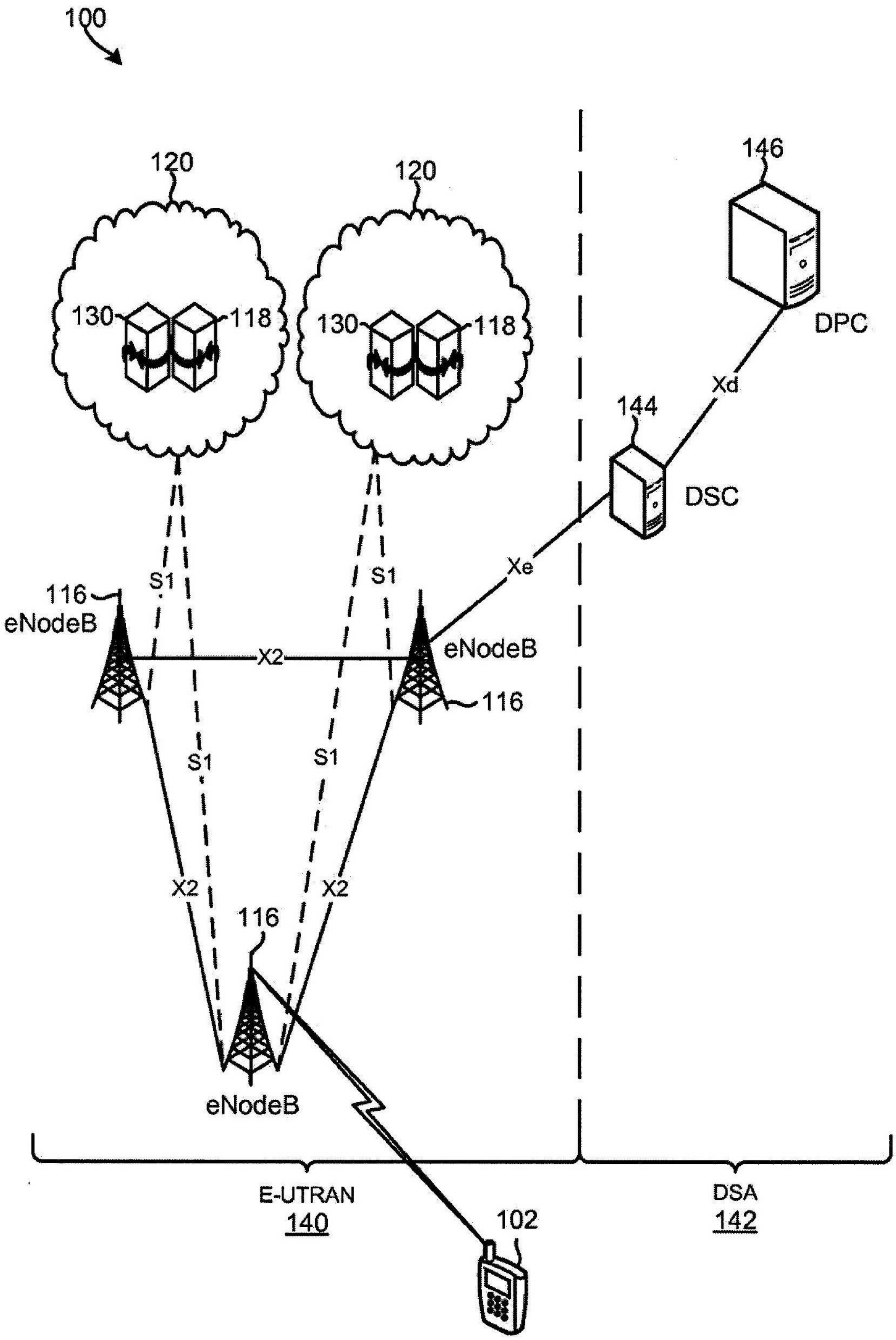

100
120
130
118
120
130
118
146
DPC
Xd
144
DSC
Xe
S1
S1
116
eNodeB
X2
eNodeB
116
S1
S1
X2
X2
116
eNodeB
E-UTRAN
140
DSA
142
102

图 1C

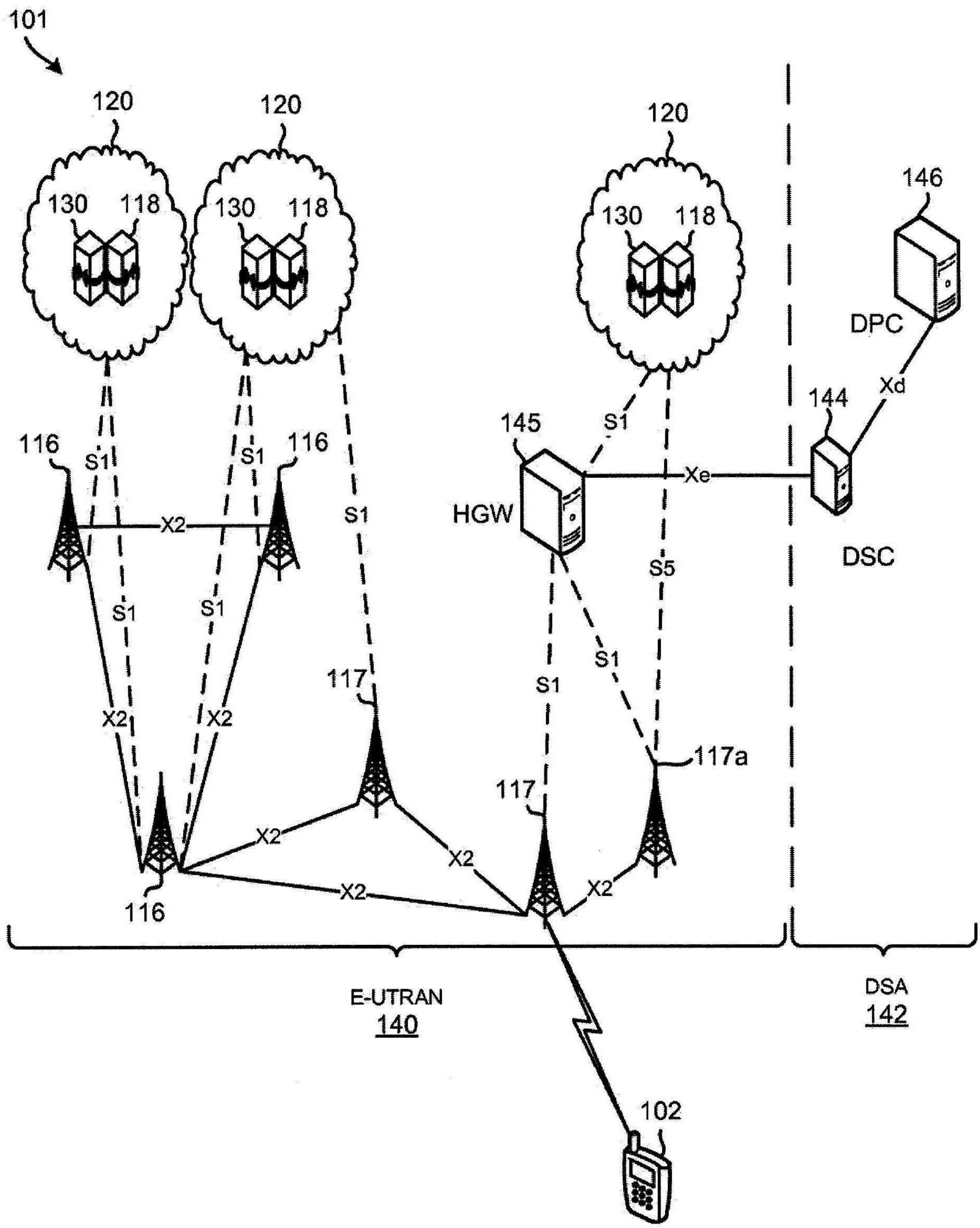

101
120
130
118
120
130
118
120
130
118
146
DPC
Xd
144
145
S1
116
S1
S1
116
Xe
S1
HGW
X2
DSC
S5
S1
S1
S1
X2
X2
117
S1
S1
117a
117
X2
X2
X2
X2
116
E-UTRAN
140
DSA
142
102

图 1D

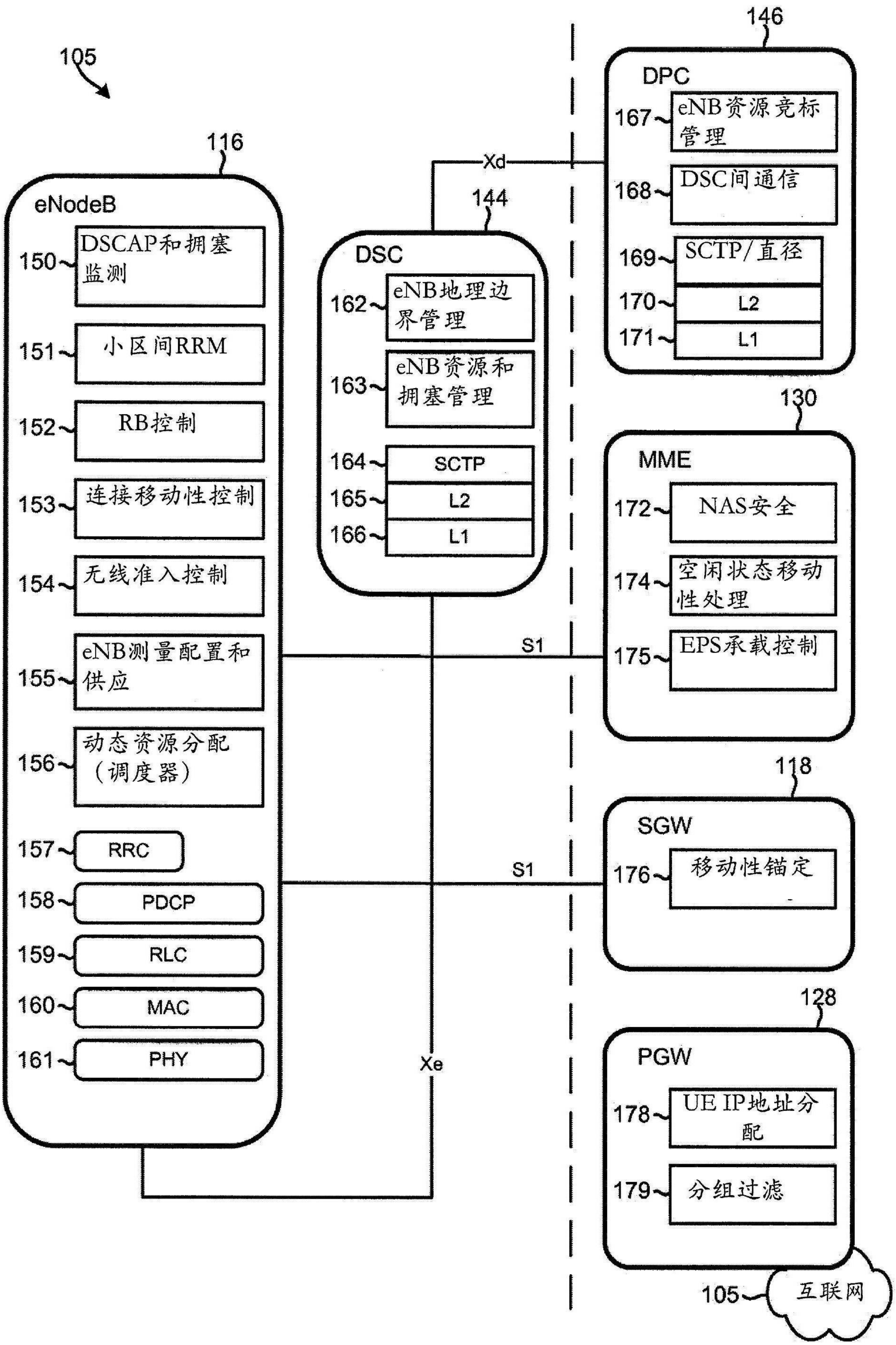

105
116
eNodeB
150 DSCAP和拥塞监测
151 小区间RRM
152 RB控制
153 连接移动性控制
154 无线准入控制
155 eNB测量配置和供应
156 动态资源分配(调度器)
157 RRC
158 PDCP
159 RLC
160 MAC
161 PHY
144
DSC
162 eNB地理边界管理
163 eNB资源和拥塞管理
164 SCTP
165 L2
166 L1
Xd
Xe
S1
S1
146
DPC
167 eNB资源竞标管理
168 DSC间通信
169 SCTP/直径
170 L2
171 L1
130
MME
172 NAS安全
174 空闲状态移动性处理
175 EPS承载控制
118
SGW
176 移动性锚定
128
PGW
178 UE IP地址分配
179 分组过滤
105 互联网

图 1E

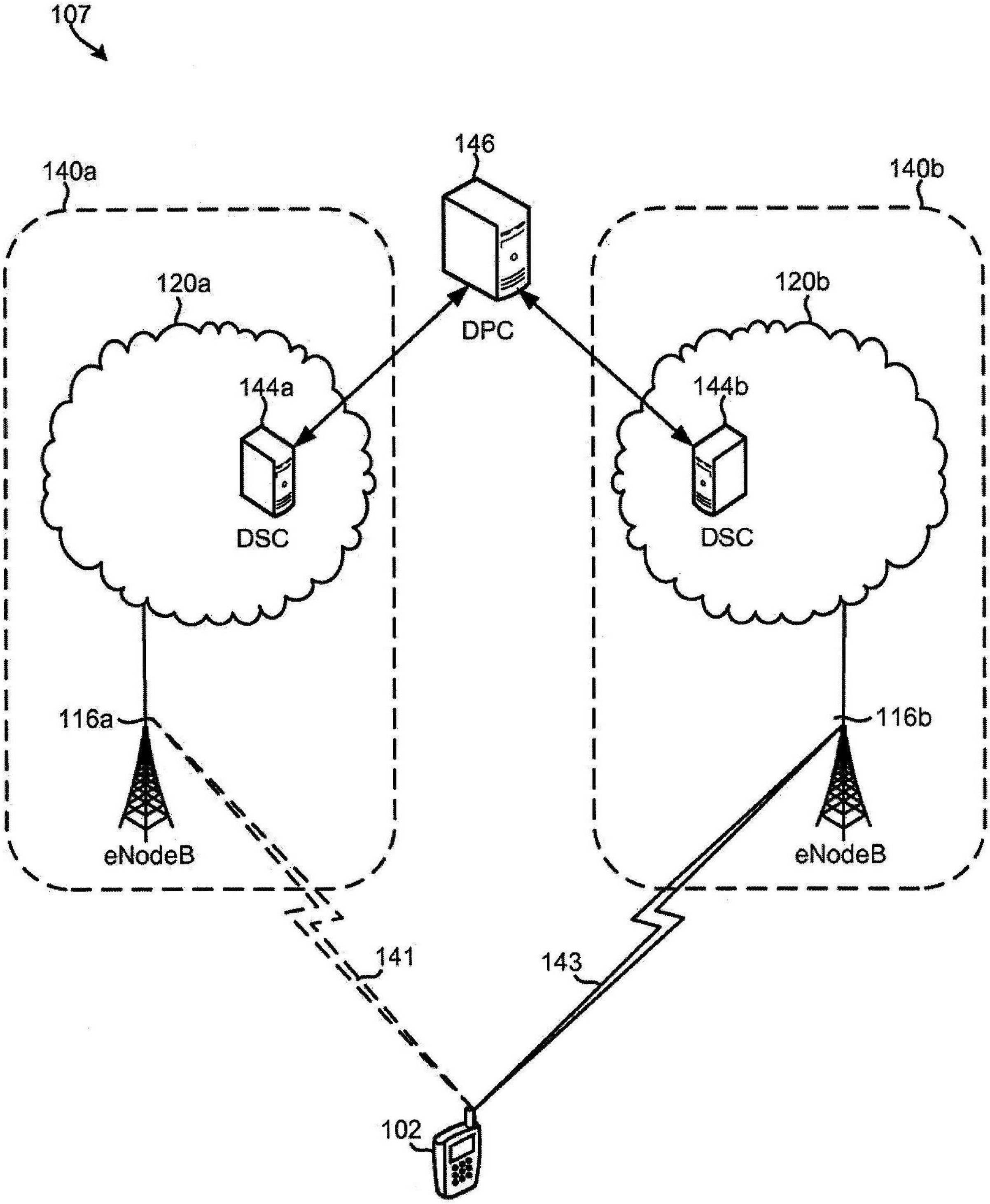

107
146
140a
140b
DPC
120a
120b
144a
144b
DSC
DSC
116a
116b
eNodeB
eNodeB
141
143
102

图 1F

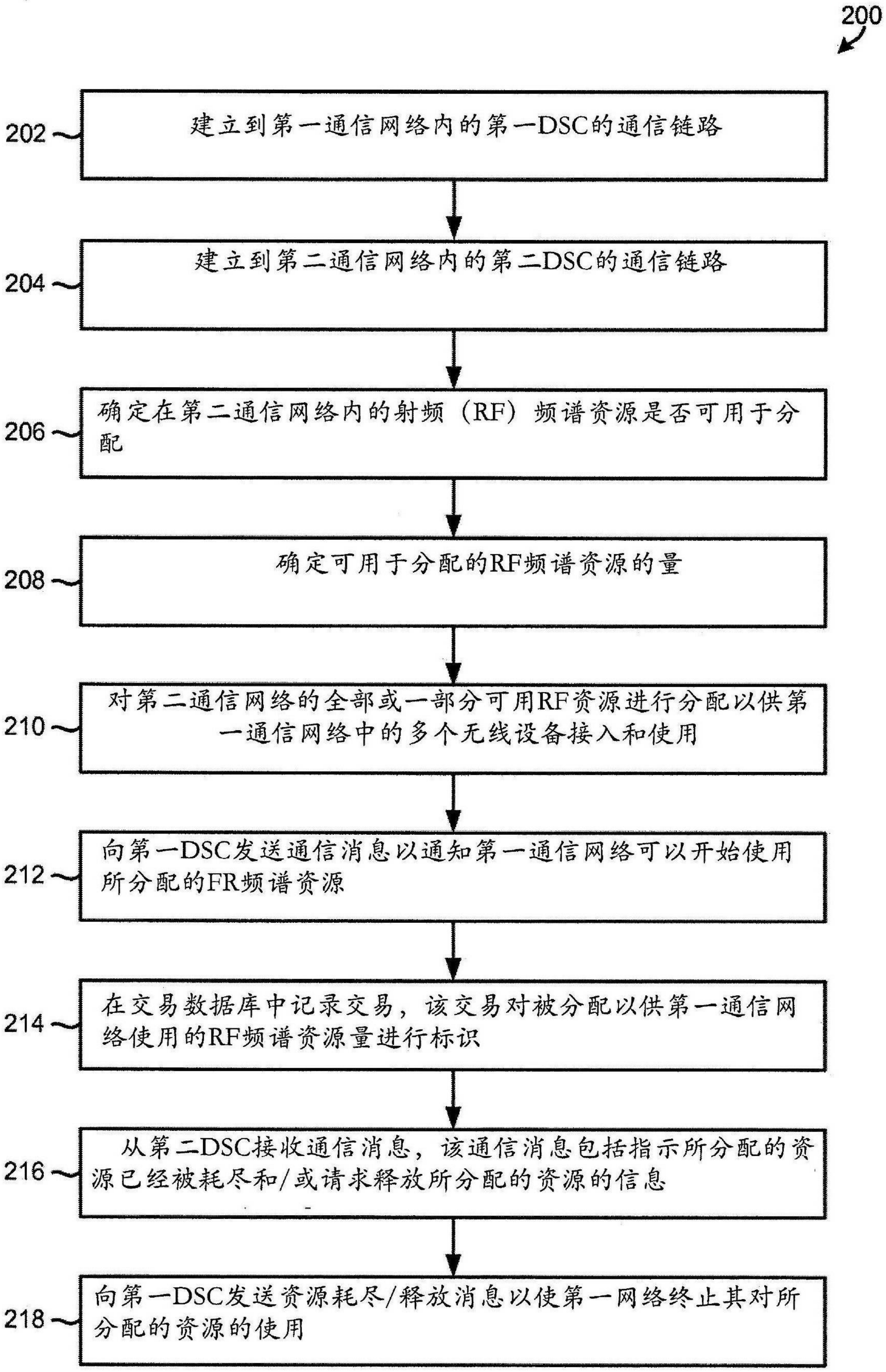

200
202
建立到第一通信网络内的第一DSC的通信链路
204
建立到第二通信网络内的第二DSC的通信链路
206
确定在第二通信网络内的射频（RF）频谱资源是否可用于分配
208
确定可用于分配的RF频谱资源的量
210
对第二通信网络的全部或一部分可用RF资源进行分配以供第一通信网络中的多个无线设备接入和使用
212
向第一DSC发送通信消息以通知第一通信网络可以开始使用所分配的FR频谱资源
214
在交易数据库中记录交易，该交易对被分配以供第一通信网络使用的RF频谱资源量进行标识
216
从第二DSC接收通信消息，该通信消息包括指示所分配的资源已经被耗尽和/或请求释放所分配的资源的信息
218
向第一DSC发送资源耗尽/释放消息以使第一网络终止其对所分配的资源的使用

图 2A

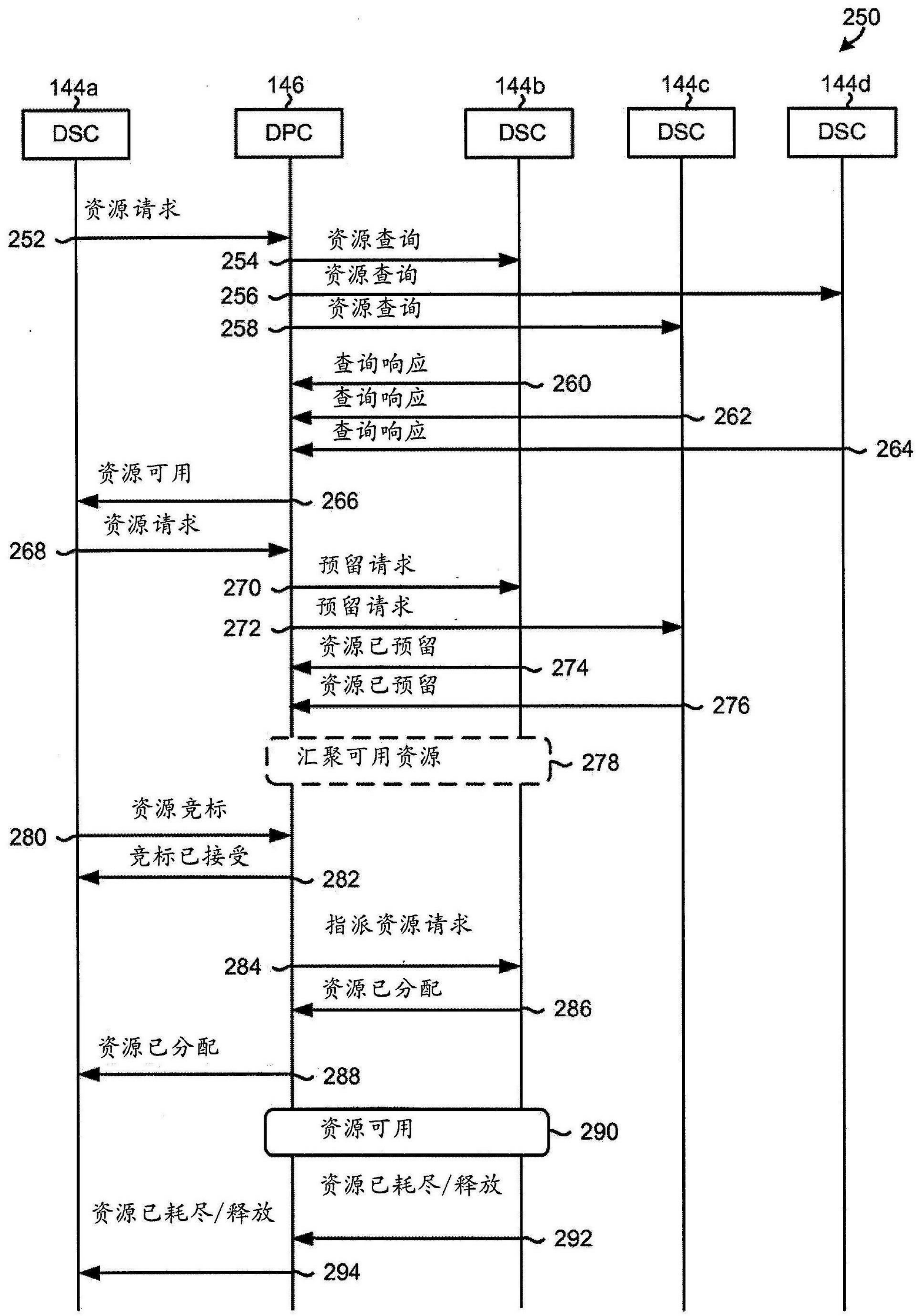

250
144a
DSC
146
DPC
144b
DSC
144c
DSC
144d
DSC
资源请求
252
资源查询
254
资源查询
256
资源查询
258
查询响应
260
查询响应
262
查询响应
264
资源可用
266
资源请求
268
预留请求
270
预留请求
272
资源已预留
274
资源已预留
276
汇聚可用资源
278
资源竞标
280
竞标已接受
282
指派资源请求
284
资源已分配
286
资源已分配
288
资源可用
290
资源已耗尽/释放
资源已耗尽/释放
292
294

图 2B

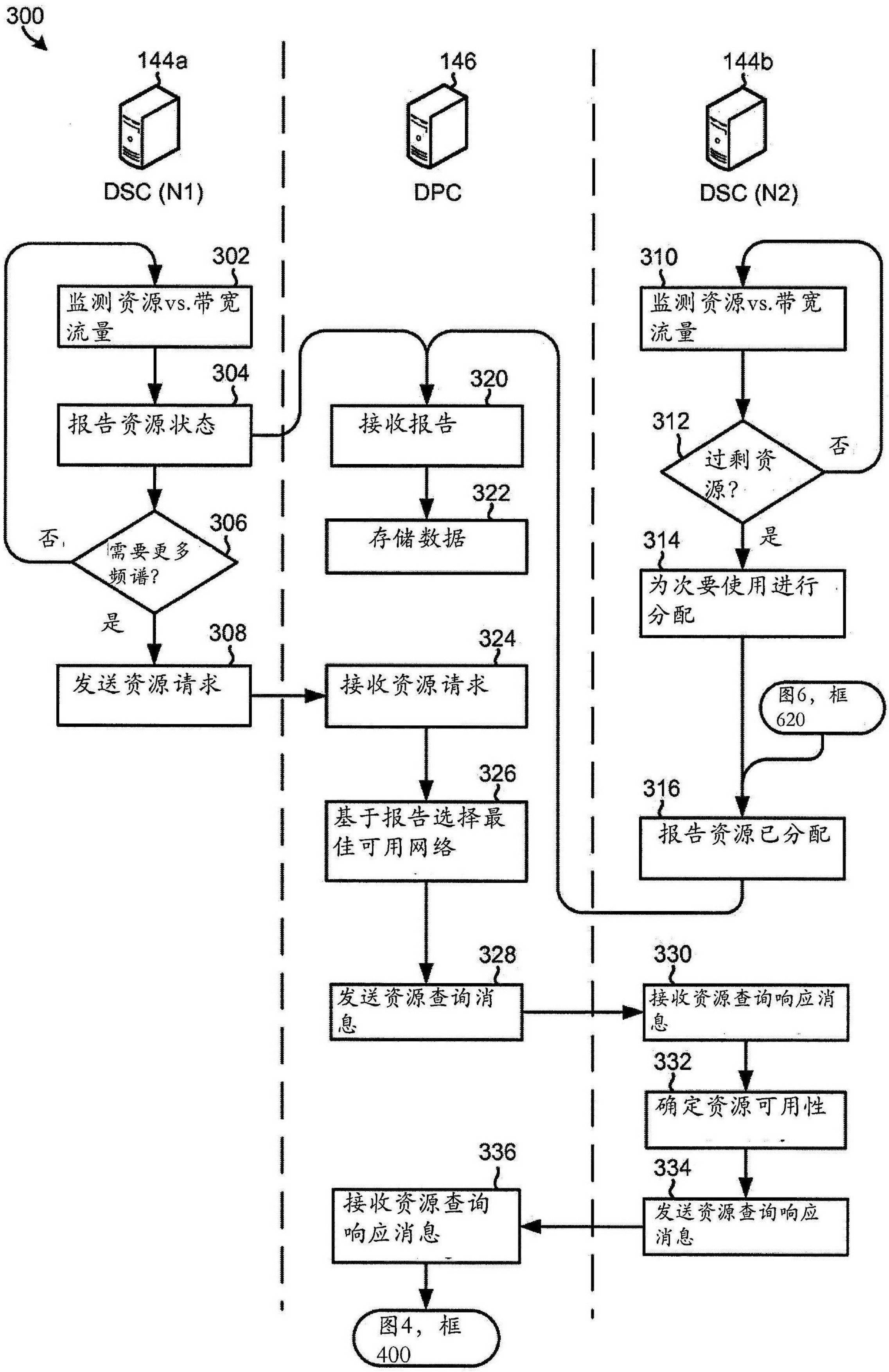

300
144a
146
144b
DSC (N1)
DPC
DSC (N2)
302
监测资源vs.带宽流量
304
报告资源状态
306
需要更多频谱?
否
是
308
发送资源请求
320
接收报告
322
存储数据
324
接收资源请求
326
基于报告选择最佳可用网络
328
发送资源查询消息
336
接收资源查询响应消息
图4，框400
310
监测资源vs.带宽流量
312
过剩资源?
否
是
314
为次要使用进行分配
图6，框620
316
报告资源已分配
330
接收资源查询响应消息
332
确定资源可用性
334
发送资源查询响应消息

图 3

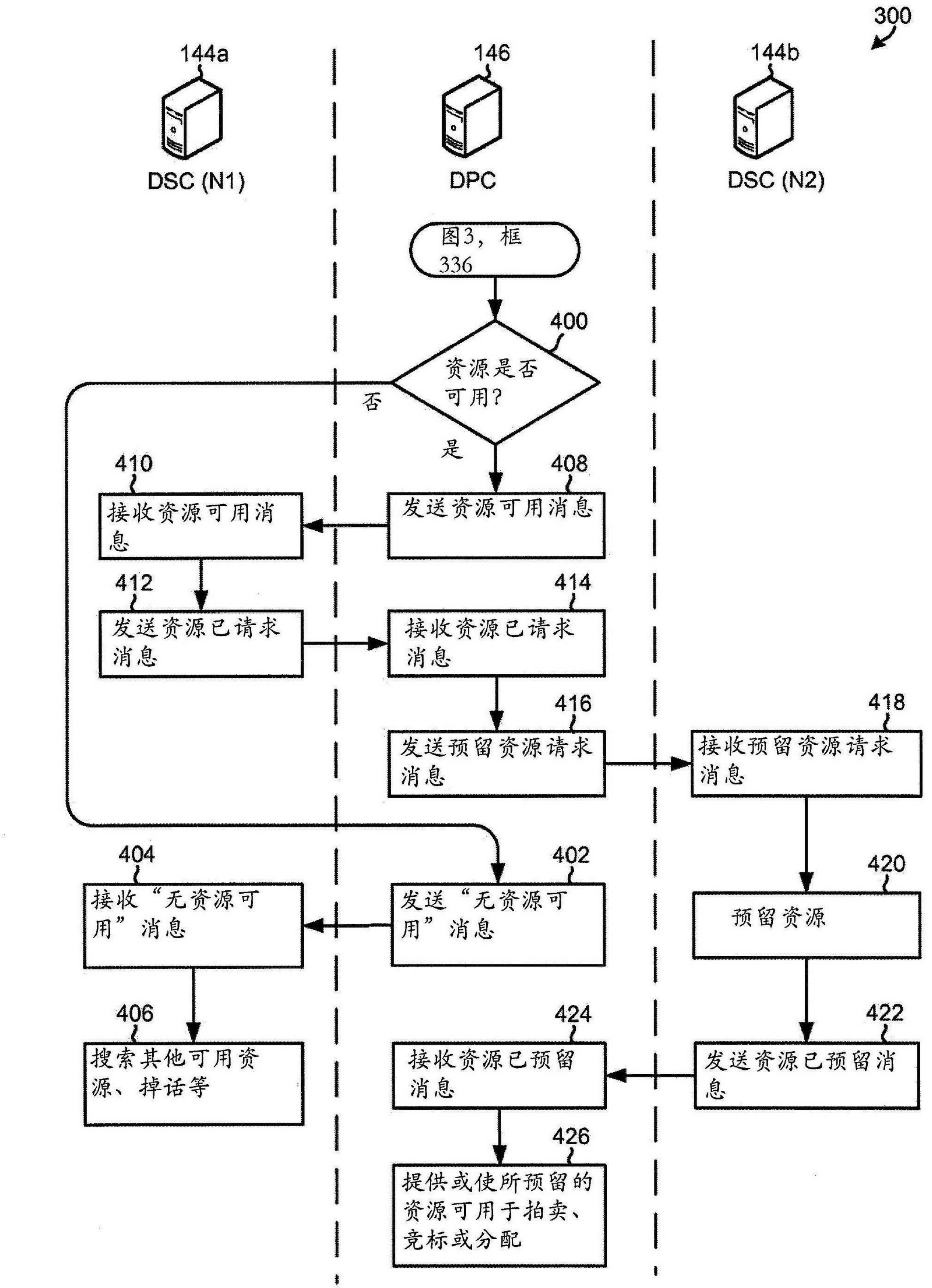

300
144a
146
144b
DSC (N1)
DPC
DSC (N2)
图3，框 336
400
资源是否可用?
否
是
410
接收资源可用消息
408
发送资源可用消息
412
发送资源已请求消息
414
接收资源已请求消息
416
发送预留资源请求消息
418
接收预留资源请求消息
404
接收“无资源可用”消息
402
发送“无资源可用”消息
420
预留资源
406
搜索其他可用资源、掉话等
424
接收资源已预留消息
422
发送资源已预留消息
426
提供或使所预留的资源可用于拍卖、竞标或分配

图 4

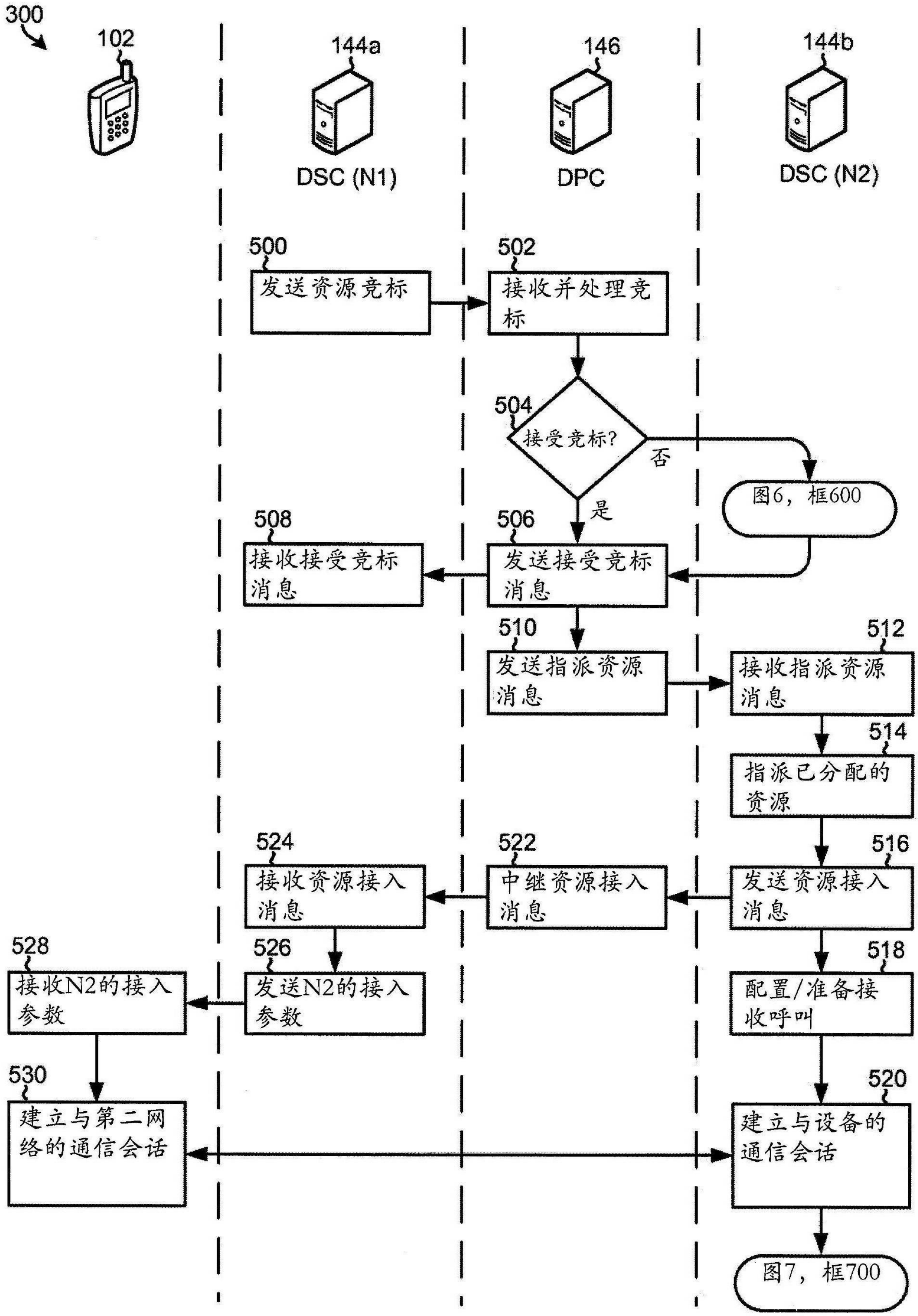

300
102
144a
DSC (N1)
146
DPC
144b
DSC (N2)
500
发送资源竞标
502
接收并处理竞标
504
接受竞标?
否
图6，框600
是
508
接收接受竞标消息
506
发送接受竞标消息
510
发送指派资源消息
512
接收指派资源消息
514
指派已分配的资源
524
接收资源接入消息
522
中继资源接入消息
516
发送资源接入消息
528
接收N2的接入参数
526
发送N2的接入参数
518
配置/准备接收呼叫
530
建立与第二网络的通信会话
520
建立与设备的通信会话
图7，框700

图 5

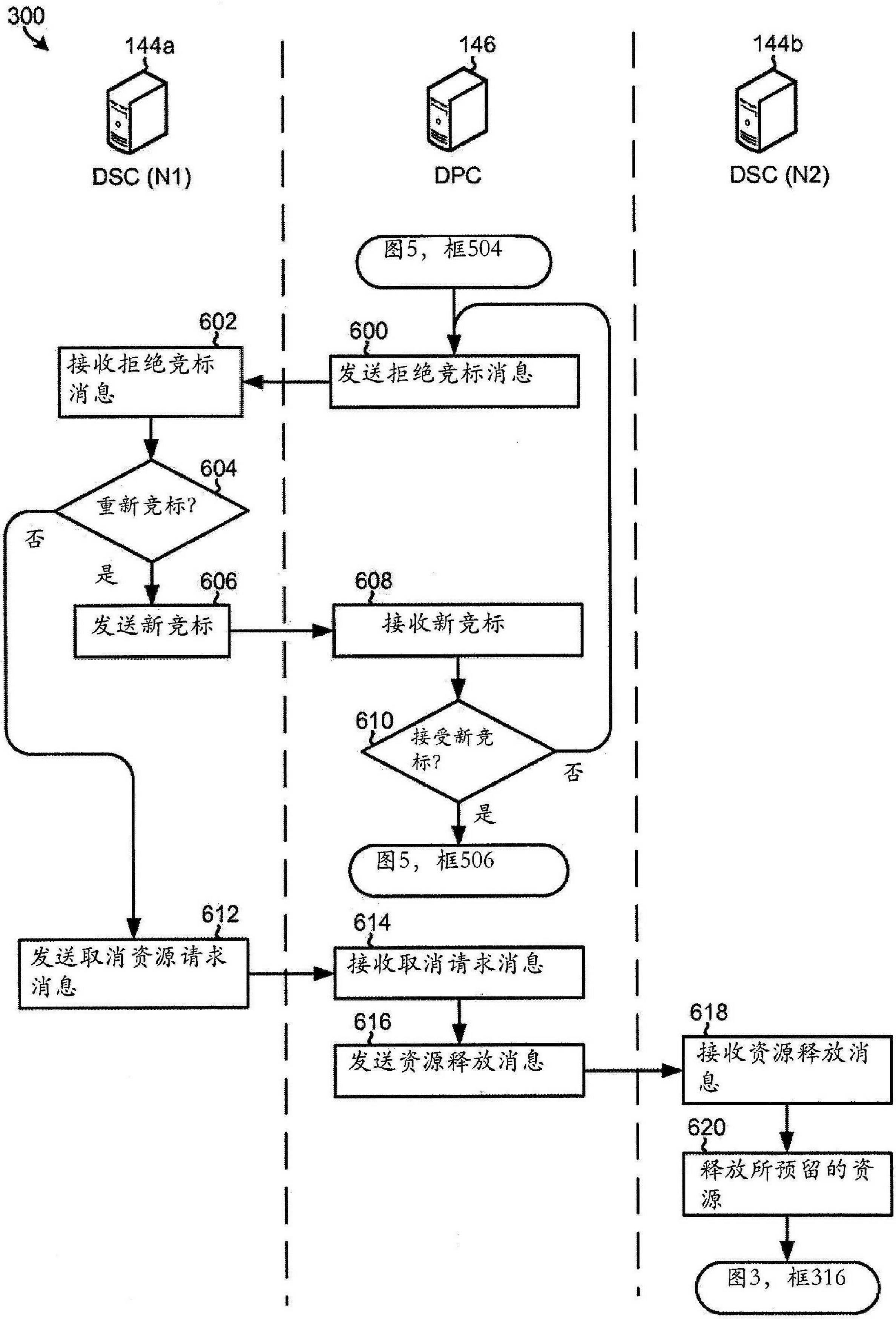

300
144a
DSC (N1)
146
DPC
144b
DSC (N2)
图5，框504
600
发送拒绝竞标消息
602
接收拒绝竞标消息
604
重新竞标?
否
是
606
发送新竞标
608
接收新竞标
610
接受新竞标?
否
是
图5，框506
612
发送取消资源请求消息
614
接收取消请求消息
616
发送资源释放消息
618
接收资源释放消息
620
释放所预留的资源
图3，框316

图 6

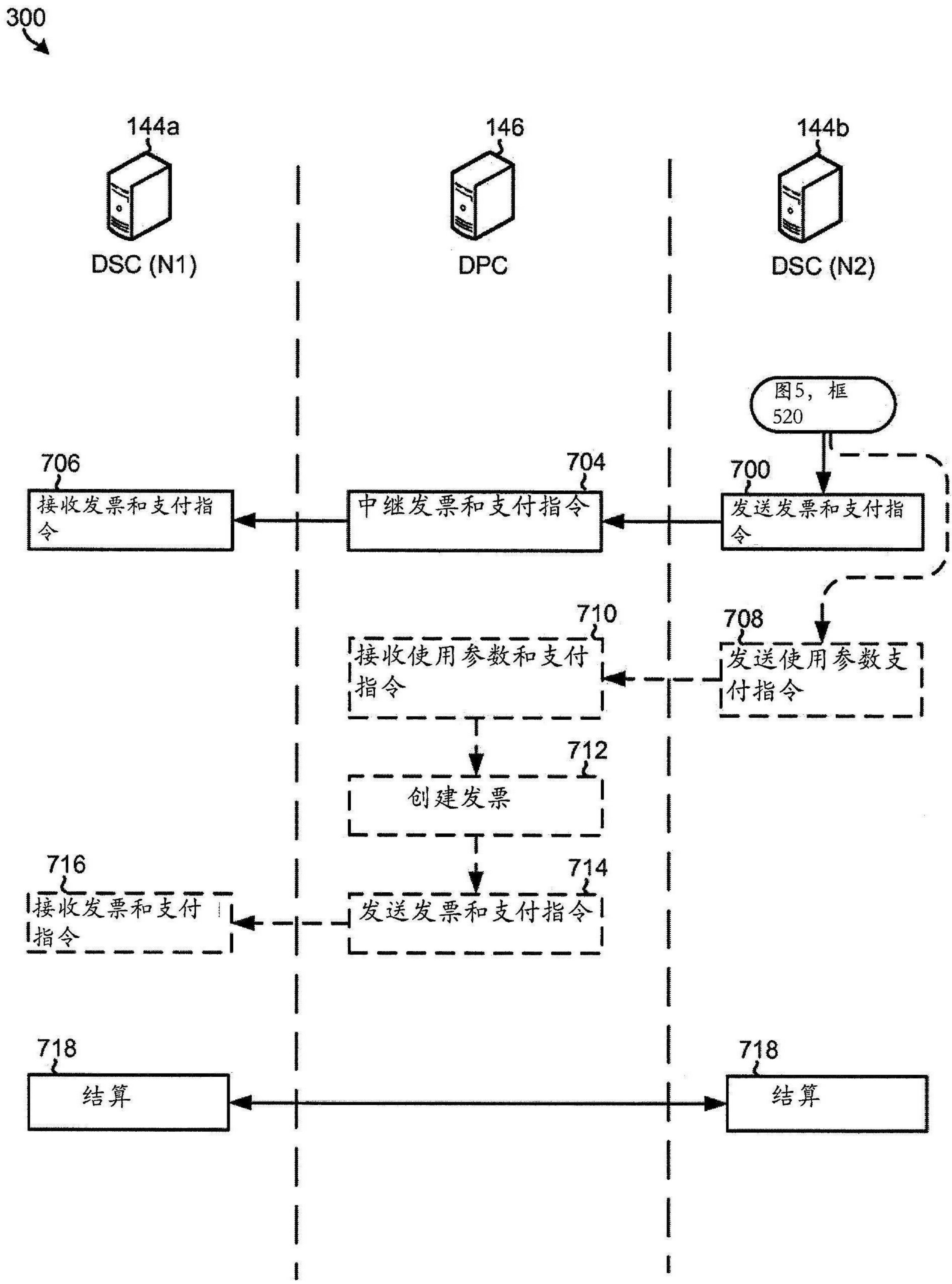

300
144a
146
144b
DSC (N1)
DPC
DSC (N2)
图5，框
520
706
接收发票和支付指令
704
中继发票和支付指令
700
发送发票和支付指令
710
接收使用参数和支付指令
708
发送使用参数支付指令
712
创建发票
716
接收发票和支付指令
714
发送发票和支付指令
718
结算
718
结算

图 7

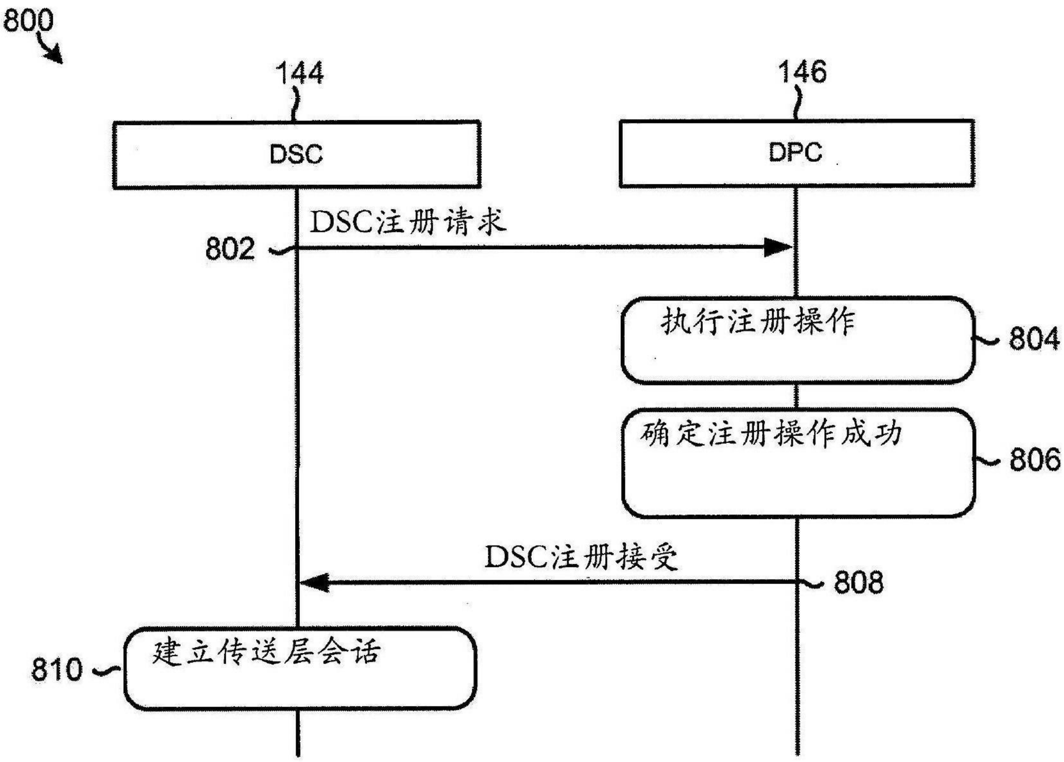

800
144
146
DSC
DPC
DSC注册请求
802
执行注册操作
804
确定注册操作成功
806
DSC注册接受
808
810
建立传送层会话

图 8A

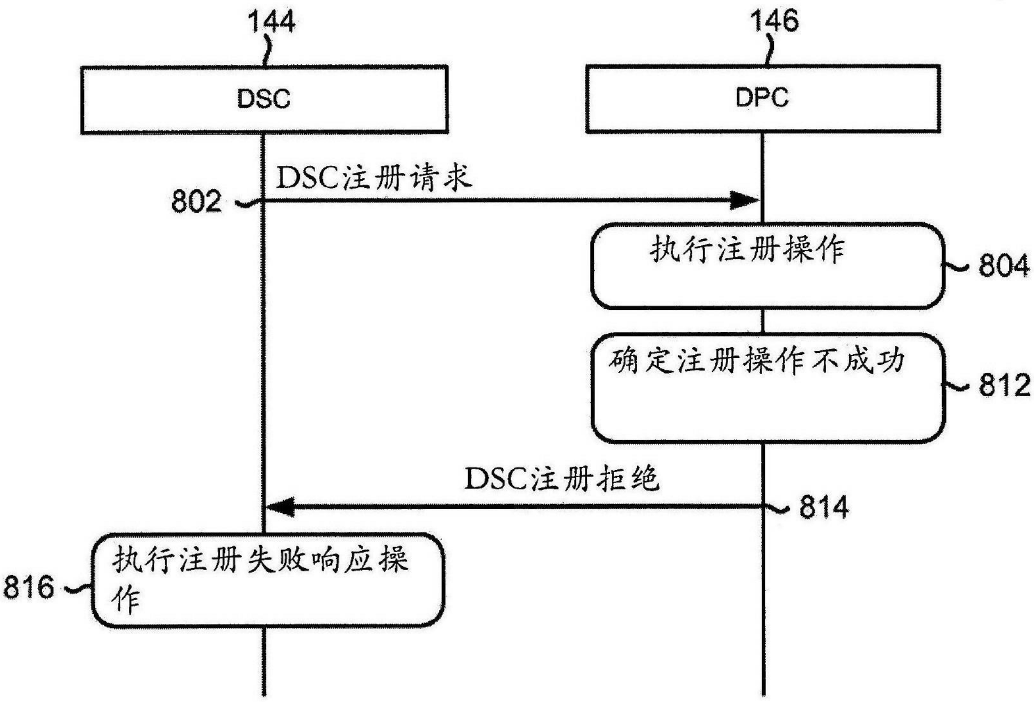

144
146
DSC
DPC
DSC注册请求
802
执行注册操作
804
确定注册操作不成功
812
DSC注册拒绝
814
816
执行注册失败响应操作

图 8B

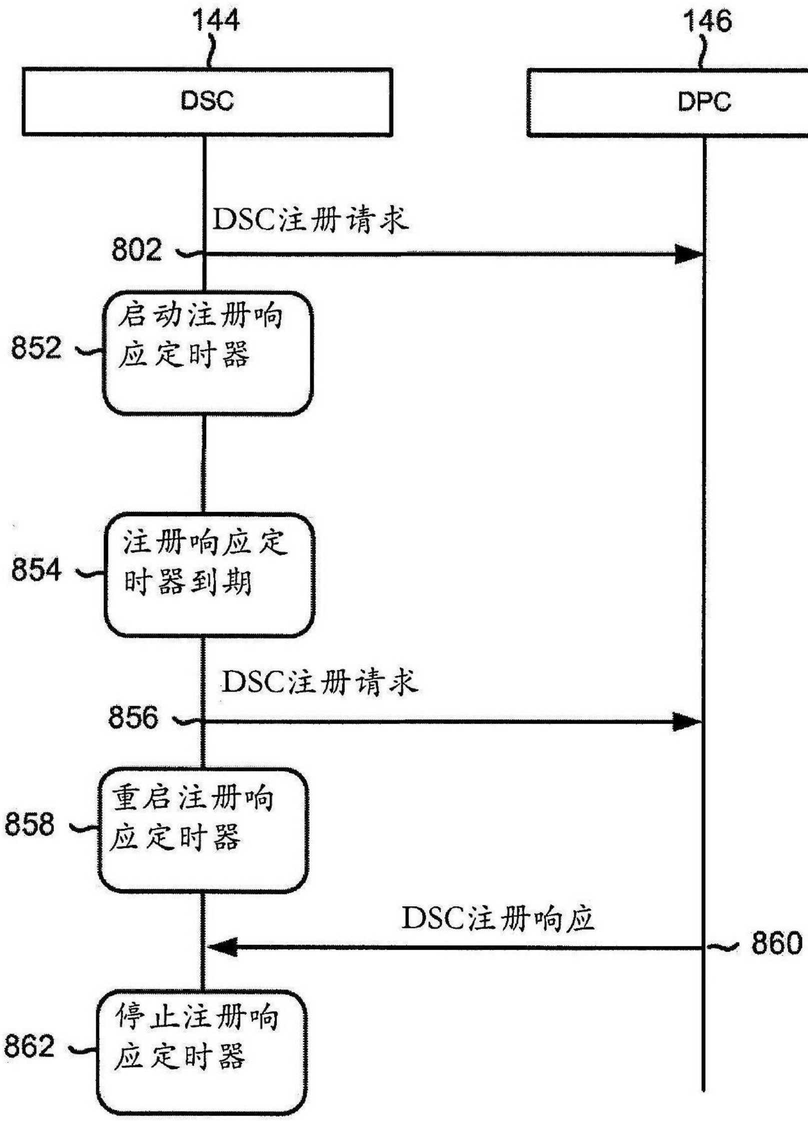

144
146
DSC
DPC
DSC注册请求
802
启动注册响应定时器
852
注册响应定时器到期
854
DSC注册请求
856
重启注册响应定时器
858
DSC注册响应
860
停止注册响应定时器
862

图 8C

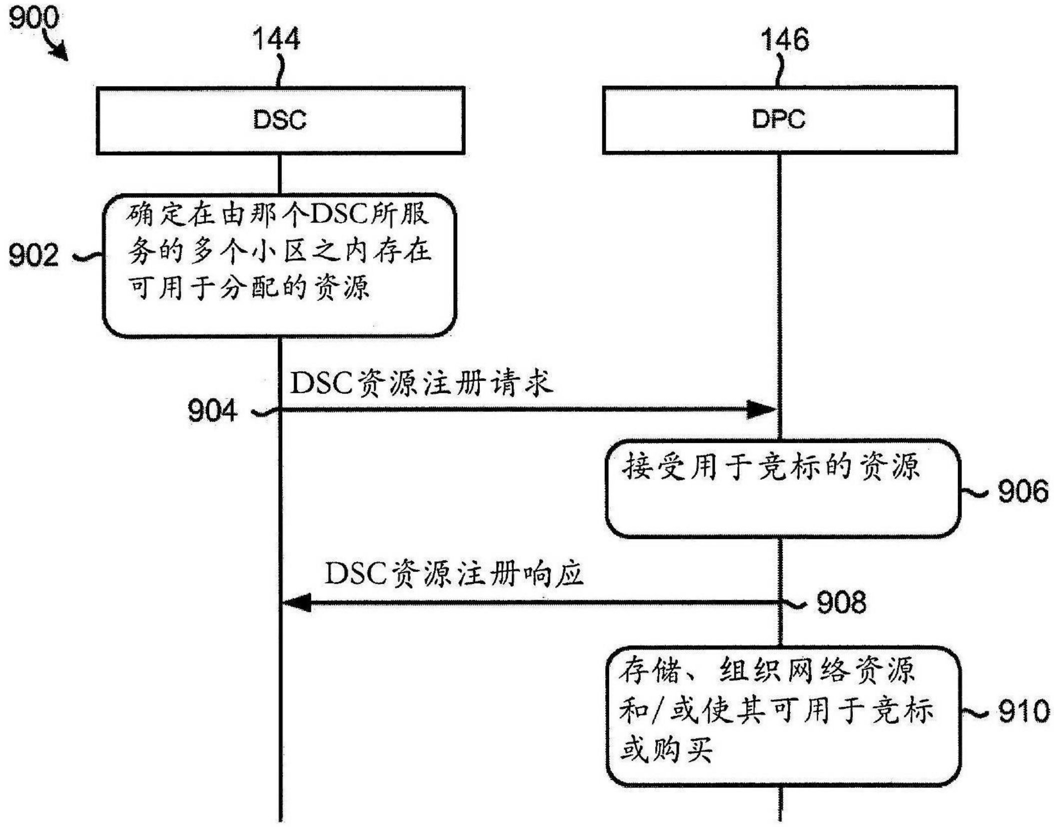

900
144
146
DSC
DPC
确定在由那个DSC所服务的多个小区之内存在可用于分配的资源
902
DSC资源注册请求
904
接受用于竞标的资源
906
DSC资源注册响应
908
存储、组织网络资源和/或使其可用于竞标或购买
910

图 9A

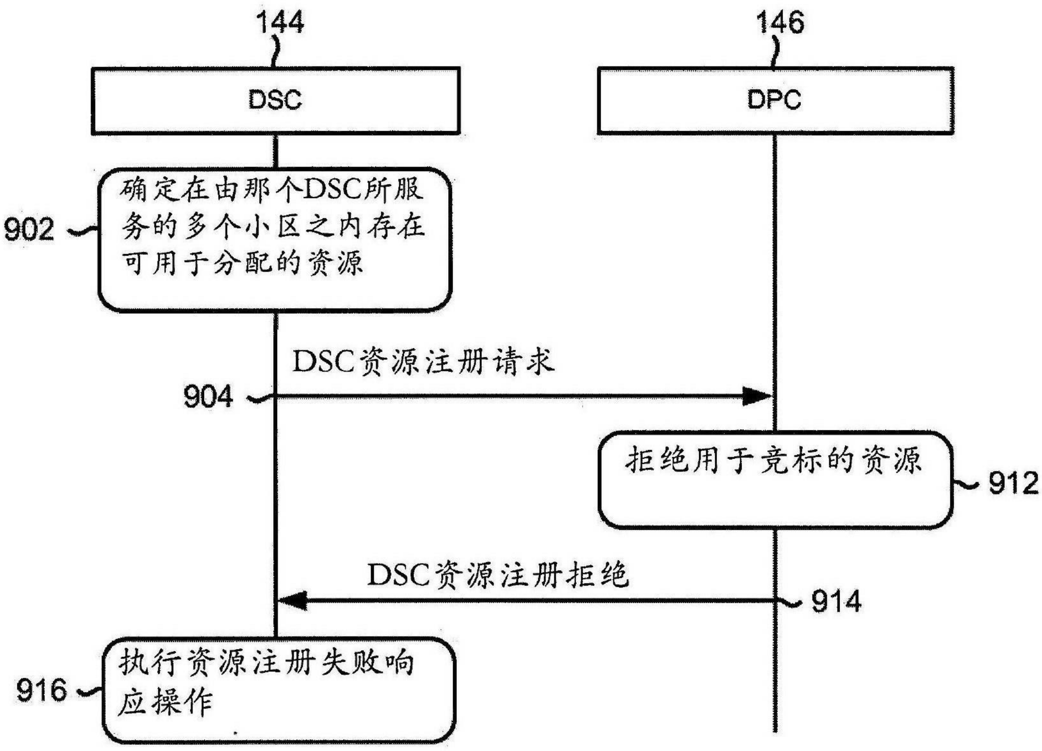

144
146
DSC
DPC
确定在由那个DSC所服务的多个小区之内存在可用于分配的资源
902
DSC资源注册请求
904
拒绝用于竞标的资源
912
DSC资源注册拒绝
914
执行资源注册失败响应操作
916

图 9B

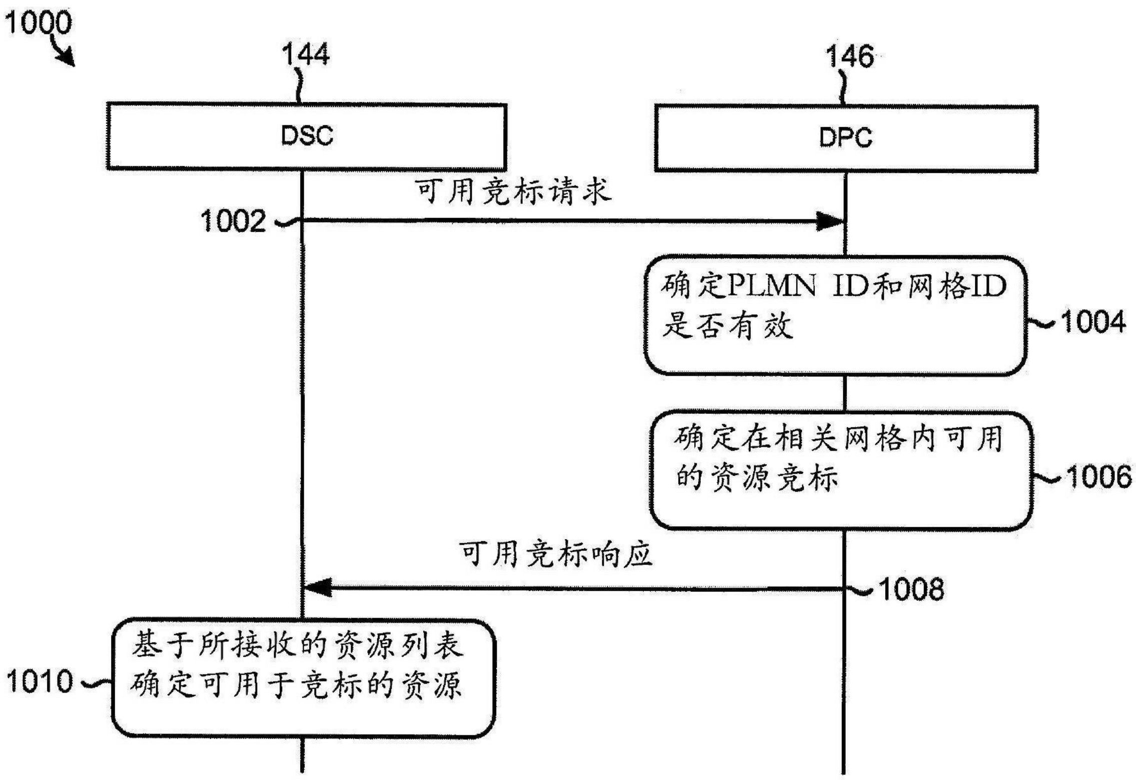

1000
144
146
DSC
DPC
可用竞标请求
1002
确定PLMN ID和网格ID是否有效
1004
确定在相关网格内可用的资源竞标
1006
可用竞标响应
1008
基于所接收的资源列表确定可用于竞标的资源
1010

图 10A

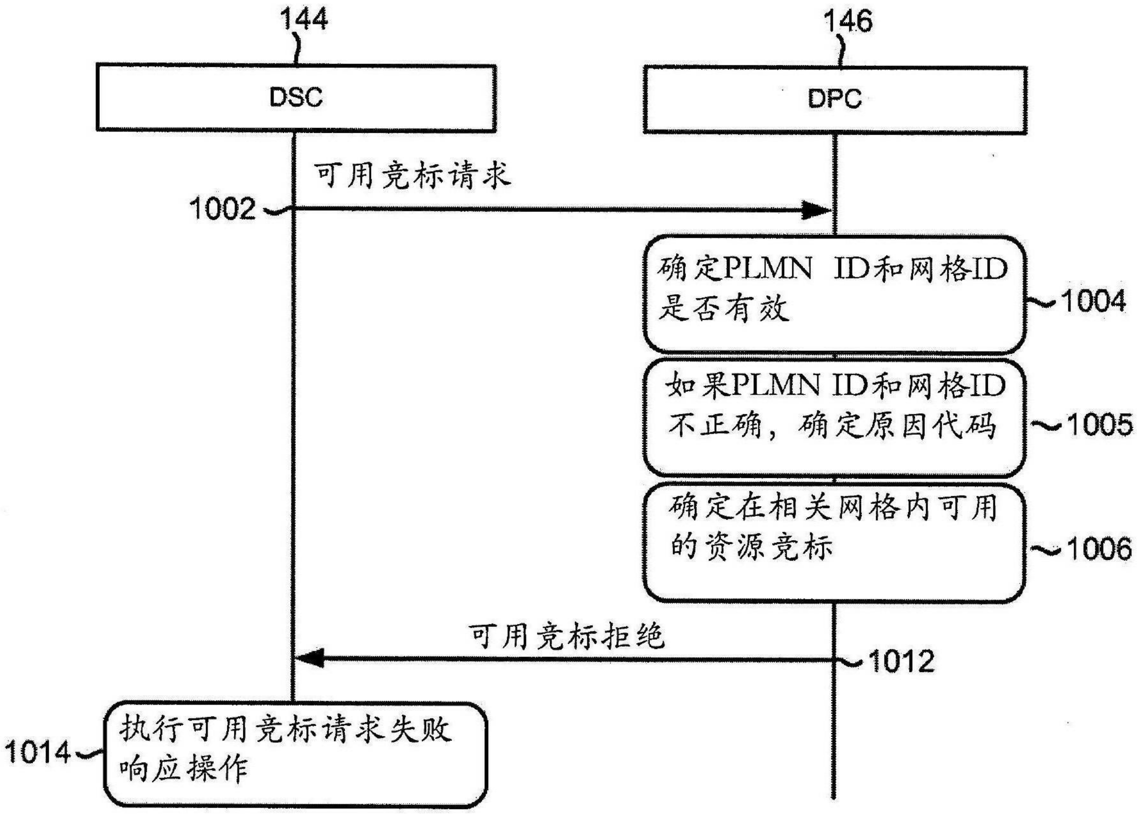

144
146
DSC
DPC
可用竞标请求
1002
确定PLMN ID和网格ID是否有效
1004
如果PLMN ID和网格ID不正确，确定原因代码
1005
确定在相关网格内可用的资源竞标
1006
可用竞标拒绝
1012
执行可用竞标请求失败响应操作
1014

图 10B

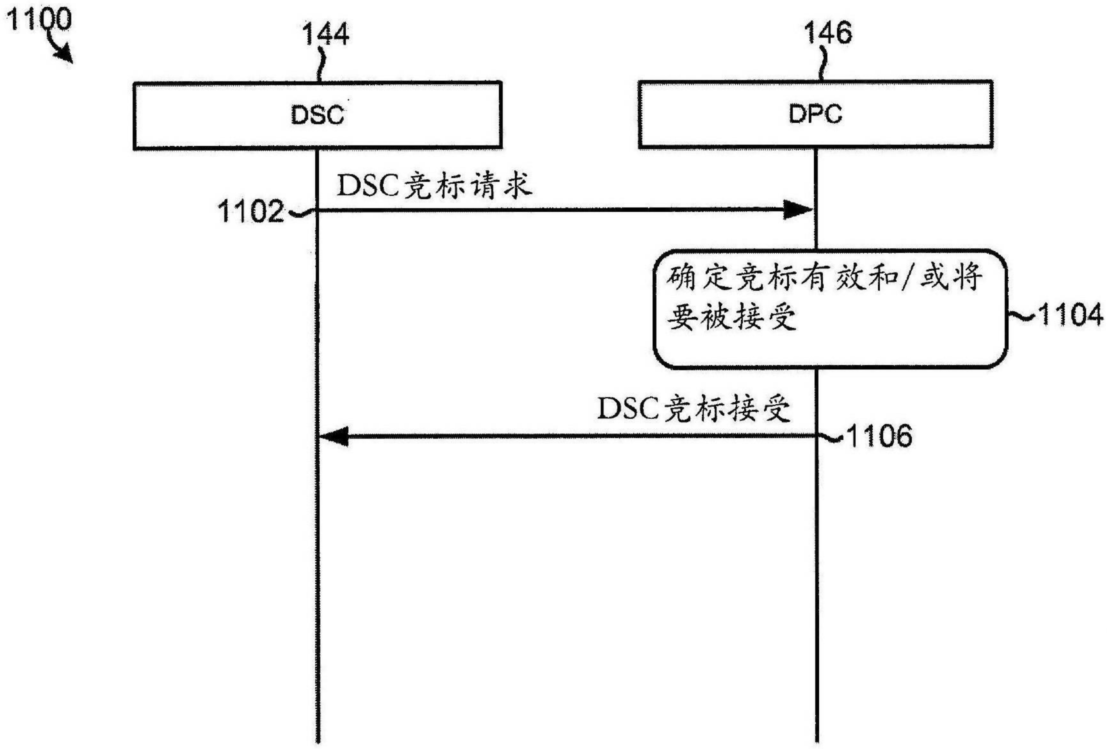

1100
144
146
DSC
DPC
DSC竞标请求
1102
确定竞标有效和/或将要被接受
1104
DSC竞标接受
1106

图 11A

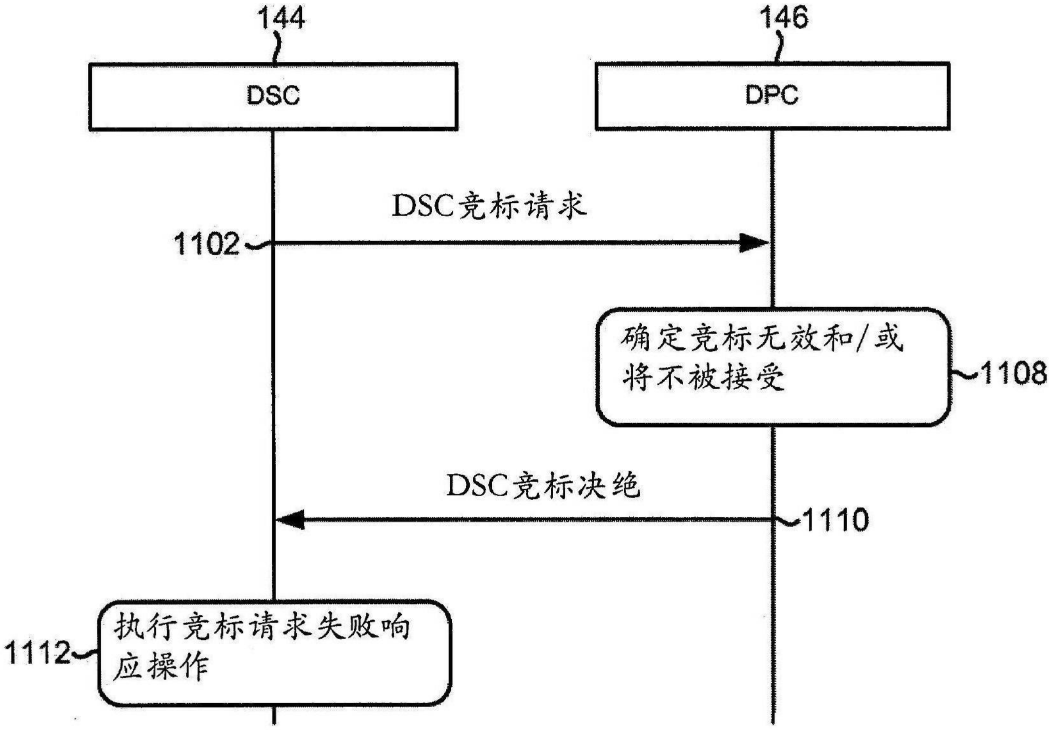

144
146
DSC
DPC
DSC竞标请求
1102
确定竞标无效和/或将不被接受
1108
DSC竞标决绝
1110
执行竞标请求失败响应操作
1112

图 11B

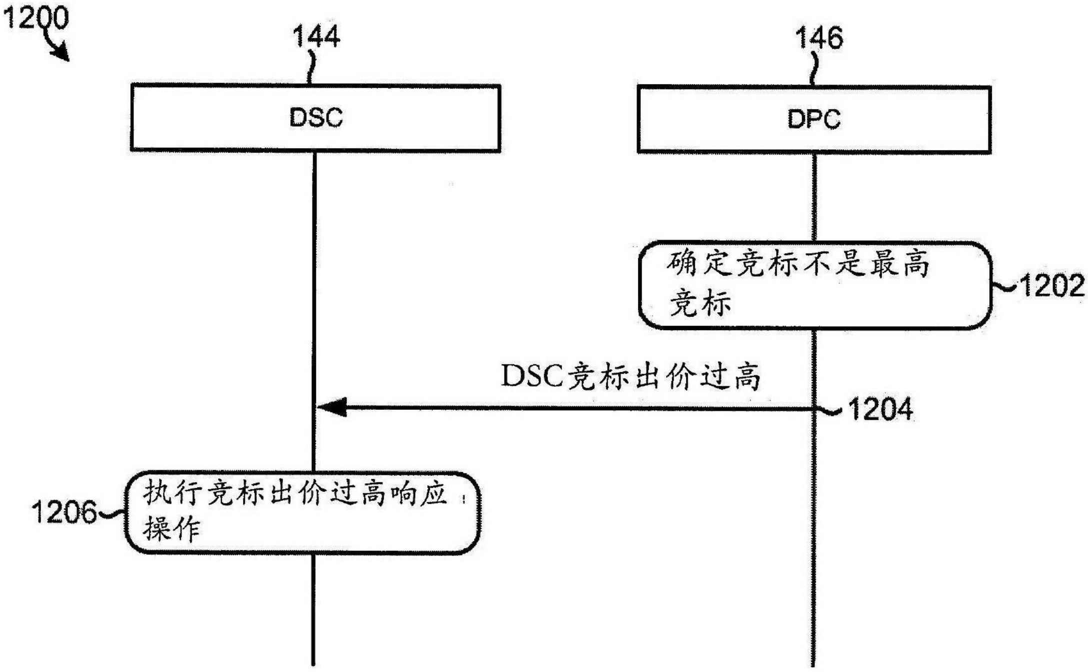

1200
144
146
DSC
DPC
确定竞标不是最高竞标
1202
DSC竞标出价过高
1204
执行竞标出价过高响应操作
1206

图 12A

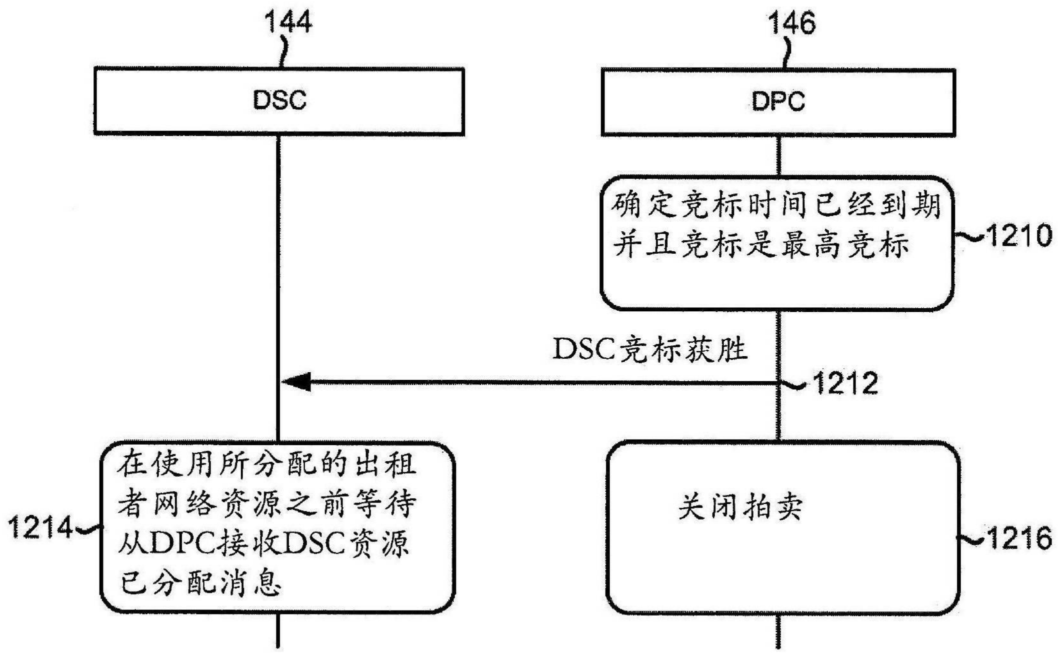

144
146
DSC
DPC
确定竞标时间已经到期并且竞标是最高竞标
1210
DSC竞标获胜
1212
在使用所分配的出租者网络资源之前等待从DPC接收DSC资源已分配消息
1214
关闭拍卖
1216

图 12B

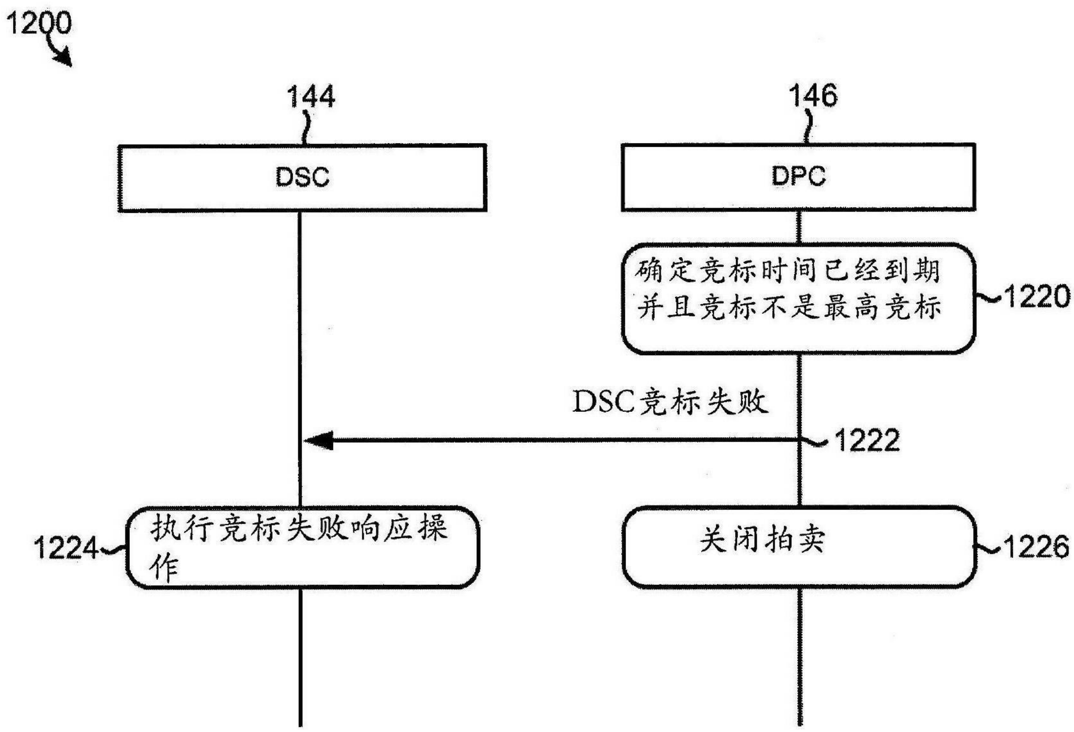

1200
144
146
DSC
DPC
确定竞标时间已经到期并且竞标不是最高竞标
1220
DSC竞标失败
1222
执行竞标失败响应操作
1224
关闭拍卖
1226

图 12C

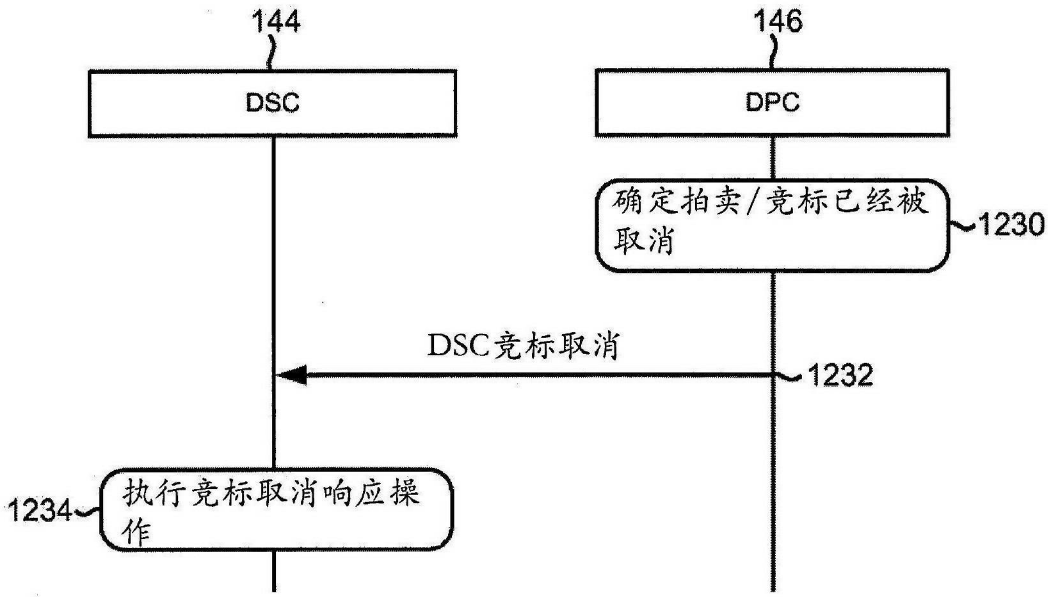

144
146
DSC
DPC
确定拍卖/竞标已经被取消
1230
DSC竞标取消
1232
1234
执行竞标取消响应操作

图 12D

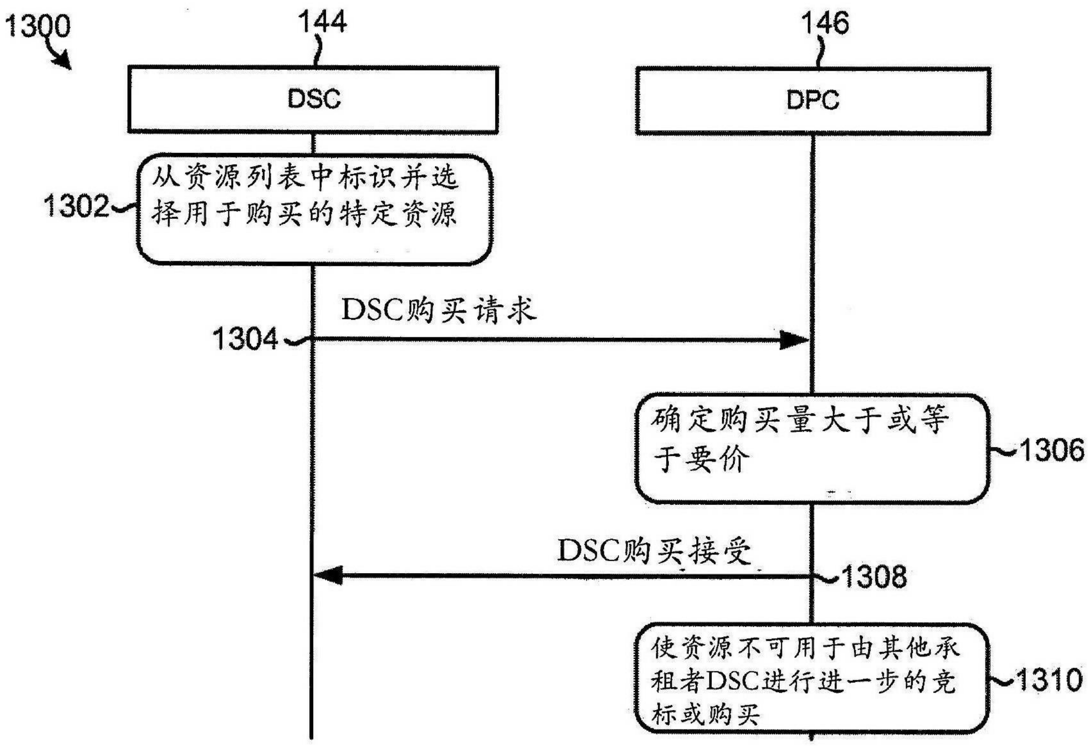

1300
144
146
DSC
DPC
1302
从资源列表中标识并选择用于购买的特定资源
DSC购买请求
1304
确定购买量大于或等于要价
1306
DSC购买接受
1308
使资源不可用于由其他承租者DSC进行进一步的竞标或购买
1310

图 13A

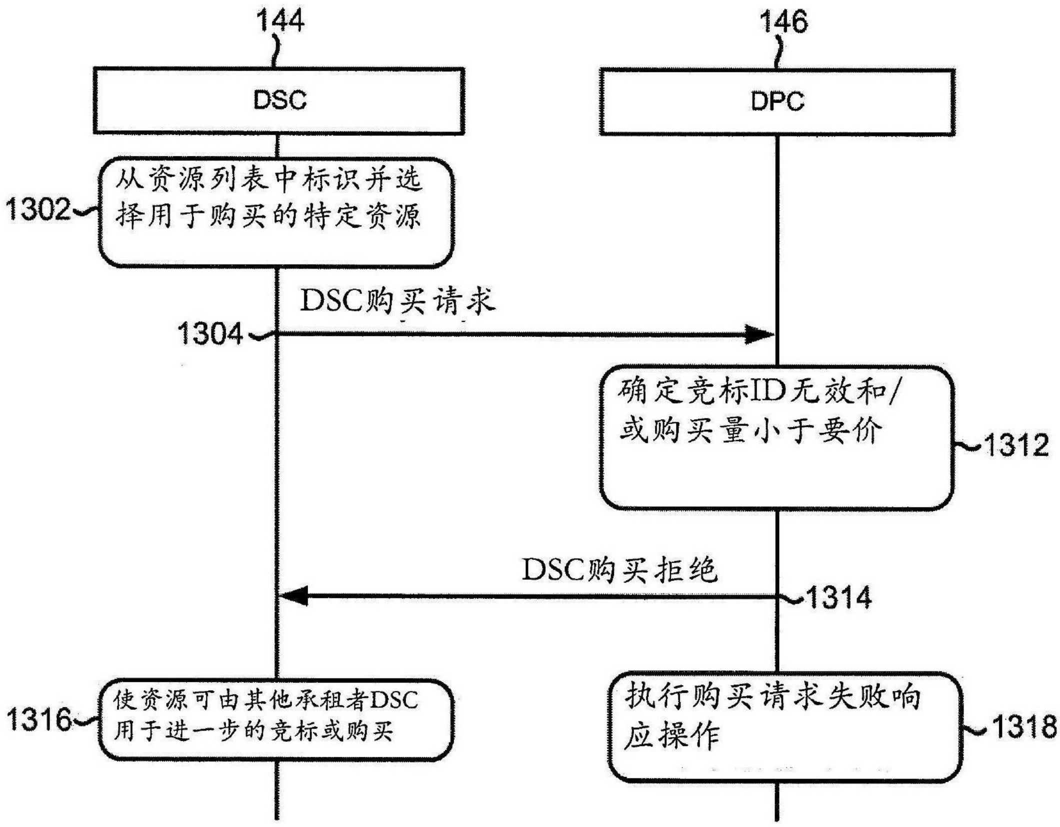

144
146
DSC
DPC
从资源列表中标识并选择用于购买的特定资源
1302
DSC购买请求
1304
确定竞标ID无效和/或购买量小于要价
1312
DSC购买拒绝
1314
使资源可由其他承租者DSC用于进一步的竞标或购买
1316
执行购买请求失败响应操作
1318

图 13B

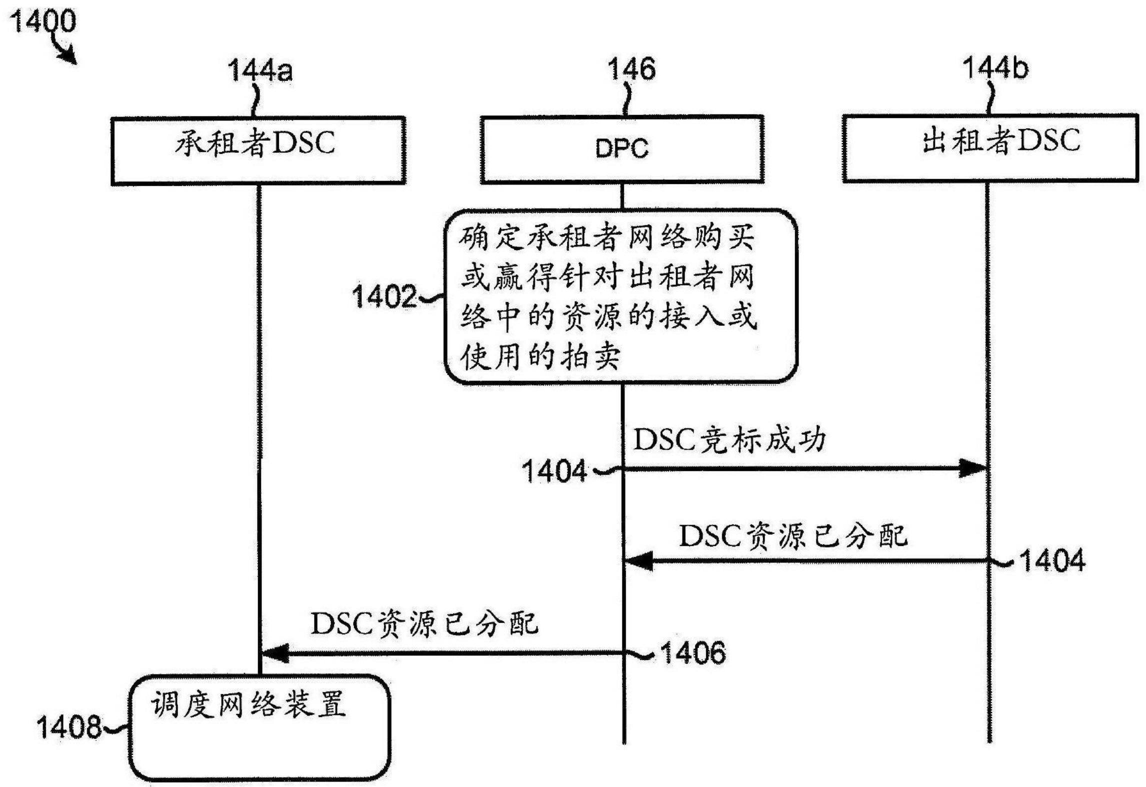

1400
144a
146
144b
承租者DSC
DPC
出租者DSC
确定承租者网络购买或赢得针对出租者网络中的资源的接入或使用的拍卖
1402
DSC竞标成功
1404
DSC资源已分配
1404
DSC资源已分配
1406
调度网络装置
1408

图 14A

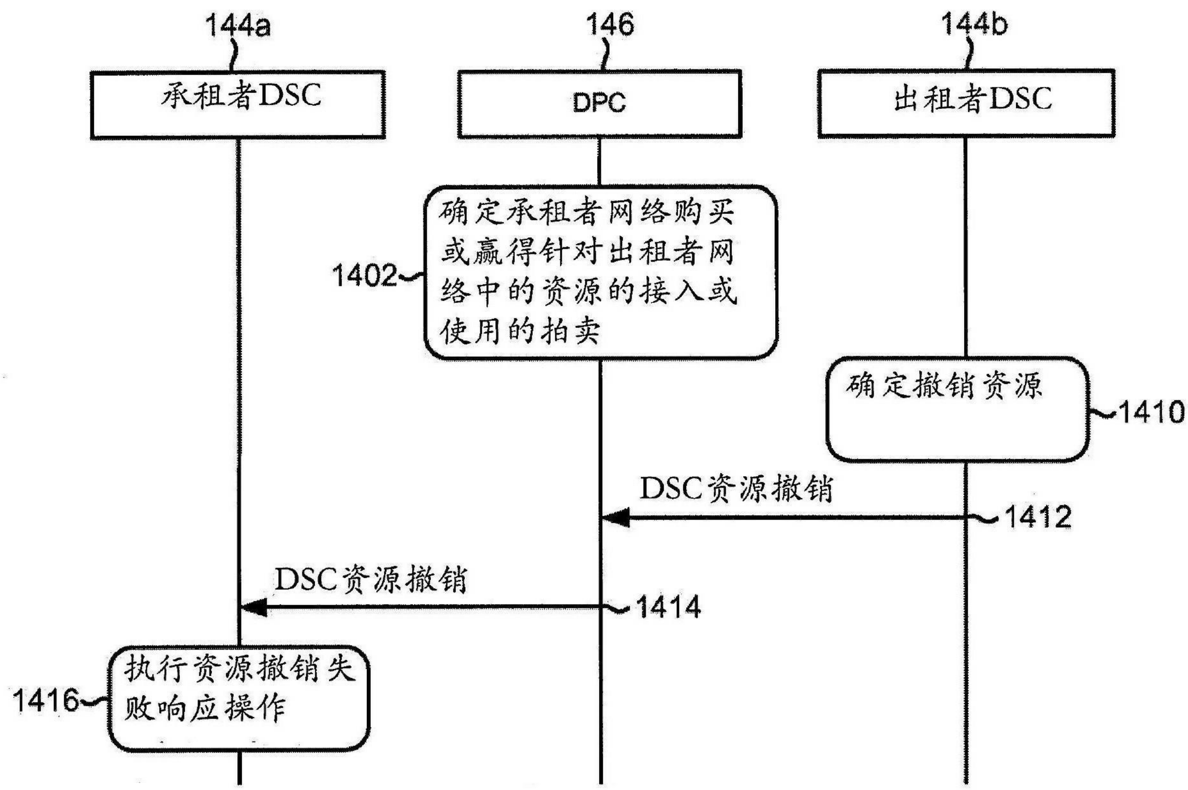

144a
146
144b
承租者DSC
DPC
出租者DSC
确定承租者网络购买或赢得针对出租者网络中的资源的接入或使用的拍卖
1402
确定撤销资源
1410
DSC资源撤销
1412
DSC资源撤销
1414
执行资源撤销失败响应操作
1416

图 14B

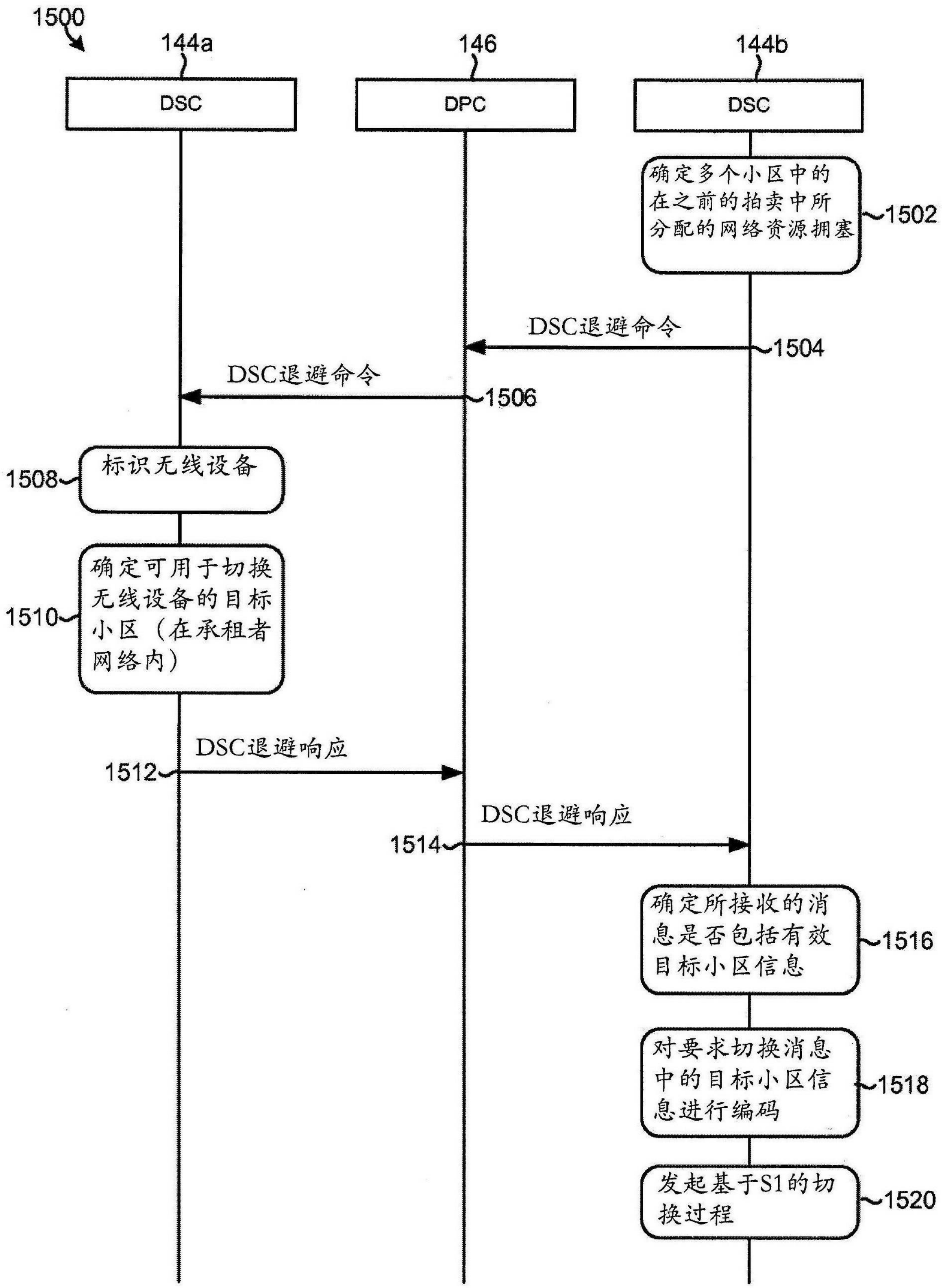

1500
144a
146
144b
DSC
DPC
DSC
确定多个小区中的在之前的拍卖中所分配的网络资源拥塞
1502
DSC退避命令
1504
DSC退避命令
1506
1508
标识无线设备
1510
确定可用于切换无线设备的目标小区（在承租者网络内）
DSC退避响应
1512
DSC退避响应
1514
确定所接收的消息是否包括有效目标小区信息
1516
对要求切换消息中的目标小区信息进行编码
1518
发起基于S1的切换过程
1520

图 15A

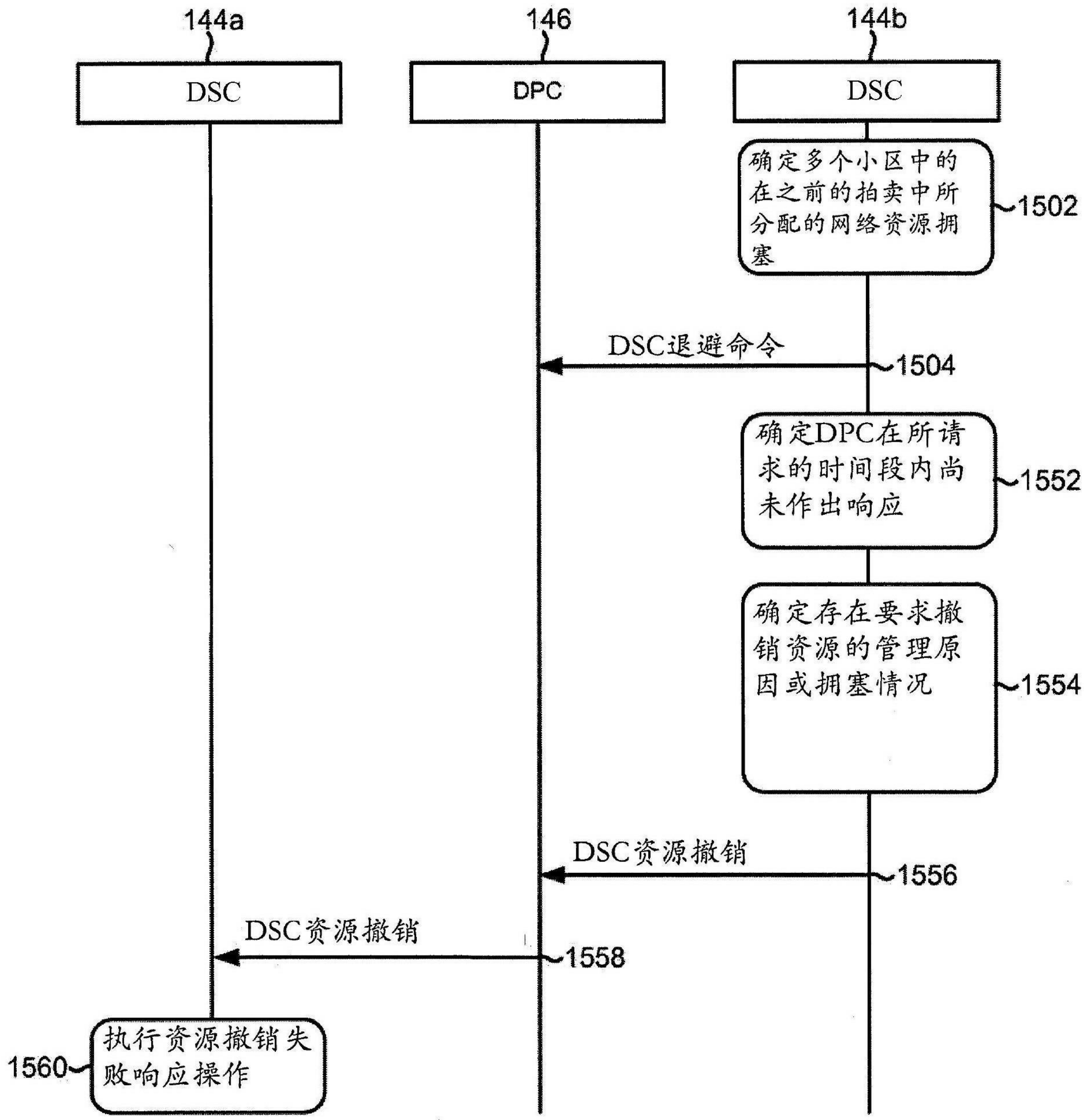

144a
146
144b
DSC
DPC
DSC
确定多个小区中的在之前的拍卖中所分配的网络资源拥塞
1502
DSC退避命令
1504
确定DPC在所请求的时间段内尚未作出响应
1552
确定存在要求撤销资源的管理原因或拥塞情况
1554
DSC资源撤销
1556
DSC资源撤销
1558
1560
执行资源撤销失败响应操作

图 15B

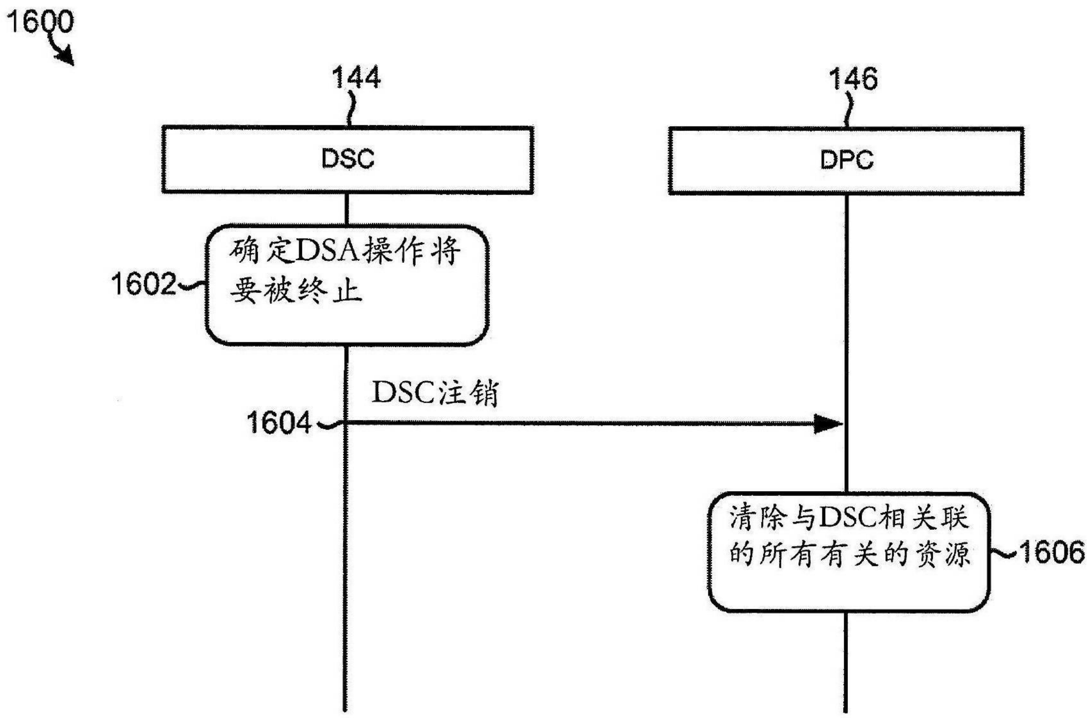

1600
144
146
DSC
DPC
确定DSA操作将要被终止
1602
DSC注销
1604
清除与DSC相关联的所有有关的资源
1606

图 16A

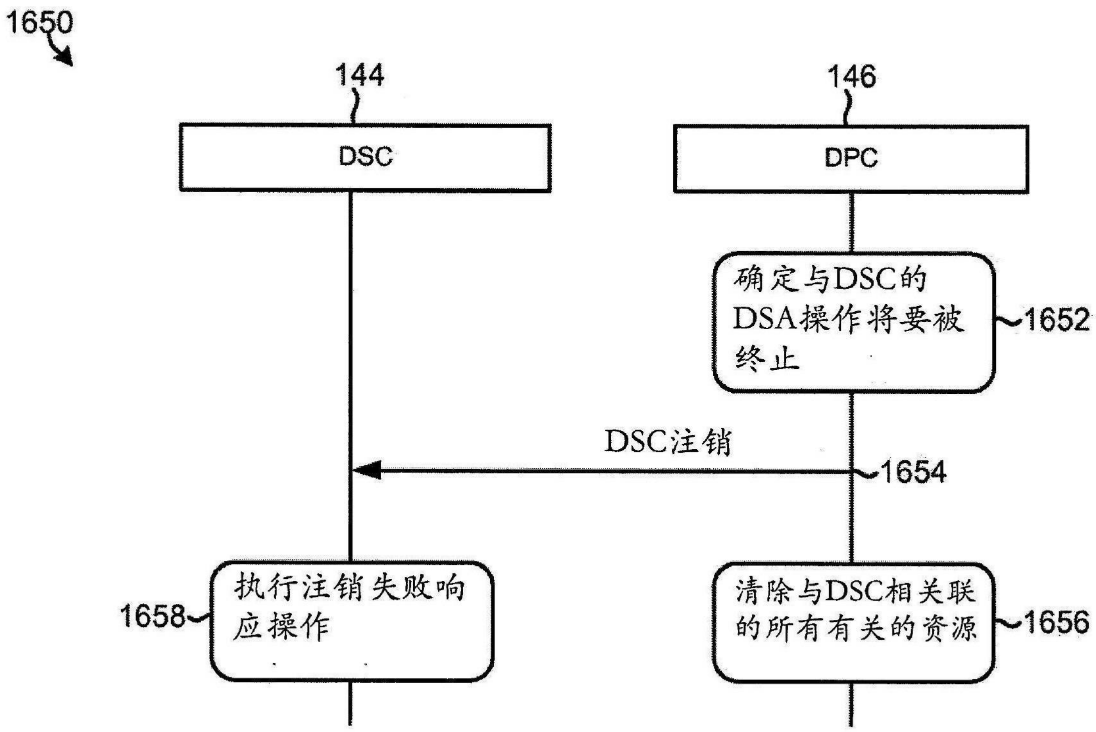

1650
144
146
DSC
DPC
确定与DSC的DSA操作将要被终止
1652
DSC注销
1654
执行注销失败响应操作
1658
清除与DSC相关联的所有有关的资源
1656

图 16B

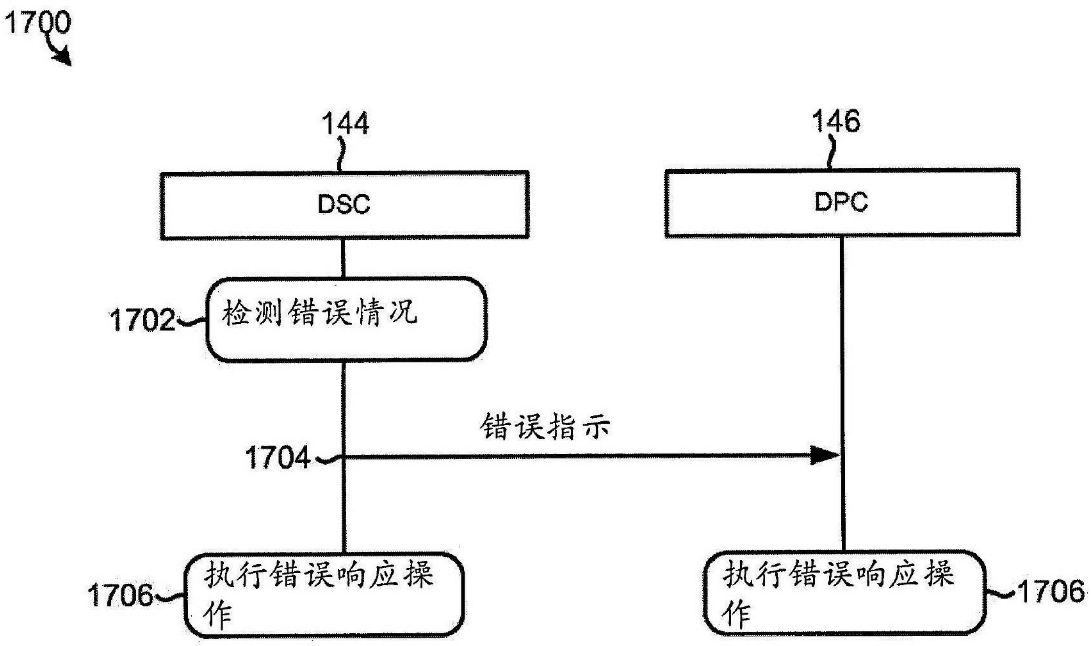

1700
144
146
DSC
DPC
1702
检测错误情况
错误指示
1704
1706
执行错误响应操作
执行错误响应操作
1706

图 17A

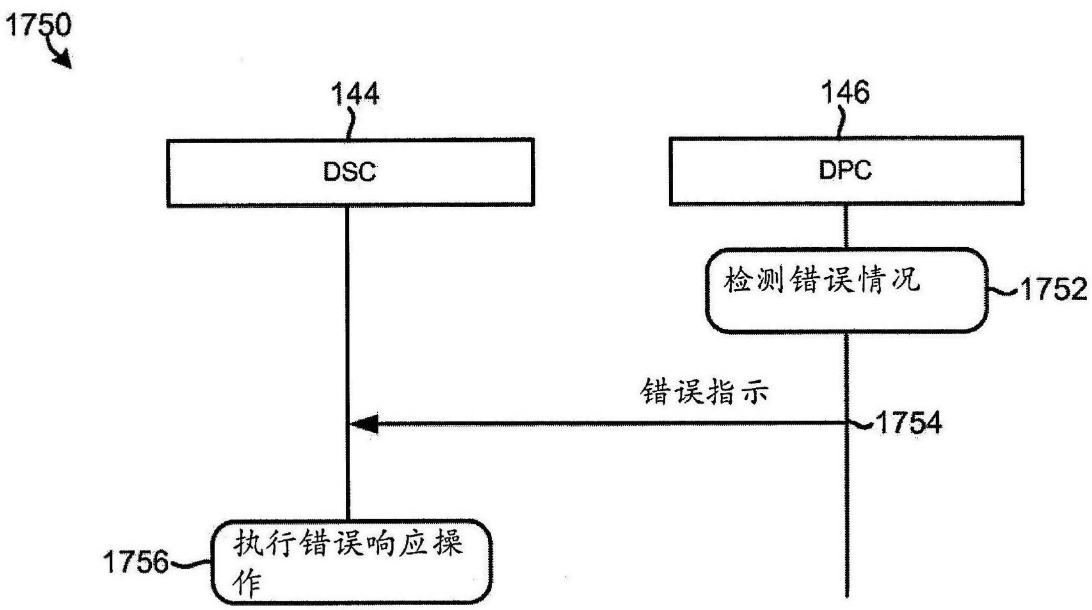

1750
144
146
DSC
DPC
检测错误情况
1752
错误指示
1754
1756
执行错误响应操作

图 17B

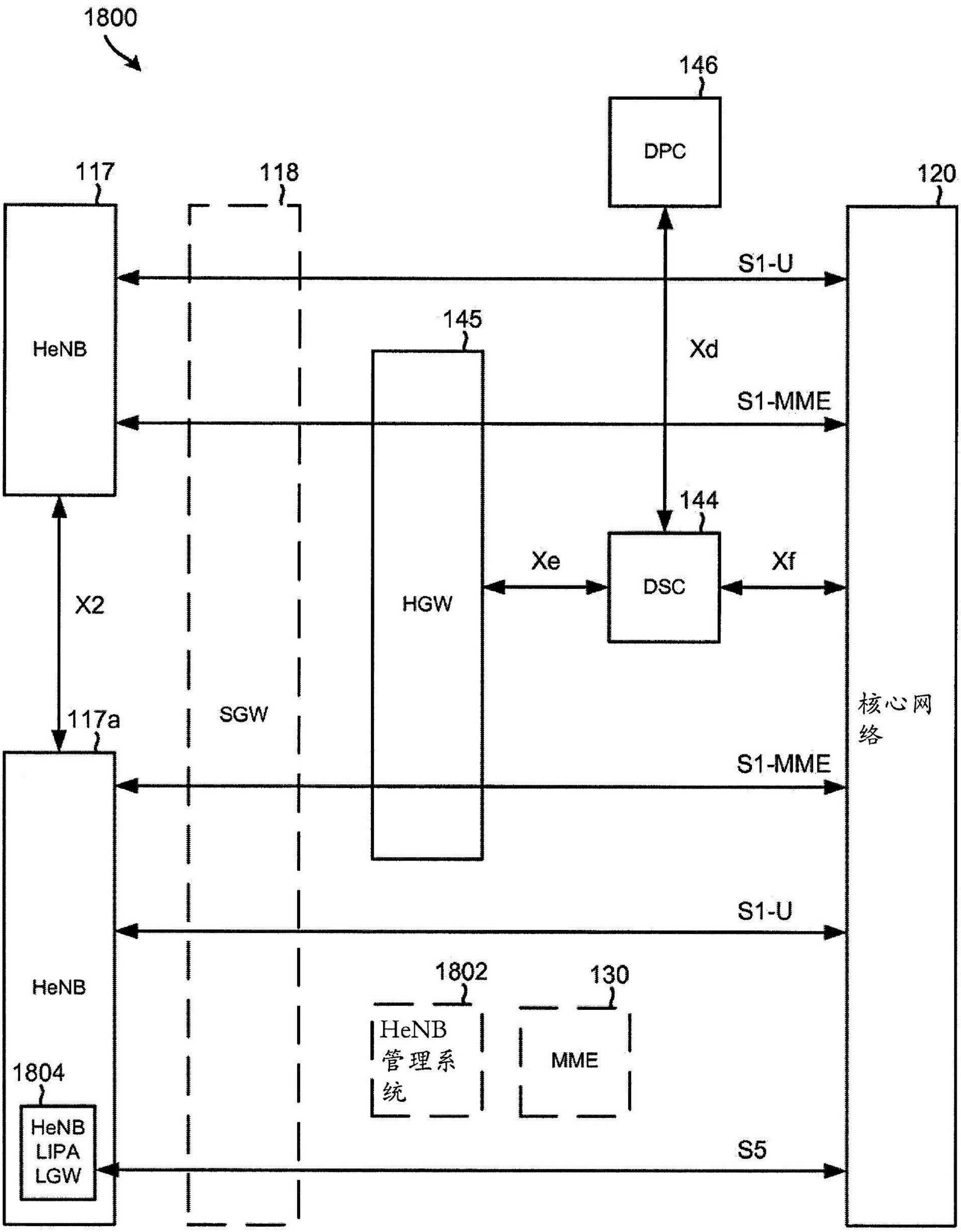

1800
146
DPC
117
118
120
S1-U
145
HeNB
Xd
S1-MME
144
Xe
Xf
X2
HGW
DSC
117a
SGW
核心网络
S1-MME
S1-U
HeNB
1802
130
HeNB
管理系统
MME
1804
HeNB
LIPA
LGW
S5

图 18

源	目标	备注
eNB或任何HeNB	开放式接入HeNB	N/A
eNB或任何HeNB	混合接入HeNB	N/A
混合接入HeNB或封闭式接入HeNB	封闭式接入HeNB	申请相同的CSG ID和PLMN，并且当无线设备是CSG小区的成员时
任何HeNB	eNB	N/A

图 19

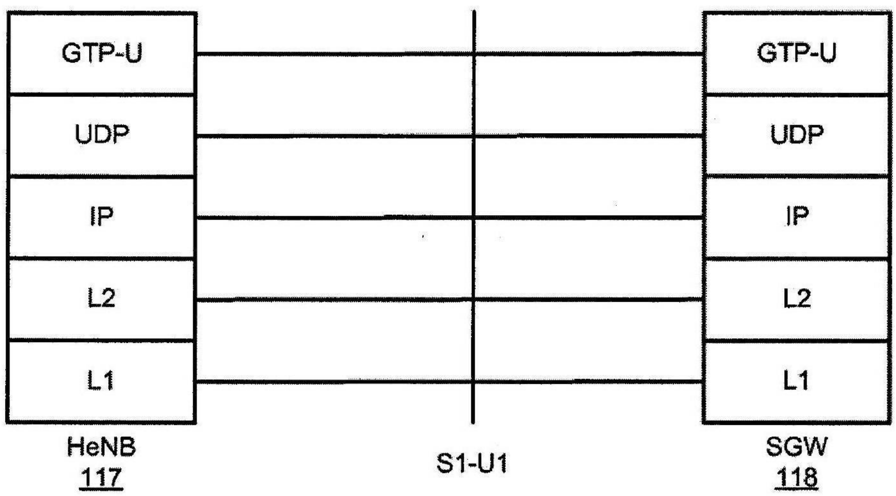


图 20A

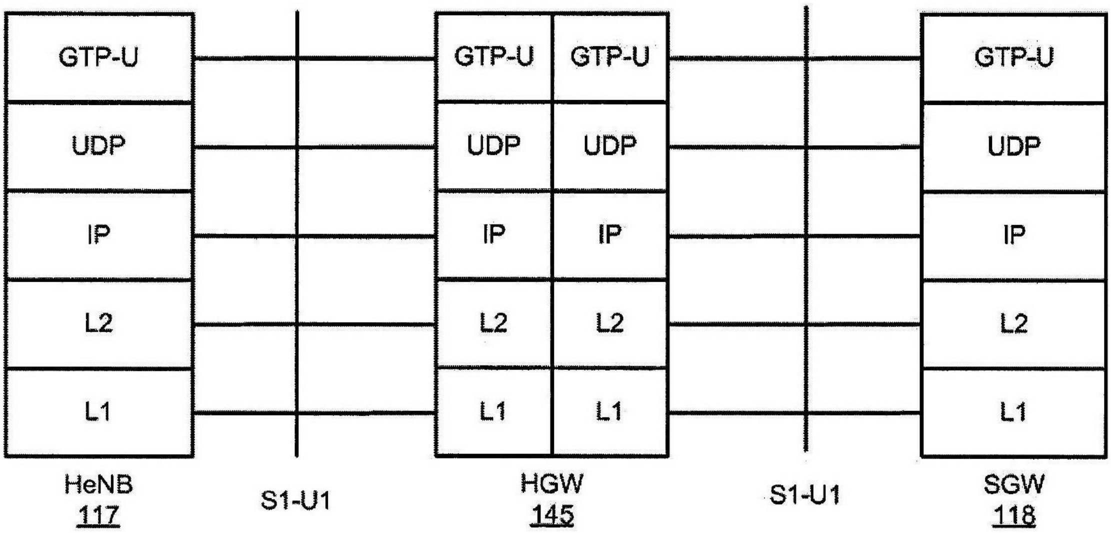

GTP-U
UDP
IP
L2
L1
HeNB
117
S1-U1
GTP-U
GTP-U
UDP
UDP
IP
IP
L2
L2
L1
L1
HGW
145
S1-U1
GTP-U
UDP
IP
L2
L1
SGW
118

图 20B

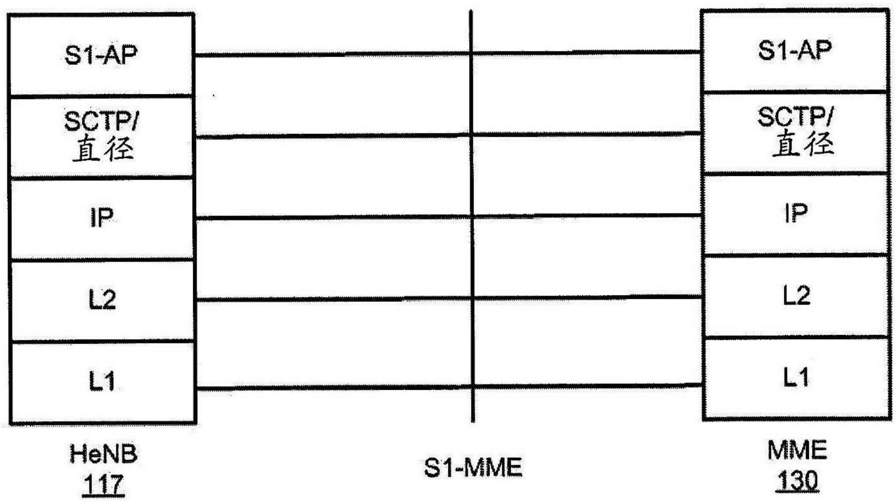

S1-AP
SCTP/
直径
IP
L2
L1
HeNB
117
S1-MME
S1-AP
SCTP/
直径
IP
L2
L1
MME
130

图 21A

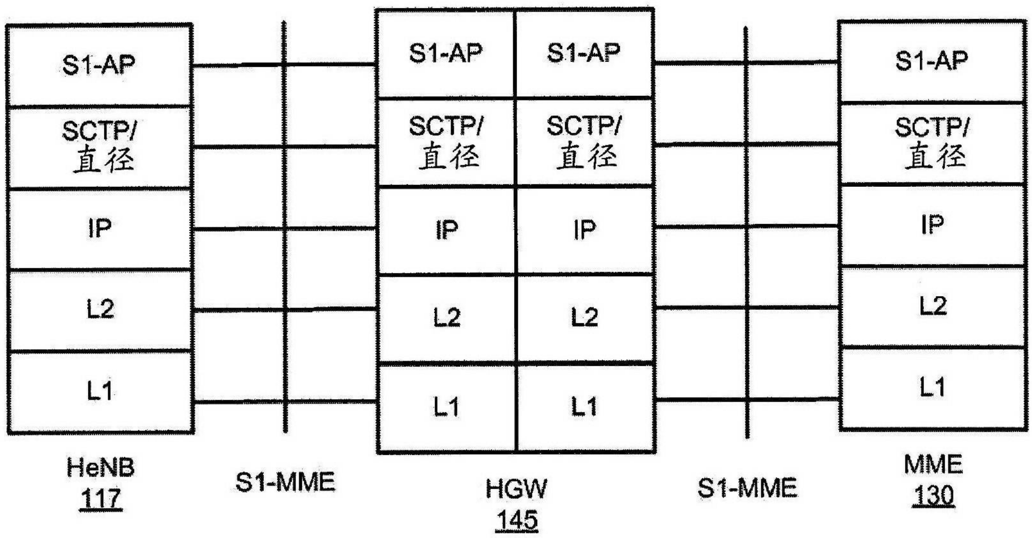

S1-AP
SCTP/直径
IP
L2
L1
HeNB
117
S1-MME
S1-AP
S1-AP
SCTP/直径
SCTP/直径
IP
IP
L2
L2
L1
L1
HGW
145
S1-MME
S1-AP
SCTP/直径
IP
L2
L1
MME
130

图 21B

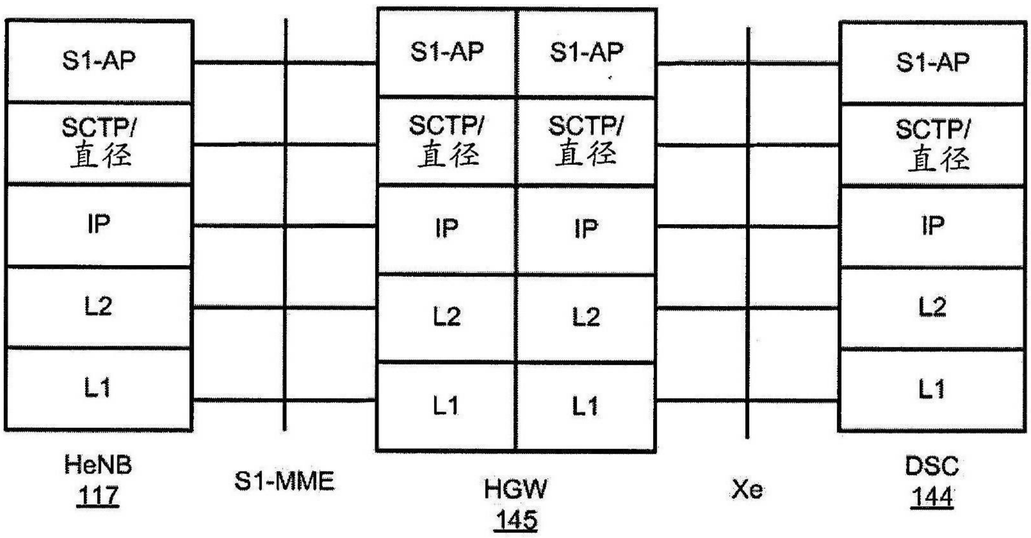

S1-AP
SCTP/直径
IP
L2
L1
HeNB
117
S1-MME
S1-AP
S1-AP
SCTP/直径
SCTP/直径
IP
IP
L2
L2
L1
L1
HGW
145
Xe
S1-AP
SCTP/直径
IP
L2
L1
DSC
144

图 22

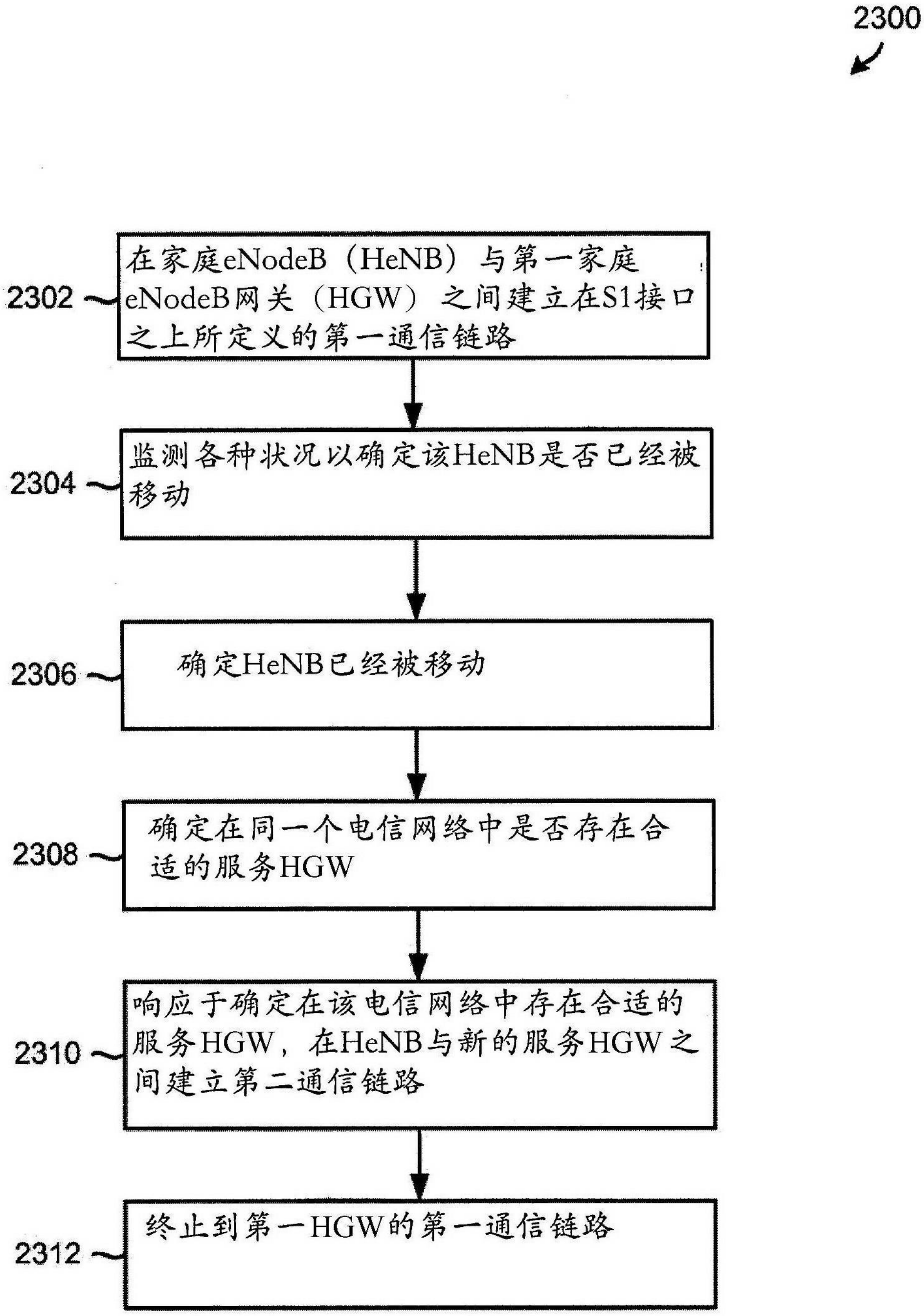

2300
2302
在家庭eNodeB（HeNB）与第一家庭eNodeB网关（HGW）之间建立在S1接口之上所定义的第一通信链路
2304
监测各种状况以确定该HeNB是否已经被移动
2306
确定HeNB已经被移动
2308
确定在同一个电信网络中是否存在合适的服务HGW
2310
响应于确定在该电信网络中存在合适的服务HGW，在HeNB与新的服务HGW之间建立第二通信链路
2312
终止到第一HGW的第一通信链路

图 23

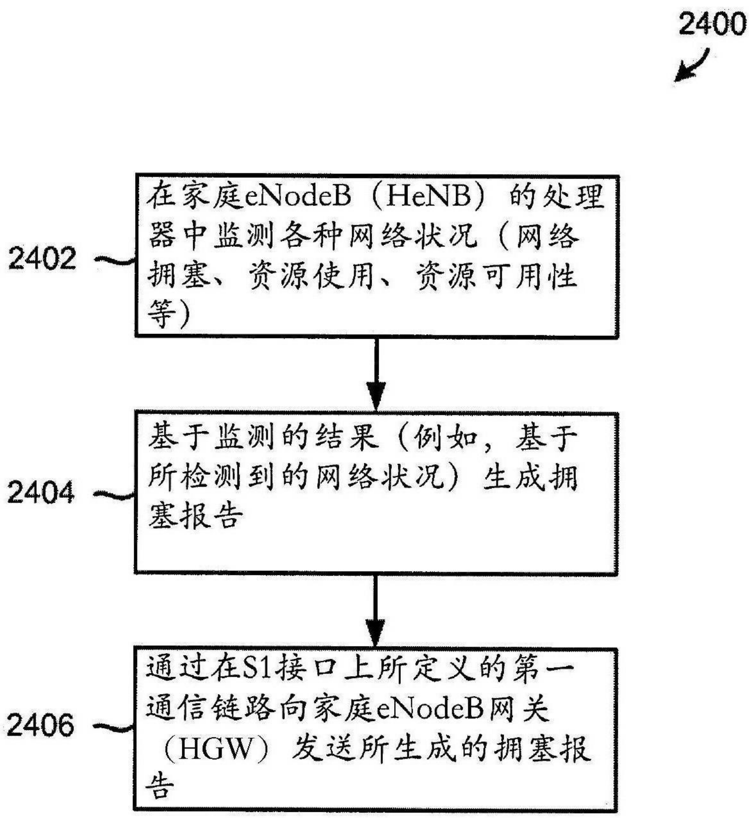

2400
2402
在家庭eNodeB（HeNB）的处理器中监测各种网络状况（网络拥塞、资源使用、资源可用性等）
2404
基于监测的结果（例如，基于所检测到的网络状况）生成拥塞报告
2406
通过在S1接口上所定义的第一通信链路向家庭eNodeB网关（HGW）发送所生成的拥塞报告

图 24

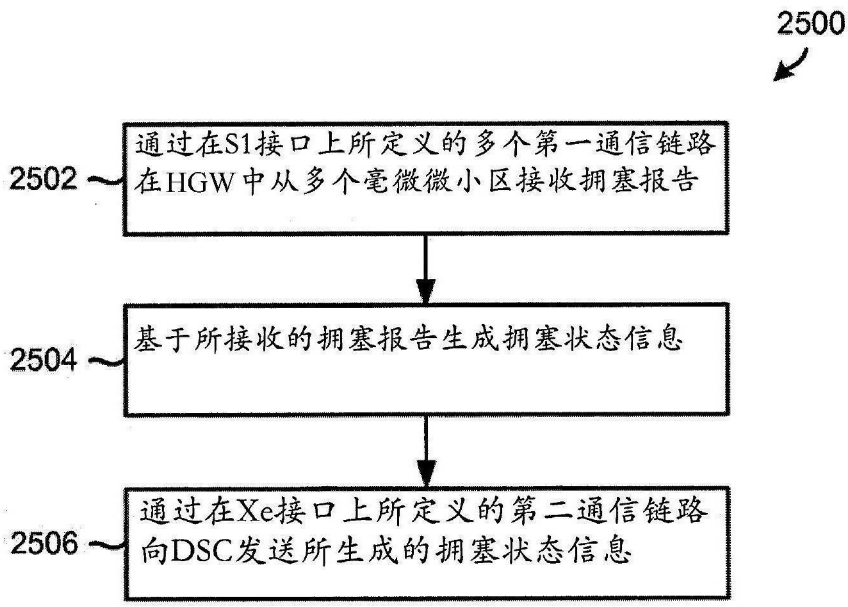

2500
2502
通过在S1接口上所定义的多个第一通信链路在HGW中从多个毫微微小区接收拥塞报告
2504
基于所接收的拥塞报告生成拥塞状态信息
2506
通过在Xe接口上所定义的第二通信链路向DSC发送所生成的拥塞状态信息

图 25

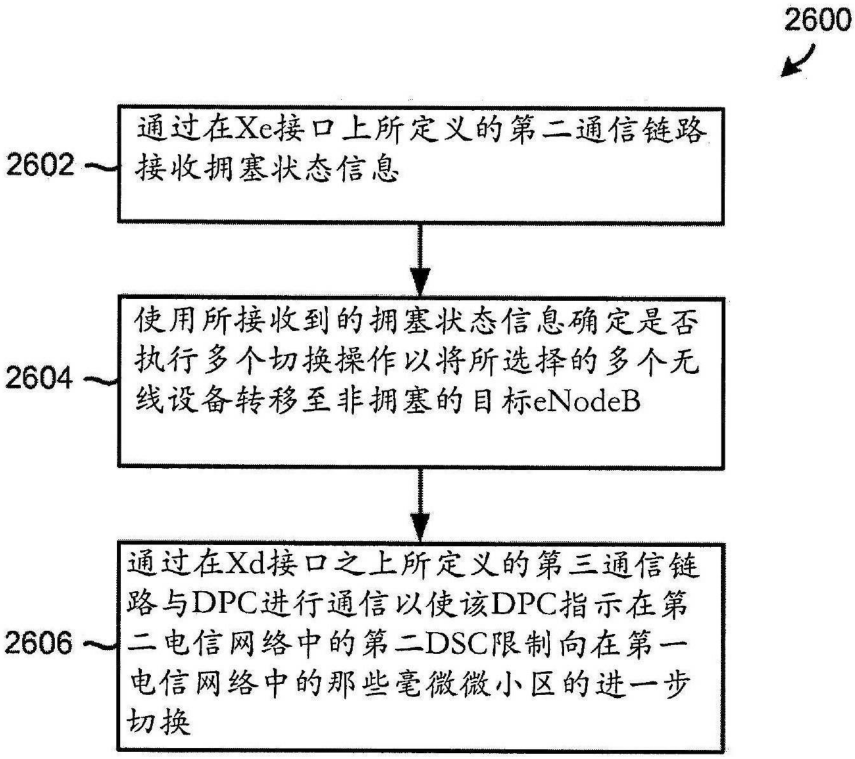

2600
2602
通过在Xe接口上所定义的第二通信链路接收拥塞状态信息
2604
使用所接收到的拥塞状态信息确定是否执行多个切换操作以将所选择的多个无线设备转移至非拥塞的目标eNodeB
2606
通过在Xd接口之上所定义的第三通信链路与DPC进行通信以使该DPC指示在第二电信网络中的第二DSC限制向在第一电信网络中的那些毫微微小区的进一步切换

图 26

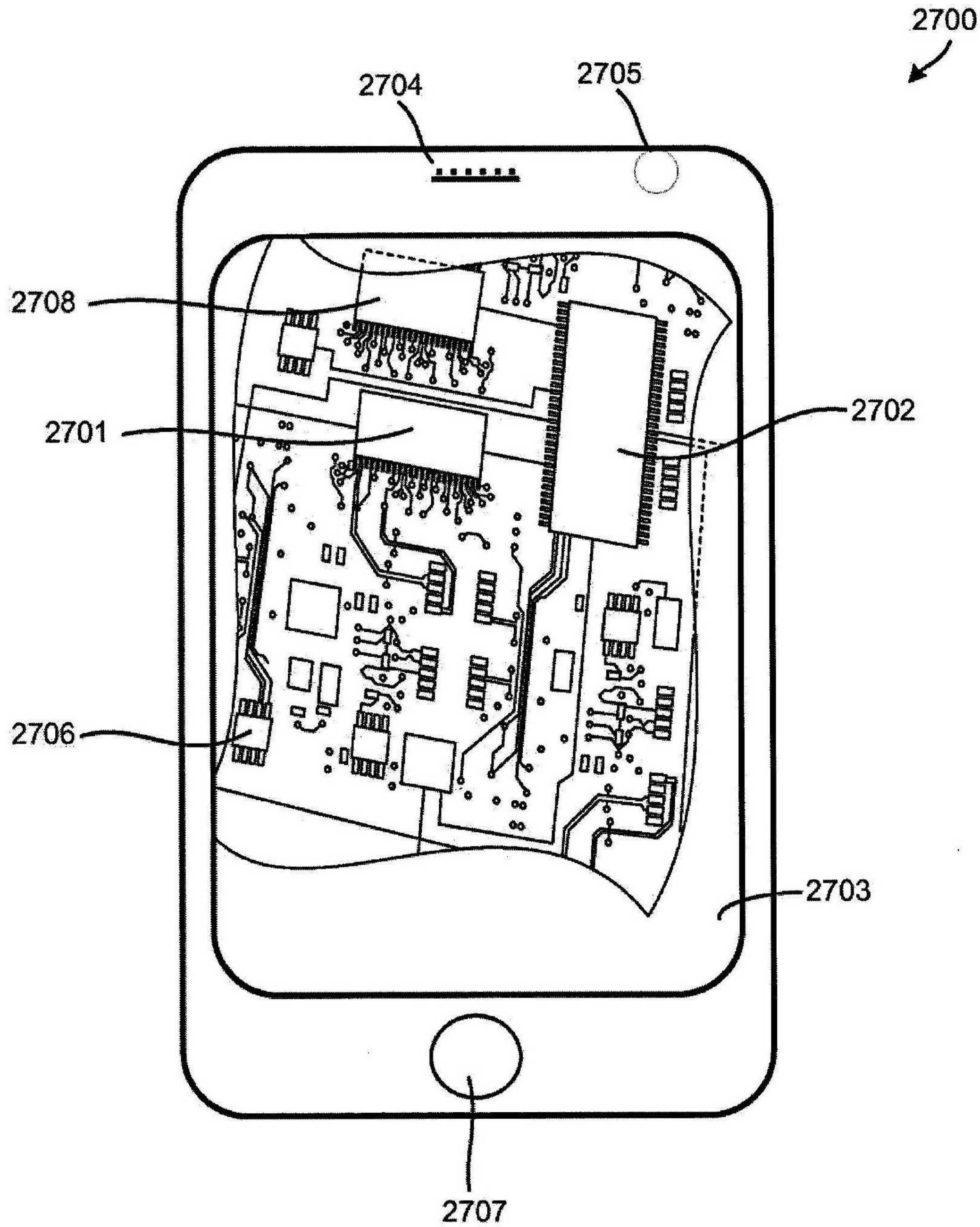


图 27

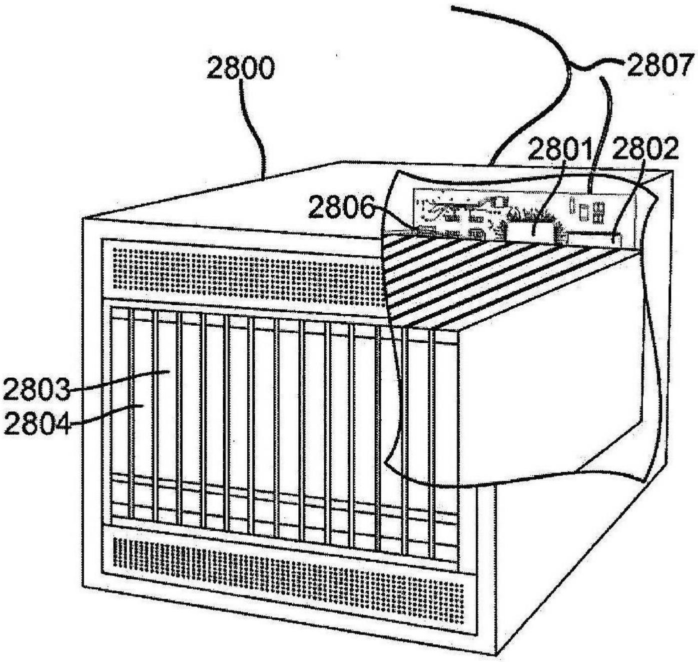


图 28