

## (51) International Patent Classification:

H04W 16/14 (2009.01) H04W 92/10 (2009.01)

H04W 84/04 (2009.01) H04W 92/20 (2009.01)

## (21) International Application Number:

PCT/EP20 13/066997

## (22) International Filing Date:

14 August 2013 (14.08.2013)

## (25) Filing Language:

English

## (26) Publication Language:

English

## (30) Priority Data:

PCT/EP2013/05971 1 10 May 2013 (10.05.2013)

PCT/EP20 13/066992

14 August 2013 (14.08.2013)

EP

EP

## (71) Applicant: NOKIA SOLUTIONS AND NETWORKS OY [FI/FI]; Karaportti 3, FI-02610 Espoo (FI).

## (72) Inventors: YU, Ling; Makituvantie 4 A 2, FI-90650 Oulu (FI). HORNEMAN, Kari Veikko; Kaijantie 36, FI-90800 Oulu (FI).

## (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, 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, 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).

## Published:

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

## (54) Title: COMMUNICATION MECHANISM USING SPECTRUM SHARING

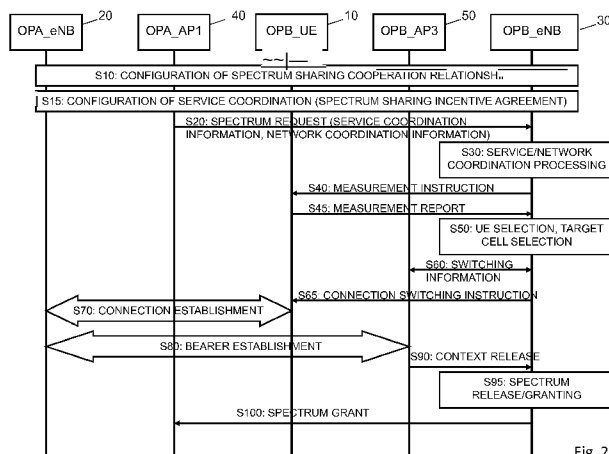


Fig. 2

(57) Abstract: An apparatus comprising at least one processor, and at least one memory for storing instructions to be executed by the processor, wherein the at least one memory and the instructions are configured to, with the at least one processor, cause the apparatus at least: to receive and process a request for using a part of a spectrum of a second communication network by a first communication network on the basis of a spectrum cooperation relationship configuration, to receive and process service coordination information and network coordination information related to the request for using a part of the spectrum, the service coordination information indicating measures offered by the first communication network allowing the second communication network to reduce a communication load by using a part of the first communication network as a communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network, and the network coordination information indicating identification information identifying communication areas or cells of the first and second communication networks usable for the offered measures and configuration information required for using the offered measures, and to conduct a processing for service coordination and network coordination for reducing the communication load in the second communication network by using a part of the first communication network as a communication relay, on the basis of the processing result of the service coordination information and the network coordination information.

## DESCRIPTION

## TITLE

## COMMUNICATION MECHANISM USING SPECTRUM SHARING

## 5 BACKGROUND

## Field

10 The present invention relates to apparatuses, methods, systems, computer programs, computer program products and computer-readable media usable for controlling a communication in a communication network wherein spectrum sharing is employed.

## Background Art

15 The following description of background art may include insights, discoveries, understandings or disclosures, or associations, together with disclosures not known to the relevant art prior, to at least some example versions of the disclosure or of some examples of embodiments of the present invention but provided by the invention. Some such contributions of the invention may be specifically pointed out below, whereas other  
20 such contributions of the invention will be apparent from their context.

The following meanings for the abbreviations used in this specification apply:

|    |         |                                         |
|----|---------|-----------------------------------------|
| 25 | AP:     | access point                            |
|    | ASA:    | authorized shared access                |
|    | BS:     | base station                            |
|    | C-RNTI: | cell radio network temporary identifier |
|    | CPU:    | central processing unit                 |

|    |           |                                              |
|----|-----------|----------------------------------------------|
|    | CR:       | cognitive radio                              |
|    | E-UTRAN:  | evolved UMTS radio access network            |
|    | ECGI:     | E-UTRAN cell global identifier               |
|    | eNB:      | evolved node B                               |
| 5  | FSU:      | flexible spectrum usage                      |
|    | GBR:      | guaranteed bit rate                          |
|    | ID:       | identification, identifier                   |
|    | ISCR      | individual spectrum cooperation relationship |
|    | LAI:      | location area identifier                     |
| 10 | LTE:      | Long Term Evolution                          |
|    | LTE-A:    | LTE Advanced                                 |
|    | O&M:      | operation and maintenance                    |
|    | OPA, OPB: | operator network A, operator network B       |
|    | PCI:      | physical cell identifier                     |
| 15 | PDCCH:    | physical downlink control channel            |
|    | PLMN:     | public land mobile network                   |
|    | PS:       | packet switched                              |
|    | PUCCH:    | physical uplink control channel              |
|    | QoE:      | quality of experience                        |
| 20 | RACH:     | random access channel                        |
|    | RAN:      | radio access network                         |
|    | RF:       | radio frequency                              |
|    | RSRP:     | reference symbol received power              |
|    | RSRQ:     | reference symbol received quality            |
| 25 | SCR:      | spectrum cooperation relationship            |
|    | SON:      | self organizing network                      |
|    | TAI:      | tracking area identifier                     |
|    | UE:       | user equipment                               |
| 30 | UMTS:     | universal mobile telecommunication system    |

In the last years, an increasing extension of communication networks, e.g. of wire based communication networks, such as the Integrated Services Digital Network (ISDN), DSL, or wireless communication networks, such as the cdma2000 (code division multiple access) system, cellular 3rd generation (3G) and fourth generation (4G) communication networks

like the Universal Mobile Telecommunications System (UMTS), enhanced communication networks based e.g. on LTE or LTE-A, cellular 2nd generation (2G) communication networks like the Global System for Mobile communications (GSM), the General Packet Radio System (GPRS), the Enhanced Data Rates for Global Evolution (EDGE), or other  
5 wireless communication system, such as the Wireless Local Area Network (WLAN), Bluetooth or Worldwide Interoperability for Microwave Access (WiMAX), took place all over the world. Various organizations, such as the 3rd Generation Partnership Project (3GPP), Telecoms & Internet converged Services & Protocols for Advanced Networks (TISPAN), the International Telecommunication Union (ITU), 3rd Generation Partnership  
10 Project 2 (3GPP2), Internet Engineering Task Force (IETF), the IEEE (Institute of Electrical and Electronics Engineers), the WiMAX Forum and the like are working on standards for telecommunication network and access environments.

Generally, for properly establishing and handling a communication connection between  
15 terminal devices such as a user device or user equipment (UE) and another communication network element or user device, a database, a server, host etc., one or more intermediate network elements such as communication network control elements, such as base stations, control nodes, support nodes or service nodes are involved which may belong to different communication network.

20 Basically, a communication network is typically divided into several cells controlled by a communication network control element like a BS or eNB, an O&M element and the like.

Besides a classical network environment where plural cells of the same type (e.g. plural  
25 macro cells) are arranged in a neighboring manner, new approaches are provided in order to enhance the performance of communication networks. One of these approaches is the implementation of a heterogeneous network structure. A heterogeneous network may comprise e.g. a "normal" communication cell (i.e. a macro cell) controlled by a communication network control element, such as an eNB in LTE or LTE-A networks, and  
30 plural small cells having also an own communication network control element or access network element (also referred to as an access point AP), which are referred to, for example, as local area or small cells controlled by a corresponding AP or the like. The

term "small cell" is typically used to describe a low-powered radio access node or cell having a range of tens or some hundred meters. A heterogeneous network provides, for example, an improved coverage and the possibility for offloading from a communication in the macro cell to a small cell. The small cells are coupled, for example, to the communication network control element of the macro cell by a backhaul network offering high capacity, or the like.

A further approach for enhancing the performance of communication networks, flexible spectrum management and dynamic access schemes are under consideration. One example is the so-called co-primary spectrum sharing. Co-primary spectrum sharing refers to a spectrum access model where two or more primary license holders (of the same radio service) agree on a joint usage of parts of their licensed spectrum. For example, co-primary spectrum sharing may require a mutual agreement on exact usage conditions (policies etc.) between the license holders, and it may also be necessary that a national regulator has to check and permit the entire model.

Basically, co-primary spectrum sharing will provide more dynamic spectrum sharing between operators providing the same radio services.

## SUMMARY

According to an example version of the disclosure, there is provided, for example, an apparatus comprising at least one processor, and at least one memory for storing instructions to be executed by the processor, wherein the at least one memory and the instructions are configured to, with the at least one processor, cause the apparatus at least: to receive and process a request for using a part of a spectrum of a second communication network by a first communication network on the basis of a spectrum cooperation relationship configuration, to receive and process service coordination information and network coordination information related to the request for using a part of the spectrum, the service coordination information indicating measures offered by the first communication network allowing the second communication network to reduce a

communication load by using a part of the first communication network as a communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network, and the network coordination information indicating identification information identifying communication areas or cells of the first and second communication networks usable for the offered measures and configuration information required for using the offered measures, and to conduct a processing for service coordination and network coordination for reducing the communication load in the second communication network by using a part of the first communication network as a communication relay, on the basis of the processing result of the service coordination information and the network coordination information.

Furthermore, according to an example version of the disclosure, there is provided, for example, a method comprising receiving and processing a request for using a part of a spectrum of a second communication network by a first communication network on the basis of a spectrum cooperation relationship configuration, receiving and processing service coordination information and network coordination information related to the request for using a part of the spectrum, the service coordination information indicating measures offered by the first communication network allowing the second communication network to reduce a communication load by using a part of the first communication network as a communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network, and the network coordination information indicating identification information identifying communication areas or cells of the first and second communication networks usable for the offered measures and configuration information required for using the offered measures, and conducting a processing for service coordination and network coordination for reducing the communication load in the second communication network by using a part of the first communication network as a communication relay, on the basis of the processing result of the service coordination information and the network coordination information.

According to a further example version of the disclosure, there is provided, for example, an apparatus comprising at least one processor, and at least one memory for storing instructions to be executed by the processor, wherein the at least one memory and the

instructions are configured to, with the at least one processor, cause the apparatus at least: to request for using a part of a spectrum of a second communication network on the basis of a spectrum cooperation relationship configuration between a first communication network and the second communication network, and to provide service coordination information and network coordination information related to the request for using a part of the spectrum of the second communication network, the service coordination information indicating measures offered by the first communication network allowing the second communication network to reduce a communication load by using a part of the first communication network as a communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network, and the network coordination information indicating identification information identifying communication areas or cells of the first and second communication networks usable for the offered measures and configuration information required for using the offered measures.

In addition, according to a further example version of the disclosure, there is provided, for example, a method comprising requesting for using a part of a spectrum of a second communication network on the basis of a spectrum cooperation relationship configuration between a first communication network and the second communication network, and providing service coordination information and network coordination information related to the request for using a part of the spectrum of the second communication network, the service coordination information indicating measures offered by the first communication network allowing the second communication network to reduce a communication load by using a part of the first communication network as a communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network, and the network coordination information indicating identification information identifying communication areas or cells of the first and second communication networks usable for the offered measures and configuration information required for using the offered measures.

Moreover, according to a further example version of the disclosure, there is provided, for example, an apparatus comprising at least one processor, and at least one memory for storing instructions to be executed by the processor, wherein the at least one memory and

the instructions are configured to, with the at least one processor, cause the apparatus at least: to receive and process at least one of network coordination information and configuration information based on network coordination information related to a request for using a part of a spectrum of a second communication network by a first communication network on the basis of a spectrum cooperation relationship configuration, the network coordination information indicating identification information identifying communication areas or cells of the first and second communication networks usable for measures offered by the first communication network allowing the second communication network to reduce a communication load by using a part of the first communication network as a communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network, and configuration information required for using the offered measures, and to conduct a processing for establishing a radio bearer connection via a spectrum cooperation relationship link to a part of the first communication network to be used as a communication relay on the basis of the processing result of the network coordination information or the configuration information related to the network coordination information.

In addition, according to a further example version of the disclosure, there is provided, for example, a method comprising receiving and processing at least one of network coordination information and configuration information based on network coordination information related to a request for using a part of a spectrum of a second communication network by a first communication network on the basis of a spectrum cooperation relationship configuration, the network coordination information indicating identification information identifying communication areas or cells of the first and second communication networks usable for measures offered by the first communication network allowing the second communication network to reduce a communication load by using a part of the first communication network as a communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network, and configuration information required for using the offered measures, and conducting a processing for establishing a radio bearer connection via a spectrum cooperation relationship link to a part of the first communication network to be used as a communication relay on the basis of the processing result of the network

coordination information or the configuration information related to the network coordination information.

Furthermore, according to a further example version of the disclosure, there is provided, for example, an apparatus comprising at least one processor, and at least one memory for storing instructions to be executed by the processor, wherein the at least one memory and the instructions are configured to, with the at least one processor, cause the apparatus at least: to conduct a processing for establishing a communication connection to a communication element of a second communication network, wherein the establishment of the communication connection to the communication element of the second communication network is based on communication element specific context information assigned by the first communication network to communication elements of the second communication network for accessing a part of a first communication network which has to act as a communication relay allowing the second communication network to reduce a communication load by using the communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network, to conduct a processing for establishing a radio bearer connection via a spectrum cooperation relationship link to an anchor node of the second communication network, to receive data from the communication element of the second communication network via the established communication connection and to cause, as the communication relay, forwarding of the received data from the communication element of the second communication network over the established radio bearer connection via the spectrum cooperation relationship link to the anchor node of the second communication network, and to receive data directed to the communication element of the second communication network from the anchor node of the second communication network over the established radio bearer connection via the spectrum cooperation relationship link and to cause forwarding, as the communication relay, the data directed to the communication element via the established communication connection to the communication element of the second communication network.

In addition, according to a further example version of the disclosure, there is provided, for example, a method comprising conducting a processing for establishing a communication connection to a communication element of a second communication network, wherein the

establishment of the communication connection to the communication element of the second communication network is based on communication element specific context information assigned by the first communication network to communication elements of the second communication network for accessing a part of a first communication network which has to act as a communication relay allowing the second communication network to reduce a communication load by using the communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network, conducting a processing for establishing a radio bearer connection via a spectrum cooperation relationship link to an anchor node of the second communication network, receiving data from the communication element of the second communication network via the established communication connection and causing, as the communication relay, forwarding of the received data from the communication element of the second communication network over the established radio bearer connection via the spectrum cooperation relationship link to the anchor node of the second communication network, and receiving data directed to the communication element of the second communication network from the anchor node of the second communication network over the established radio bearer connection via the spectrum cooperation relationship link and causing forwarding, as the communication relay, the data directed to the communication element via the established communication connection to the communication element of the second communication network.

In addition, according to example versions of the disclosure, there is provided, for example, a computer program product for a computer, comprising software code portions for performing the steps of the above defined methods, when said product is run on the computer. The computer program product may comprise a computer-readable medium on which said software code portions are stored. Furthermore, the computer program product may be directly loadable into the internal memory of the computer and/or transmittable via a network by means of at least one of upload, download and push procedures.

## BRIEF DESCRIPTION OF THE DRAWINGS

Some example versions of the disclosure are described below, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 shows a diagram illustrating a communication network configuration where some example versions of the disclosure are implemented;

- 5 Fig. 2 shows a signaling diagram illustrating controlling of a communication using a spectrum sharing based on a spectrum cooperation relationship with service coordination and network coordination according to some example versions of the disclosure;

10 Fig. 3 shows a diagram illustrating a communication network configuration where some example versions of the disclosure are implemented;

Fig. 4 shows a signaling diagram illustrating controlling of a communication using a spectrum sharing based on a spectrum cooperation relationship with service coordination and network coordination according to some example versions of the disclosure;

15

Fig. 5 shows a flow chart of a processing conducted in a communication network control element acting as a spectrum request processing/granting part with regard to a control of a communication using a spectrum sharing based on a spectrum cooperation relationship with service coordination and network coordination according to some example versions of the disclosure;

20

Fig. 6 shows a flow chart of a processing conducted in a communication network control element acting as a spectrum requesting part with regard to a control of a communication using a spectrum sharing based on a spectrum cooperation relationship with service coordination and network coordination according to some example versions of the disclosure;

25

Fig. 7 shows a flow chart of a processing conducted in a communication network control element acting as a target cell controlling part with regard to a control of a communication

using a spectrum sharing based on a spectrum cooperation relationship with service coordination and network coordination according to some example versions of the disclosure;

- 5 Fig. 8 shows a flow chart of a processing conducted in a communication network control element acting as a serving cell controlling part with regard to a control of a communication using a spectrum sharing based on a spectrum cooperation relationship with service coordination and network coordination according to some example versions of the disclosure;

10

Fig. 9 shows a flow chart of a processing conducted in a communication element with regard to a control of a communication using a spectrum sharing based on a spectrum cooperation relationship with service coordination and network coordination according to some example versions of the disclosure;

15

Fig. 10 shows a diagram of a communication network control element including processing portions conducting functions according to some example versions of the disclosure;

- 20 Fig. 11 shows a diagram of a communication network control element including processing portions conducting functions according to some example versions of the disclosure;

- 25 Fig. 12 shows a diagram of a communication network control element including processing portions conducting functions according to some example versions of the disclosure;

Fig. 13 shows a diagram of a communication network control element including processing portions conducting functions according to some example versions of the disclosure; and

- 5 Fig. 14 shows a diagram of a communication element including processing portions conducting functions according to some example versions of the disclosure.

#### DESCRIPTION OF EXAMPLES

10 In the following, some example versions of the disclosure are described with reference to the drawings wherein, as an example of a communication network, an LTE-Advanced based system is used. However, it is to be noted that the present invention is not limited to an application using such types of communication system, but is also applicable in other types of communication systems and the like.

15

The following example versions of the disclosure are only examples. Although the specification may refer to "an", "one", or "some" example versions of the disclosure in several locations, this does not necessarily mean that each such reference is to the example version of the disclosure, or that the feature only applies to a single example  
20 version of the disclosure. Single features of different example versions of the disclosure may also be combined to provide other example versions of the disclosure. Furthermore, words "comprising" and "including" should be understood as not limiting the described example versions of the disclosure to consist of only those features that have been mentioned and such example versions of the disclosure may also contain also features,  
25 structures, units, modules etc. that have not been specifically mentioned.

A basic system architecture of a communication system where example versions of the disclosure are applicable may comprise a commonly known architecture of one or more communication networks comprising a wired or wireless access network subsystem and a  
30 core network. Such an architecture may comprise one or more communication network

control elements, access network elements, radio access network elements, access service network gateways or base transceiver stations, such as a base station, an access point or an eNB, which control a respective coverage area or cell (macro cell, small cell) and with which one or more communication elements or terminal devices such as a UE or another device having a similar function, such as a modem chipset, a chip, a module etc., which can also be part of a UE or attached as a separate element to a UE, or the like, are capable to communicate via one or more channels for transmitting several types of data. Furthermore, core network elements such as gateway network elements, policy and charging control network elements, mobility management entities, operation and maintenance elements, and the like may be comprised.

The general functions and interconnections of the described elements, which also depend on the actual network type, are known to those skilled in the art and described in corresponding specifications, so that a detailed description thereof is omitted herein. However, it is to be noted that several additional network elements and signaling links may be employed for a communication to or from an access network element like an AP and a communication network besides those described in detail herein below.

The communication networks are also able to communicate with other networks, such as a public switched telephone network or the Internet. The communication network may also be able to support the usage of cloud services. It should be appreciated that APs and/or eNBs or their functionalities may be implemented by using any node, host, server or access node etc. entity suitable for such a usage.

Furthermore, the described network elements, such as terminal devices or user devices like UEs, communication network control elements of a cell, like an eNB, an O&M element, access network elements like APs and the like, as well as corresponding functions as described herein may be implemented by software, e.g. by a computer program product for a computer, and/or by hardware. In any case, for executing their respective functions, correspondingly used devices, nodes or network elements may comprise several means, modules, units, components, etc. (not shown) which are required for control, processing and/or communication/signaling functionality. Such means, modules, units and components may comprise, for example, one or more

processors or processor units including one or more processing portions for executing instructions and/or programs and/or for processing data, storage or memory units or means for storing instructions, programs and/or data, for serving as a work area of the processor or processing portion and the like (e.g. ROM, RAM, EEPROM, and the like),  
5 input or interface means for inputting data and instructions by software (e.g. floppy disc, CD-ROM, EEPROM, and the like), a user interface for providing monitor and manipulation possibilities to a user (e.g. a screen, a keyboard and the like), other interface or means for establishing links and/or connections under the control of the processor unit or portion (e.g. wired and wireless interface means, radio interface means comprising e.g. an  
10 antenna unit or the like, means for forming a radio communication part etc.) and the like, wherein respective means forming an interface, such as a radio communication part, can be also located on a remote site (e.g. a radio head or a radio station etc.). It is to be noted that in the present specification processing portions should not be only considered to represent physical portions of one or more processors, but may also be considered as a  
15 logical division of the referred processing tasks performed by one or more processors.

According to some example versions of the disclosure, a communication mechanism related to wireless communication systems, such as 3GPP LTE-A systems, is provided which includes intelligent spectrum management aspects, such as cognitive radio (CR)  
20 aspects, wherein a spectrum sharing mechanism such as co-primary spectrum sharing for providing a flexible spectrum management and dynamic access schemes is used.

Cognitive radio aspects relate, for example, to a communication control scheme where available channels in a wireless communication spectrum (e.g. RF spectrum) are  
25 detected, the best available wireless channels in the vicinity of a corresponding communicating network element (such as an AP or the like) are selected and then transmission and reception parameters are changed accordingly to use the selected channels. This makes it possible to enhance the overall performance in the communication network by utilizing available resources in a given spectrum at a certain  
30 location.

When combining a co-primary sharing access mode and cognitive radio access procedures, higher peak data rates for end users as well as higher capacity and wider

coverage are achievable. According to some example versions of the disclosure, a shared spectrum usage is especially beneficial and appropriate for small cell deployments (heterogeneous network scenario), for example since small cells may be more isolated than larger macro cells. According to some example versions of the disclosure, a system scenario is considered where a wide area with exclusive spectrum for each operator is provided, while small cells of multiple operators being controlled by a respective macro cell can share the common spectrum pool in co-primary way. That is, according to some example versions of the disclosure, a system scenario may be considered where each operator has exclusive spectrum band for wide area (in which macro cells under control of communication network control elements like eNBs are deployed on the exclusive spectrum band of each operator) and multiple operators can share the same spectrum band for local area (in which small cells under control of communication network control elements like APs are deployed). To facilitate spectrum sharing between multiple operator's small cells, it is considered, according to some example versions of the disclosure, to chop the spectrum band into multiple chunks and each operator may use one or more chunks with high priority (which means the operator can use high-priority chunks without permission from other operator). One operator, if more spectrum than the high-priority chunks allowed is required, may request another operator to grant the spectrum usage for the chunks that the other operator has high-priority to use. The request may be coordinated and communicated via macro cell eNB. The spectrum usage right may be granted by a authorized element of the granting network, e.g. by a function in the core network or in the access network.

With regard to Fig. 1, a diagram illustrating a communication network configuration is shown where some example versions of the disclosure invention are implemented. It is to be noted that the configuration shown in Fig. 1 shows only those devices, network elements, functions and/or parts which are useful for understanding principles underlying the example versions of the disclosure. As also known by those skilled in the art there may be several other network elements or devices involved in a communication network which are omitted here for the sake of simplicity.

The network configuration according to Fig. 1 is for example based on the 3GPP specifications and comprises elements of a heterogeneous network including one or more wide area cells (macro cell) and one or more local area cells (small cells), and elements of

parallel (neighboring) macro cells and small cells. It is to be noted that the general functions of the elements described in connection with Fig. 1 as well as of reference points/interfaces between the elements are known to those skilled in the art so that a detailed description thereof is omitted here for the sake of simplicity.

5

The term "neighboring cell" is to be understood in such a manner that the respective cells have at least partly overlapping coverage areas for their radio connections towards a communication element (i.e. a UE) so that it is possible that an communication element or the access network element can communicate with the neighboring cell via a radio connection. In other words, neighboring cells are those cells which represent candidates for a handover or roaming procedure to and from each other, wherein of course more than two cells can be neighboring cells to each other, depending on the current network architecture, communication conditions, etc..

15 As shown in Fig. 1, in the exemplary communication network system, two neighboring macro cells 200 and 300 are provided. Cell 200 is part of a communication network of a first operator (OPA) and cell 300 is part of a communication network of a second operator (OPB), respectively, wherein each operator's exclusive (RF) spectrum is used in each cell.

20 Each of the macro cells 200, 300 is controlled by a corresponding communication network control element comprising, e.g. a (macro) eNB (OPA\_eNB 20 of operator network OPA) and an O&M element (OPA\_O&M 20a) of the first operator network OPA, or a (macro) eNB (OPB\_eNB 30 of operator network OPB) and an O&M element (OPB\_O&M 30a) of the second operator network OPB.

25

As shown in Fig. 1, each of the OPA and OPB networks comprise one or more small cells in a heterogeneous network structure, which are connected to a corresponding communication network control element of the macro cell via a corresponding backhaul link. Specifically, in the example shown in Fig. 1, the OPA network comprises a small cell controlled by an access network element or access point denoted as OPA\_AP 1 40. The OPB network comprises two small cells controlled by access network elements or access points denoted as OPB\_AP2 60 and OPB\_AP3 50, respectively. It is to be noted that the

30

OPA and OPB networks may comprise more small cells than those shown in Fig. 1. As can be seen in Fig. 1, the small cells and the macro cells can have various neighboring cell relationships: for example the small cell of OPA\_AP1 40 is a neighboring cell to the OPB macro cell and the OPB small cell of OPB\_AP2 60, while the small cell of OPB\_AP3 50 is a neighboring cell to the OPA macro cell, for example.

It is to be noted that according to some example versions of the disclosure, the small cell of a respective operator network, such as OPA\_AP1 40, may be under control of the macro cell to which it is connected (i.e. controlled by the OPA\_eNB 20, for example). That is, the macro cell communication network control element is configured to execute several control procedures for the respective small cell AP, such as control, allocation and/or coordination of a flexible spectrum usage of the small cells (the small cell APs, such as OPA\_AP1 40).

According to example versions of the disclosure, the APs of the respective small cells and the communication network control element of the respective operator are connected by interfaces using a backhaul network or another connection type, such as a wired or wireless communication line, or the like.

Furthermore, as indicated in Fig. 1, communication elements or devices such as UEs may be located in the cell areas. In Fig. 1, only one UE 10 is shown which is assumed to be originally connected to the OPB network (i.e. OPB network is home network of UE 10).

It should be appreciated that according to some example versions of the disclosure, a so-called "liquid" or flexible radio concept is employed where the operations and functionalities of a communication network control element or of another entity of the communication network, such as of one or more of the shown eNBs or APs, may be performed in different entities, such as a node, host or server, in a flexible manner. In other words, a "division of labour" between involved network elements or entities may vary case by case. One possible alternative to the example illustrated is, for example, to make a base station or the like to deliver local content.

It is to be noted that even though Fig. 1 shows two macro cells 200 and 300, the number of cells is not limited thereto and can be more than two, wherein at least respective two cells are neighboring cells (as will be discussed below).

5

During spectrum sharing, it is assumed in the following that one operator (e.g. OPB) may grant a usage right for its spectrum with higher usage priority to the other operator (OPA) for its cells.

10

In the example shown in Fig. 1, it is now assumed that a spectrum sharing agreement between multiple (here two) operator networks has been negotiated allowing spectrum cooperation relationship (SCR) to be established between e.g. OPA and OPB on different levels, e.g. between small cells and macro cells. In the example version of the disclosure as indicated in Fig. 1, it is assumed that an SCR is established between a small cell of one network and a macro cell of the other network. Specifically, as indicated by a dashed arrow between OPA\_AP1 40 and OPB\_eNB 30 or between OPB\_AP3 50 and OPA\_eNB 20, SCR is assumed to be established between these elements. By means of the SCR, the spectrum sharing between the two operator networks is facilitated. Rules being negotiated between the operator networks concern, for example, rules defining details of the spectrum sharing, such as which part of the shared spectrum one operator network (such as OPB network) may use with higher priority than the other operator network (such as OBA network). The agreement defines, for example, what and at which time spectrum parts can be requested or granted, how long a spectrum part may be granted etc.. Corresponding parameters may be stored in the operator networks, e.g. in corresponding communication network control elements, and used when a spectrum sharing is requested (i.e. the corresponding elements are correspondingly configured).

During the spectrum sharing, it is assumed in the following that one operator network (e.g. OPB network) may grant a usage right for its spectrum to the other operator network (OPA network) for its cells.

According to some example versions of the disclosure, a fast and dynamic control on the shared spectrum usage among the multiple operators is achieved by using cooperation opportunities in RAN level between the networks. For example, as shown in Fig. 1, the spectrum cooperation relationship is set up between a small cell AP of one operator and eNB of the other operators. Upon the established spectrum cooperation relationship, for example, a small cell AP can communicate with a cell or communication area (e.g. one of the other operator's eNB), for example like an active UE for spectrum usage coordination. Thus, the coordination of the spectrum usage in RAN level between the different operators is improved.

For example, in the configuration as shown in Fig. 1, the small cell of OPA\_AP1 is allowed to use an allowed part of the spectrum for which the OPB network has a higher usage priority and which is granted to OPA\_AP1 to use. That is, the OPB communication network control element (e.g. OPB\_eNB 30) grants a usage right for a part of the high-priority spectrum chunk to the OPA\_AP1 40 to use. This is indicated in Fig. 1 by a dashed arrow indicating a spectrum cooperation relationship (link) between the networks of OPA and OPB with regard to the access network element OPA\_AP1 40. Similarly, a spectrum cooperation relationship (link) is established between OPB\_AP3 50 and OPA\_eNB 20, for example. That is, a SCR link via e.g. an air interface is established, as indicated by the dashed arrows.

Example versions of the disclosure for setting up the spectrum cooperation relationship between a small cell AP of one operator (here of OPA\_AP1 40) and the other operator network (here OPB), and for configuring the involved network elements such as eNBs and APs, may comprise, for example, the following processing.

In order to set up the sharing spectrum cooperation relationship with the OPB network, the small cell AP (OPA\_AP1 40) executes a detection of the other network, i.e. of OPB network, preferably of the macro network or cell 300 of OPB. For this purpose, for example, system information provided by the OPB network (in form of broadcasting messages) are detected and processed. In order to facilitate the detection conducted by

the small cell OPA\_AP1 40, the OPA\_AP1 40 may be (pre-)configured with OPB's network related information, such as RF channels and PLMN identifiers thereof. Based on the information, the OPA\_AP1 40 then searches the OPB's network.

5 When the detection is finished, OPA\_AP1 40 reports the detection result of OPB's network to the OPA network (e.g. the OPA\_eNB 20 or the OPA\_O&M 20a). The report comprises, for example, cell identifiers (e.g. EGC1), downlink measurements (e.g. RSRP and/or RSRQ) etc. with regard to the OPB network. Furthermore, for example, in case more than one cell (macro cells and/or small cells) from the multiple operators' network (OPB  
10 network) are detected, the OPA\_AP1 40 may relate the report to the strongest cell from each operator's network, or to all the detected cells from all the relevant operators.

Based on the detection report from OPA\_AP1 40, the OPA network (e.g. the controlling OPA\_eNB 20 of the OPA\_AP1 40 or the OPA\_O&M element 20a) initiates a setup or an  
15 establishment of a spectrum sharing cooperation relationship with OPB network. For this purpose, for example, a spectrum cooperation relationship establishment request is sent to a selected operator (e.g. OPB) network, e.g. to a communication network control element like OPB\_eNB 30 indicated in the report. For example, the spectrum cooperation relationship establishment request may include information on IDs of detected OPB's  
20 cell(s) (macro/small cells), and information of the small cell AP (i.e. OPA\_AP1 40) which detects OPB's cell(s) as well as a capability information indicating the capability of the OPA\_AP1 40 to act as an UE entity. The OPA network may also conduct a selection procedure for determining a target operator or cell for the establishment of the spectrum cooperation relationship. This selection procedure may be based on an algorithm and can  
25 consider e.g. current detection results, history data, pre-selection parameters etc..

The OPB network (e.g. OPB\_eNB 30 or OPB\_O&M 30a) may determine a macro cell of the OPB network which shall serve to the small cell AP (OPA\_AP1 40) for requesting a spectrum usage right. Furthermore, relevant UE contexts information may be determined  
30 enabling an access to the determined serving cell as a UE (for example, a C-RNTI, scheduling request configuration, signaling radio bearer configuration, DRX configuration, security configuration etc.). A corresponding spectrum cooperation relationship

establishment response is then sent back to the OPA network (e.g. OPA\_eNB 20). The spectrum cooperation relationship establishment response comprises e.g. an ID of the determined serving cell of OPB for the small cell AP of OPA, information about the high-priority spectrum of OPB, and the determined UE context information.

5

Then, the communication network control element of OPA (e.g. OPA\_eNB 20 or OPA\_0&M 20a) provides the relevant information to the small cell AP (OPA\_AP1 40) as control or configuration information for the establishment of the spectrum cooperation relationship. Based on the control or configuration information, the OPA\_AP1 40 executes an access procedure to the OPB serving cell identified in the control information by using the UE context information. That is (in the present example) the OPA\_AP1 40 and the serving cell of OPB (e.g. OPB\_eNB 30) executes an access procedure wherein the OPA\_AP1 40 acts like a UE trying to connect to the serving cell of OPB. For example, a RACH procedure using the indicated UE context information is executed. By means of this access procedure, the cooperation relationship establishment is confirmed. Furthermore, the OPA\_AP1 40 learns required timing advance information towards to the indicated serving cell.

As a result of the access procedure, a communication connection path (also referred to as SCR link) is established and the OPA\_AP1 40 is ready to communicate with the SCR serving cell (OPB\_eNB 30) of the OPB network, e.g. in the way as an RRC connected state UE of OPB. On the other hand, the serving cell (OPB\_eNB 30) keeps active UE contexts for the OPA\_AP1 40. That is, an air interface representing a spectrum cooperation communication opportunity is provided (also referred to as SCR link).

25

It is to be noted that a spectrum cooperation communication opportunity may be provided also in another manner. For example, a spectrum cooperation relationship may be programmed by an operator with measurements or a detection for the other communication network (OPB network) which is conducted by an access network element or the like (i.e. pre-configured spectrum cooperation).

30

Another example version of the disclosure regarding spectrum cooperation opportunity is discussed below.

In order to decrease a scalability challenge resulting when small cell AP sets up a spectrum cooperation relationship with other operators' network, especially in an area with a dense deployment of small cells, spectrum cooperation opportunities for smalls cells of multiple operators are created and maintained by utilizing an already established spectrum cooperation relationship between e.g. one operator's small cell AP and the other operator's network. That is, in these example versions of the disclosure, there is already established a spectrum cooperation relationship opportunity (SCR link) between the networks (i.e. between OPA and OPB), e.g. between one access network element of a small cell of OPA (for example, OPA\_AP1 40) and a serving eNB of the OPB network (for example, OPB\_eNB 30). According to some example versions of the disclosure, the established spectrum cooperation relationship between an access network element of a small cell of one communication network (OPA network) and a serving cell of another operator network (OPB network) is used to create and maintain spectrum cooperation opportunities for the small cells of multiple operators. Thus, it is not required that every small cell has to setup an individual SCR with other operator's network for coordinating a shared spectrum usage. Instead, some of the small cells may use the established SCR to communicate with the other operator's network for spectrum coordination.

It is to be noted that on the basis of the SCR, the network elements involved in the communication conduct corresponding configurations, such as a setting of communication paths, a preparation for scheduling transmission of data, etc..

However, when an SCR is established and spectrum sharing mechanisms are implemented, the communication network from which a part of the spectrum is requested (i.e. where usage rights of the spectrum in question are temporally transferred from one communication network to another communication network) loses for a certain time some of its capacity, and this capacity may be re-gained only with a certain effort (e.g. when signaling between the networks is required etc.). That is, under certain circumstances, spectrum sharing is not advantageous for all parties involved therein. Hence, in order to ensure that all networks operators have benefits from the spectrum

sharing participation, a certain level of fairness between operators has to be ensured when using shared spectrum, in particular in scenarios where a flexible spectrum usage is implemented in a multiple operator scenario.

5 Hence, according to some example versions of the disclosure, mechanisms for service coordination and network coordination are proposed which support spectrum sharing by providing solutions for motivating a network operator to participate in sharing a part of the spectrum, wherein measures for compensating for a spectrum usage by another network can be communicated and processed. Thus, the available spectrum can be utilized in a  
10 more efficient manner.

By virtue of some example versions of the disclosure, it is possible to provide an enhanced mechanism implementable in a spectrum sharing system which allows avoiding that the spectrum sharing is excessively used by single operators. Furthermore, it is  
15 possible that network operators (which will be referred to hereinafter as OPA and OPB, wherein the number of operators is not necessarily limited to two) are able to utilize example versions of the disclosure to further optimize the performance of the own network when participating in the spectrum sharing. For example, it is possible, in a flexible manner, to adapt measures offered or selected for compensation for the grant of a part of  
20 the spectrum in view of local communication situations, for example by value controlling overhead, overload, capacity requirements, spectrum resources and charging possibilities at the same time.

According to some examples versions of the disclosure, the service coordination and  
25 network coordination processing allowing to implement measures for compensating for the grant of spectrum usage rights is based on using a part of the requesting network as a communication relay element for communications in the network granting the spectrum usage right.

30 That is, by coordinating the switching of the communication connection of UEs in a suitable manner so that a RAN of the other network is used as a relay towards the own

network while using an SCR link to an anchor node of the own network having an established SCR link with the other network, a load caused by the communication of a UE can be shifted to another part of the communication network which decreases e.g. a traffic load in specified parts of the spectrum granting network. This, in turn, allows to release  
5 resources/spectrum for the granting of spectrum usage rights under the SCR. Hence, the available spectrum can be used in a flexible manner while a compensation for the spectrum usage by the other network can be achieved, for example, by an overload reduction in some cells or some areas of the spectrum granting network.

10 In order to enable that a suitable compensation in the form of using a part of the requesting network (OPA network) as a communication relay for a communicating UE of the granting network (OPB network), according to some example versions of the disclosure, in addition to a spectrum cooperation relationship establishment, a function for enabling a service coordination and network coordination is to be configured in the  
15 involved network elements. Specifically, service coordination and network coordination is described for a case where a spectrum cooperation relationship is established between the communication networks of OPA and OPB and a spectrum usage of the OPB's high-priority spectrum by the OPA network (e.g. by OPA\_AP 140) is requested.

20 Referring to Fig. 2, an example version of the disclosure regarding a communication using a spectrum sharing based on a spectrum cooperation relationship with service coordination and network coordination is explained by means of a signaling diagram illustrating a control scheme of the communication. The signaling diagram illustrates processings and functions executed by communication network control elements (such as  
25 eNBs and APs) and communication elements (such as UEs) in a scenario as indicated in Fig. 1, for example. That is, it is assumed that there is are spectrum cooperation opportunities in RAN level between OPA and OPB, such as SCR links between OPA\_eNB 20 and OPB\_AP3 50 on the one side and OPA\_AP1 40 and OPB\_eNB 30 on the other side. As a matter of course, example versions of the disclosure are not limited to the  
30 described scenario, and corresponding processing is implementable also with other SCR links.

In S10, network elements involved in a spectrum cooperation relationship are configured in accordance with the result of a spectrum sharing cooperation negotiation between the operators (i.e. OPA and OPB). That is, communication network control elements are configured to establish an SCR link, when suitable (e.g. when measurement results are

5 thus that an SCR link can be established between e.g. a small cell AP of one network and the macro cell eNB of the other network), resulting in a SCR opportunity or link as indicated e.g. in Fig. 1.

In addition, a function enabling a service coordination is configured in the communication

10 network control elements involved in the communication procedure according to example versions of the disclosure. That is, in S15, a configuration based on a spectrum sharing incentive agreement (which is negotiated between the networks (e.g. OPB and OPA)) is executed.

For example, it is agreed between OPA and OPB which balance between spectrum

15 request and compensation measure is to be considered (e.g. ranges of a capacity/resource commitment (like a number of UEs switchable to the OPA and using the OPA part as a communication relay etc.) by the requesting network versus the amount of spectrum requested/granted). Also rules regarding a situation where an overuse of

20 capacity/resource commitment happens are agreed (for example, if the operator providing the communication relay is allowed to reject a switching UE).

It is to be noted that the above discussed rules are only examples for parameters of the spectrum sharing incentive agreement, and other rules can be agreed to in addition or

25 alternatively.

By means of this, according to some example versions of the disclosure, a spectrum requesting communication network control element (such as a small cell AP) is configured to indicate measures to be offered for compensating for a spectrum request, for example.

30 As another option, corresponding measures are indicated by a central control unit, such as a macro cell eNB, controlling a requesting small cell AP.

According to example versions of the disclosure, the spectrum cooperation opportunities (SCR links) in the RAN of the OPA and OPB networks are utilized, when a spectrum usage right is requested e.g. by the OPA network (e.g. by an OPA small cell) from the OPB network, for service cooperation and network coordination processing so as to provide services to UEs of one operator by another operator's RAN as an incentive/reward scheme for the spectrum sharing. Specifically, according to some example versions of the disclosure, UEs of OPB are allowed to switch to the RAN of OPA and using it as a communication relay towards the core network of OPB (i.e. the core network of OPA is not used by the UEs), so that user data are routed to OPB's core network via the available spectrum cooperation opportunities (SCR link) in RAN. Thus, OPBs RAN can be unburdened .

In S20, a decision is made e.g. in the OPA\_AP 140 to request for spectrum usage right of a part of the OPB spectrum. Consequently, a request is sent to the OPB network via the SCR link (i.e. to OPB\_eNB 30). The request comprises service coordination information and network coordination information. In the service coordination information, according to rules of the spectrum sharing incentive agreement, measures decided to be taken by the OPA network and offered to the OPB network for compensation purpose are indicated. In the decision which measures are offered, it is considered, for example, which amount of spectrum is requested. According to some example versions of the disclosure, it may also be considered how the load situation in the own network is (for example, when a switch of a UE of OPB to OPA is offered, an area with low load is preferably selected). Thus, the service coordination information may include information related to the capacity/resource commitment (e.g. in the form of GBR and/or a number of UEs) of OPA to serve the UEs of OPB. Furthermore, the service coordination information may comprise information indicating an allowed service area of the OPA network for serving OPB UEs, e.g. in the form of either a forbidden zone or a permission zone, for example by geo-location information, LAIs/TAIs, etc.

In addition to the service coordination information, OPA provides by the spectrum requesting node the network coordination information. The network coordination information provides data and parameters usable for supporting serving of UEs of OPB as

compensation when the small cell of OPA requests the spectrum usage right from OPB via spectrum cooperation opportunities in RAN.

For example, the network coordination information comprises an indication of an identification and parameters of the part of the OPA network usable as a communication relay, for example by means of OPA's serving cell information (e.g. RF channels, PCI, ECGI of the cells that can be accessed by UEs of OPB). Furthermore, the network coordination information comprises an indication of a communication area or cell (macro cell, small cell) of the OPB network with which a SCR is configured, i.e. an information (such as ECGI) of OPB's small cell that has an established SCR link with the indicated OPA serving cell. In addition, the network coordination information comprises an indication of UE context information to be used for UEs of the OPB network for accessing the part of the OPA network acting as a communication relay (serving cell), such as reserved C-RNTIs, RACH preambles for the UEs of OPB to be used to access to the indicated OPA serving cells. Moreover, the network coordination information comprises an indication of connection parameters required for getting access to the part of the OPA network acting as a communication relay, such as conditions for a UE to access the indicated OPA serving cells (e.g. in the form of the threshold for downlink measurement such as RSRP and/or RSRQ).

In S30, the receiving side of the spectrum request, such as the OPB\_eNB 30, processes the request and the contained service coordination and network coordination information. For example, based on the service and network coordination information indicated in the spectrum request sent by the OPA\_AP1 40, the receiving macro eNB of operator B may decide on whether and which measures offered for compensation are acceptable and start by using the network coordination information as a basis of compensation, to grant some spectrum to the OPA.

In the service and network coordination processing according to the example of Fig. 2, in S40, the OPB\_eNB 30 puts the OPA serving cells indicated in the network coordination information as neighboring cells that UEs of OPB can access and instructs at least one UE of the OPB (here UE 10) to conduct measurements for those cells for handover or cell

re-selection purpose. The instruction in S40 is provided, for example, by either a common signaling (e.g. by updating system information regarding inter-frequency or intra-frequency neighboring cells related information) or a dedicated signaling (e.g. by a measurement configuration signaling message).

5

In S45, after the UE 10 has made the requested measurement of the OPA serving cell (i.e. after a determination of communication situation towards OPA\_eNB 20, for example), a measurement report is sent from UE 10 to the OPB\_eNB 30.

10 In S50, on the basis of the measurement report, OB\_eNB 30 selects UEs (here e.g. UE 10) for making a switch (handover) to the serving cells of OPA (i.e. for using it as a communication relay). It is to be noted that the number of UEs selected for switching is not limited to one.

15 According to some example versions of the disclosure, with regard to S50, for each selected UE, the OPB\_eNB 30 determines also one of the small cells of OPB indicated in network coordination information as a target cell in the own operator's (OPB) network for the UE to handover. For example, the OPB\_eNB 30 uses a suitable interface towards the communication network control element of the cell determined to be the target cell (such  
20 as a X2 or S1 interface in LTE/LTE-A system) for informing the cell about the usage as a target cell. That is, according to some example versions of the disclosure, the target cell is informed by means of e.g. a handover preparation procedure about the coming handover of the selected UE. That is, for supporting the handover preparation, a handover preparation procedure is enhanced to inform the target cell that it is only an anchor point  
25 for the UE to connect to the core network of OPB, but that the UE does not access the target cell over the radio directly (i.e. a regular handover is not conducted). In other words, the target cell (i.e. the communication network control element such as the OPB\_AP3 50) is informed that the UE accesses the target cell via an OPA radio cell and the SCR link established between the target cell and OPA serving cell. This information is provided in  
30 S60.

In S65, OPB\_eNB 30 commands the selected UE (here UE 10) to switch the communication connection (i.e. to handover) to the OPA serving cell (OPA\_eNB 20). In connection with the command, according to some example versions of the disclosure, additional information of the target cell (OPB\_AP3 50) that OPB\_eNB 30 has determined for the UE 10 is provided. Furthermore, a set of access information, such as RACH preamble and C-RNTI, which is derived from the network coordination information, is provided to the UE 10.

Upon receiving the connection switching command from OPB\_eNB 30, the UE 10 accesses in S70 the OPA serving cell indicated in the command by using the RACH preamble and C-RNTI indicated in the handover command in order to establish an RRC connection, for example.

In S80, a radio bearer establishment is conducted between the OPA serving cell and the OPB target cell via the SCR link. For example, S80 is executed in reaction to S60, i.e. when the OPB small cell is informed about being the target cell. Then, the OPB target cell triggers the radio bearers establishment over the SCR link towards the OPA serving cell. In this connection, also an information may be provided informing the OPA serving cell that a UE will be handed over soon. Furthermore, UE context information may be delivered to OPA serving cell at the same time.

On the other hand, according to some further example versions of the disclosure, S80 may be executed when the UE 10 accesses the OPA serving cell in S70, i.e. when a connection establishment between UE 10 and OPA\_eNB 20 is conducted. That is, since in this case no UE context information including information on the target cell in OPB network is available on the OPA serving cell side before the UE 10 accesses to the OPA serving cell (OPA\_eNB 20), in the connection establishment procedure in S80, also information indicating the determined OPB target cell is provided to the OPA serving cell by the UE 10. Then, S80 is executed, triggered by the OPA serving cell.

As a result of S80, the OPA serving cell establishes the radio bearers for the UE 10 to the OPB target cell over the SCR link allowing the user traffic to be routed to OPB's core network from the OPB target cell.

- 5      Based on the network coordination offered by OPA, OPB may consider to release some of its spectrum from its own small cells, for example in case there is an interference with the requesting small cell of OPA (OPA\_AP1 40). This decision is made, for example, in case some of current active UEs (i.e. UE 10) is redirected to the other cells (i.e. OPB\_AP3 50 acting as a target cell). This is indicated for example by means of a signaling from
- 10      OPB\_AP3 50 indicating that the relay connection to UE 10 via the SCR link to OPA\_eNB 20 is established (see S90). Based on this indication, the OPB\_eNB 30 decides in S95 on a spectrum release for the own small cells and a corresponding spectrum grant for the OPA network.
- 15      For example, in S95, OPB\_eNB 30 deactivates a part or the whole small cell of OPB\_AP2 60, for example in case it is possible to redirect all current UEs of the cell to other cells (i.e. to OPB\_AP3 50 via the SCR link, for example). Alternatively, active UEs may be redirected to the other cells of the OPB network wherein the OPB\_eNB 30 may select some of its active UEs to handover to the OPA serving cell in order to allow the macro
- 20      eNB to have sufficient capacity to accept the UEs from the small cells of which the spectrum may be granted to the OPA small cells.

In S100, the granted spectrum is indicated to the requesting side, i.e. to OPA\_AP1 40.

- 25      It is to be noted that according to some example versions of the disclosure, the spectrum request may be provided with an urgency indication. For example, in case the urgency of the spectrum request is high, the spectrum grant may happen also before the network coordination procedure has been completed.

As a result of the processing shown in Fig. 2, when OPB shares or grants some of its spectrum (e.g. part of the co-primary spectrum that is used with higher priority by operator B) to OPA, one or more of the active UEs (like UE 10 shown in Figure 1) of OPB are allowed to use OPA's RAN and SCR link towards some part of OPB for services as compensation for the shared spectrum. Therefore, when viewing e.g. Fig. 1, data traffic of UE 10 (after switching the communication to the OPA network part acting as communication relay) is transmitted on the radio links via OPA\_eNB 20 and the SCR link between OPA\_eNB 20 and OPB\_AP3 50 acting as the target cell, from which the data is forwarded to OPB's core network (either directly or through a controlling macro eNB).

With regard to Fig. 3, a diagram illustrating a further communication network configuration is shown where some example versions of the disclosure invention are implemented. It is to be noted that the configuration shown in Fig. 3 shows only those devices, network elements, functions and/or parts which are useful for understanding principles underlying the example versions of the disclosure. As also known by those skilled in the art there may be several other network elements or devices involved in a communication network which are omitted here for the sake of simplicity.

The network configuration according to Fig. 3, like that of Fig. 1, is for example based on the 3GPP specifications and comprises elements of a heterogeneous network including one or more wide area cells (macro cell) and one or more local area cells (small cells), and elements of parallel (neighboring) macro cells and small cells.

Fig. 3 shows a communication network system where three neighboring macro cells 200, 300 and 700 are provided. Cell 200 is part of a communication network of a first operator (OPA) and cells 300 and 700 are part of a communication network of a second operator (OPB), respectively, wherein each operator's exclusive (RF) spectrum is used in the respective cell.

Each of the macro cells 200, 300, 700 is controlled by a corresponding communication network control element comprising, e.g. a (macro) eNB (OPA\_eNB 20 of operator

network OPA) and an O&M element (OPA\_O&M 20a) of the first operator network OPA, or a (macro) eNB (OPB\_eNB1 30 or OPB\_eNB2 70 of operator network OPB) and an O&M element (OPB\_O&M 30a) of the second operator network OPB. According to some example versions of the disclosure, the communication control network elements of the one of the respective different networks (such as for the OPB network OPB\_eNB1 30 and OPB\_eNB2 70) are configured to communicate with each other by a direct communication connection or by means of a communication path involving, for example, the core network of the operator network, or another communication path, such as the Internet, a dedicated connection, etc.. Furthermore, a communication path between communication network control element (e.g. eNBs) of different operator networks may be provided via several elements in the networks (for example an eNB may communicate with some core network entity of its own network and then the core network entity of two operators may exchange information regarding information related to corresponding eNB).

As shown in Fig. 3, each of the OPA and OPB networks comprise one or more small cells in a heterogeneous network structure, which are connected to a corresponding communication network control element of the macro cell via a corresponding backhaul link. Specifically, in the example shown in Fig. 3, the OPA network comprises a small cell controlled by an access network element or access point denoted as OPA\_AP1 40. The OPB network comprises two small cells controlled by access network elements or access points denoted as OPB\_AP2 60 and OPB\_AP3 50, respectively, wherein the small cell of OPB\_AP50 is located in the area of macro cell 700 (and may be hence controlled by the OPB\_eNB2 70). It is to be noted that the OPA and OPB networks may comprise more small cells than those shown in Fig. 1. As can be seen in Fig. 3, the small cells and the macro cells can have various neighboring cell relationships: for example the small cell of OPA\_AP1 40 is a neighboring cell to the OPB macro cells and the OPB small cell of OPB\_AP2 60, while the small cell of OPB\_AP3 50 is a neighboring cell to the OPA macro cell, for example.

According to example versions of the disclosure, the APs of the respective small cells and the communication network control element of the respective operator are connected by interfaces using a backhaul network or another connection type, such as a wired or wireless communication line, or the like.

Furthermore, as indicated in Fig. 3, communication elements or devices such as UEs may be located in the cell areas. In Fig. 3, only one UE 10 is shown which is assumed to be originally connected to the OPB network (i.e. OPB network is home network of UE 10).

5

It should be appreciated that according to some example versions of the disclosure, a so-called "liquid" or flexible radio concept is employed where the operations and functionalities of a communication network control element or of another entity of the communication network, such as of one or more of the shown eNBs or APs, may be performed in different entities, such as a node, host or server, in a flexible manner. In other words, a "division of labour" between involved network elements or entities may vary case by case. One possible alternative to the example illustrated is, for example, to make a base station or the like to deliver local content.

10

In the example shown in Fig. 3, it is now assumed that a spectrum sharing relationship (spectrum cooperation relationship (SCR)) can be established among the multiple (here two) network operators OPA and OPB. The SCR may be set up between OPA and OPB on different levels, e.g. between the macro cells, between small cells and macro cells, or between small cells. In the example version of the disclosure as indicated in Fig. 3, it is assumed that an SCR is established between a small cell of one network and a macro cell of the other network. Specifically, as indicated by a dashed arrow between OPA\_AP1 40 and OPB\_eNB 30 or between OPB\_AP3 50 and OPA\_eNB 20, SCR is assumed to be established between these elements.

20

Referring to Fig. 4, an example version of the disclosure regarding a communication using a spectrum sharing based on a spectrum cooperation relationship with service coordination and network coordination is explained by means of a signaling diagram illustrating a control scheme of the communication. The signaling diagram illustrates processings and functions executed by communication network control elements (such as eNBs and APs) and communication elements (such as UEs) in a scenario as indicated in Fig. 3, for example. That is, it is assumed that there are spectrum cooperation opportunities in RAN level between OPA and OPB, such as SCR links between OPA\_eNB

25

30

20 and OPB\_AP3 50 on the one side and OPA\_AP1 40 and OPB\_eNB 30 on the other side.

5 In S110, as in S10 of Fig. 2, network elements involved in a spectrum cooperation relationship are configured in accordance with the result of a spectrum sharing cooperation negotiation between the operators (i.e. OPA and OPB). That is, communication network control elements are configured to establish an SCR link, when suitable (e.g. when measurement results are thus that an SCR link can be established between e.g. a small cell AP of one network and the macro cell eNB of the other network),  
10 resulting in a SCR opportunity or link as indicated e.g. in Fig. 3.

In addition, a function enabling a service coordination is configured in the communication network control elements involved in the communication procedure according to example versions of the disclosure. That is, in S115, as in S15 of Fig. 2, a configuration based on a  
15 spectrum sharing incentive agreement (which is negotiated between the networks (e.g. OPB and OPA)) is executed.

In S120, a decision is made e.g. in the OPA\_AP1 40 to request for spectrum usage right of a part of the OPB spectrum. Consequently, a request is sent to the OPB network via the  
20 SCR link (i.e. to OPB\_eNB 30). The request comprises service coordination information and network coordination information, like in case of S20 of Fig. 2, so that a further detailed explanation thereof is omitted here.

In S30, the receiving side of the spectrum request, such as the OPB\_eNB 30, processes  
25 the request and the contained service coordination and network coordination information. For example, based on the service and network coordination information indicated in the spectrum request sent by the OPA\_AP1 40, the receiving macro eNB of operator B may decide on whether and which measures offered for compensation are acceptable and start by using the network coordination information as a basis of compensation, to grant some  
30 spectrum to the OPA. According to the present example versions of the disclosure, the receiving macro eNB (i.e. OPB\_eNB 30) determines also a neighboring cell is involved in

the network coordination, i.e. cell 700 controlled by OPB\_eNB2 70. This is based, for example, on small cells information provided in network coordination information indicating e.g. small cell of OPB\_AP3 50 which is located in cell 700 and controlled by OPB\_eNB2 70.

5

Thus, in S125, by using suitable interface procedures (e.g. X2 interface procedure in LTE/LTE-A system) between the receiving macro eNB (OPB\_eNB1 30) and the neighboring macro eNB (OPB\_eNB2 70), network coordination information are delivered to the other involved communication network control elements.

10

According to some example versions of the disclosure, the message exchanged in S125 includes a full copy of the network coordination information received in S120. Alternatively, the message includes only a part of the network coordination information that is relevant to the neighboring macro eNBs. For example, reserved C-RNTIs and RACH preambles may be divided among the receiving and the neighboring macro eNBs in order to avoid double use of them, wherein only that part of C-RNTIs and RACH preambles that is allocated to the neighboring cell is included in the message in S125.

15

20

In the service and network coordination processing according to the example of Fig. 4, in S140, the OPB\_eNB1 30 puts the OPA serving cells indicated in the network coordination information as neighboring cells that UEs of OPB can access and instructs at least one UE of the OPB (here UE 10) to conduct measurements for those cells for handover or cell re-selection purpose. The instruction in S140 is provided, for example, by either a common signaling (e.g. by updating system information regarding inter-frequency or intra-frequency neighboring cells related information) or a dedicated signaling (e.g. by a measurement configuration signaling message).

25

30

In S145, after the UE 10 has made the requested measurement of the OPA serving cell (i.e. after a determination of communication situation towards OPA\_eNB 20, for example), a measurement report is sent from UE 10 to the OPB\_eNB1 30.

In S150, on the basis of the measurement report, OB\_eNB1 30 selects UEs (here e.g. UE 10) for making a switch (handover) to the serving cells of OPA (i.e. for using it as a communication relay). It is to be noted that the number of UEs selected for switching is not limited to one.

5

According to some example versions of the disclosure, with regard to S150, for each selected UE, the OPB\_eNB1 30 determines also one of the small cells of OPB indicated in network coordination information as a target cell in the own operator's (OPB) network for the UE to handover. For example, OPB\_AP3 50 is determined. Since OPB\_AP3 50 is controlled by OPB\_eNB2 70, the OPB\_eNB1 30 uses a suitable interface towards the communication network control element (OPB\_AP3 50) of the cell determined to be the target cell (such as a X2 or S1 interface as in LTE/LTE-A system) for informing the cell about the usage as a target cell. That is, according to some example versions of the disclosure, the target cell is informed by means of e.g. a handover preparation procedure about the coming handover of the selected UE. That is, for supporting the handover preparation, a handover preparation procedure is enhanced to inform the target cell that it is only an anchor point for the UE to connect to the core network of OPB, but that the UE does not access the target cell over the radio directly (i.e. a regular handover is not conducted). In other words, the target cell (i.e. the communication network control element such as the OPB\_AP3 50) is informed that the UE accesses the target cell via an OPA radio cell and the SCR link established between the target cell and OPA serving cell. This information is provided in S160 and S163 (e.g. by means of handover request and response messages exchanged between OPB\_eNB1 30 and OPB\_eNB2 70 as well as between OPB\_eNB2 70 and OPB\_AP3 50).

25

In S165, OPB\_eNB1 30 commands the selected UE (here UE 10) to switch the communication connection (i.e. to handover) to the OPA serving cell (OPA\_eNB 20). In connection with the command, according to some example versions of the disclosure, additional information of the target cell (OPB\_AP3 50) that OPB\_eNB1 30 has determined for the UE 10 is provided. Furthermore, a set of access information, such as RACH preamble and C-RNTI, which is derived from the network coordination information, is provided to the UE 10.

30

Upon receiving the connection switching command from OPB\_eNB1 30, the UE 10 accesses in S170 the OPA serving cell indicated in the command by using the RACH preamble and C-RNTI indicated in the handover command in order to establish an RRC connection, for example.

5

In S180, a radio bearer establishment is conducted between the OPA serving cell and the OPB target cell via the SCR link. For example, S180 is executed in reaction to S163, i.e. when the OPB small cell is informed about being the target cell. Then, the OPB target cell triggers the radio bearers establishment over the SCR link towards the OPA serving cell.

10 In this connection, also an information may be provided informing the OPA serving cell that a UE will be handed over soon. Furthermore, UE context information may be delivered to OPA serving cell at the same time.

On the other hand, according to some further example versions of the disclosure, S180  
15 may be executed when the UE 10 accesses the OPA serving cell in S170, i.e. when a connection establishment between UE 10 and OPA\_eNB 20 is conducted. That is, since in this case no UE context information including information on the target cell in OPB network is available on the OPA serving cell side before the UE 10 accesses to the OPA serving cell (OPA\_eNB 20), in the connection establishment procedure in S180, also  
20 information indicating the determined OPB target cell is provided to the OPA serving cell by the UE 10. Then, S180 is executed, triggered by the OPA serving cell.

As a result of S180, the OPA serving cell establishes the radio bearers for the UE 10 to the OPB target cell over the SCR link allowing the user traffic to be routed to OPB's core  
25 network from the OPB target cell.

Based on the network coordination offered by OPA, OPB may consider to release some of its spectrum from its own small cells, for example in case there is an interference with the requesting small cell of OPA (OPA\_AP1 40). This decision is made, for example, in case  
30 some of current active UEs (i.e. UE 10) are redirected to the other cells (i.e. OPB\_AP3 50 acting as a target cell). This is indicated for example by means of a signaling from

OPB\_AP3 50 via OPB\_eNB2 70 indicating that the relay connection to UE 10 via the SCR link to OPA\_eNB 20 is established (see S190 and S193). Based on this indication, the OPB\_eNB1 30 decides in S195 on a spectrum release for the own small cells and a corresponding spectrum grant for the OPA network.

5

For example, in S195, OPB\_eNB1 30 deactivate a part or the whole small cell of OPB\_AP2 60, for example in case it is possible to redirect all current UEs of the cell to other cells (i.e. to OPB\_AP3 50 via the SCR link, for example). Alternatively, active UEs may be redirected to the other cells of the OPB network wherein the OPB\_eNB1 30 may select some of its active UEs to handover to the OPA serving cell in order to allow the macro eNB to have sufficient capacity to accept the UEs from the small cells of which the spectrum may be granted to the OPA small cells.

10

In S200, the granted spectrum is indicated to the requesting side, i.e. to OPA\_AP1 40.

15

In the above described example versions of the disclosure, as indicated in Figs. 1 to 4, only one macro eNB of OPA is illustrated. However, according to example versions of the disclosure, serving cells for network coordination proposed by OPA are not limited to be that of the controlling macro eNB of a small cell AP that requests the spectrum from OPB. Serving cells may be also any neighboring macro cell or even small cell of OPA, as long as an SCR link towards a OPB network part is available.

20

Furthermore, according to example versions of the disclosure, the network coordination process executed in the OPB network like in S130 and S150 is not limited to be executed by the macro eNB that receives the spectrum request from OPA. Any of the macro eNBs of neighboring cells may also perform the network coordination process and instruct its UEs to switch to a serving cell of the OPA network as indicated, as long as the neighboring cells have an overlapping service area with the indicated serving cell of OPA.

25

Furthermore, in the sequences indicated in Figs. 2 and 4, it is indicated that the radio bearer establishment happens after the UE accesses the OPA serving. As indicated above, the radio bearer establishment may be also triggered by the OPB target cell before the UE 10 accesses to the OPA serving cell.

5

Similarly, the spectrum grant message may be sent even if the network coordination procedure is not completed. In this case, the granted spectrum may be determined by the estimation on the possible network cooperation opportunities.

10 It is to be noted that according to some example versions of the disclosure, a procedure for setting up an SCR (or an SCR link) as indicated to be present in Fig. 1 may be executed, for example, during a deployment of a small cell of the respective network, a reconfiguration thereof or in a reset case. Furthermore, it is possible that small cells are allowed and able to use the high-priority usage spectrum of the OPB. For example, a  
15 setup of an SCR link between a small cell AP and the other operator's eNB (e.g. between OPA\_eNB 20 and OPB\_AP3 50 or between OPB\_eNB 1 30 and OPA\_AP 1 40) may be based on different conditions, such as a quality of radio connection between the AP and other operator's eNB (e.g. whether or not an AP is in the cell center rather than cell edge), load conditions etc.. In addition, as described above, an established SCR link may be  
20 used not only for this particular AP to request the spectrum, but it can also be used by other APs.

Fig. 5 shows a flow chart of a processing conducted in a communication network control element (e.g. of OPB, such as OPB\_eNB 30) acting as a spectrum request  
25 processing/granting part with regard to a control of a communication using a spectrum sharing based on a spectrum cooperation relationship with service coordination and network coordination according to some example versions of the disclosure.

In S300, a request for using a part of a spectrum of a second communication network by a  
30 first communication network on the basis of a SCR configuration is received and processed.

It is to be noted that before receiving and processing the spectrum request, a processing related to configure the SCR related to the usage of the spectrum of the second communication network in a sharing manner by the first communication network is conducted, i.e. the SCR is established between the respective communication networks and the involved network elements are configured to be able to use the SCR.

Furthermore, similarly to the SCR configuration, a processing related to configure a function for enabling the processing for service coordination and network coordination according to service coordination and network coordination rules agreed between the first communication network and the second communication network according in a spectrum sharing incentive agreement is conducted in advance to the processing of the request for using a part of the spectrum of the second communication network. The spectrum sharing incentive agreement defines rules for a compensation by communication load reduction enabled by the first communication network for a spectrum grant provided by the second communication network, wherein the service coordination information is based on the spectrum sharing incentive agreement.

In S310, service coordination information and network coordination information related to the request for using a part of the spectrum are received and processed. The service coordination information indicates measures offered by the first communication network allowing the second communication network to reduce a communication load by using a part of the first communication network as a communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network. The network coordination information indicates identification information identifying communication areas or cells of the first and second communication networks usable for the offered measures and configuration information required for using the offered measures. For example, the network coordination information comprises an indication of an identification and parameters of the part of the first communication network usable as a communication relay (e.g. RF channels, PCI, ECGI of OPA cells that are offered to be accessed by UEs of OPB). Alternatively or additionally, the network coordination information comprises an indication (e.g. ECGI) of a communication area or cell of the second communication network with which a spectrum

cooperation relationship is configured with the indicated part of the first communication network usable as a communication relay. Alternatively or additionally, the network coordination information comprises an indication of UE context information to be used for communication elements of the second communication network for accessing the part of the first communication network acting as a communication relay (e.g. reserved C-RNTIs, RACH preambles for UEs to be switched, which are to be used to access the indicated serving cell). Alternatively or additionally, the network coordination information comprises an indication of connection parameters required for getting access to the part of the first communication network acting as a communication relay (for example, conditions for the UE to access the indicated serving cell, such as thresholds for downlink measurements like RSRP and/or RSRQ thresholds).

In S320, a processing for service coordination and network coordination for reducing the communication load in the second communication network by using a part of the first communication network as a communication relay is conducted on the basis of the processing result of the service coordination information and the network coordination information.

For example, the processing for service coordination and network coordination for reducing the communication load in the second communication network by using a part of the first communication network as a communication relay comprises determining, on the basis of the processing result of the network coordination information, a communication area or cell of the second communication network involved in usage of the part of the first communication network as a communication relay (i.e. determination of a target cell acting as an anchor point). Furthermore, the processing comprises to provide configuration data based on the received network coordination information to communication network control elements of the determined communication area or cell of the second communication network, the configuration data being related to the usage of the part of the first communication network as a communication relay.

In addition, on the basis of the network coordination information, a neighboring cell measurement on the basis of the identification information identifying communication

areas or cells of the first communication network usable for the offered measures is initiated to be conducted by at least one communication element (UE) of the second communication network. Corresponding measurement reports of the at least one UE are received and processed.

5

It is to be noted that the processing for service coordination and network coordination for reducing the communication load in the second communication network by using a part of the first communication network as a communication relay may further comprise to inform a communication area or cell of the second communication network to be used as an anchor point (target cell) for the part of the first communication network acting as the communication relay for accessing the second communication network on the basis of the SCR about a (coming) switch of a UE to the part of the first communication network acting as a communication relay (i.e. to inform that the UE does not connect directly to the target cell but via the relay element).

10

In S330, at least one UE is selected to be switched on the basis of the measurement report and the network coordination information, i.e. to using the indicated part of the first communication network as a communication relay. Then, the selected UE(s) is instructed to switch a communication connection to the part of the first communication network acting as a communication relay. The instruction may comprise information indicating a communication area or cell of the second communication network to be used as an anchor point (target cell) for the part of the first communication network acting as the communication relay for accessing the second communication network on the basis of the SCR.

15

In S340, it is decided which part of the spectrum of the second communication network is granted to the request. A corresponding response to the request for using a part of the spectrum of the second communication network is transmitted to the requesting side.

20

It is to be noted that e.g. depending on an urgency of a spectrum request (which may be indicated by a corresponding indication), S340 may be executed also before S320, i.e. the

decision which part of the spectrum of the second communication network is granted and the transmission of the response to the request are executed before the processing for service coordination and network coordination. Furthermore, in S340, a release of spectrum usage by the second communication network may be executed, in  
5 correspondence with the granted spectrum.

Fig. 6 shows a flow chart of a processing conducted in a communication network control element (e.g. of OPA, such as OPA\_AP1 40) acting as a spectrum requesting part with regard to a control of a communication using a spectrum sharing based on a spectrum  
10 cooperation relationship with service coordination and network coordination according to some example versions of the disclosure.

In S400, a request for using a part of a spectrum of a second communication network on the basis of a SCR configuration between a first communication network and the second  
15 communication network is made.

Furthermore, in S410, service coordination information and network coordination information related to the request for using a part of the spectrum of the second communication network are provided.

The service coordination information indicates measures offered by the first communication network allowing the second communication network to reduce a communication load by using a part of the first communication network as a communication relay as compensation for allowing to use a part of the spectrum of the  
20 second communication network by the first communication network.

The network coordination information indicates identification information identifying communication areas or cells of the first and second communication networks usable for the offered measures and configuration information required for using the offered  
30 measures. For example, the network coordination information comprises an indication of

an identification and parameters of the part of the first communication network usable as a communication relay (e.g. RF channels, PCI, ECGI of OPA cells that are offered to be accessed by UEs of OPB). Alternatively or additionally, the network coordination information comprises an indication (e.g. ECGI) of a communication area or cell of the second communication network with which a spectrum cooperation relationship is configured with the indicated part of the first communication network usable as a communication relay. Alternatively or additionally, the network coordination information comprises an indication of UE context information to be used for communication elements of the second communication network for accessing the part of the first communication network acting as a communication relay (e.g. reserved C-RNTIs, RACH preambles for UEs to be switched, which are to be used to access the indicated serving cell). Alternatively or additionally, the network coordination information comprises an indication of connection parameters required for getting access to the part of the first communication network acting as a communication relay (for example, conditions for the UE to access the indicated serving cell, such as thresholds for downlink measurements like RSRP and/or RSRQ thresholds).

It is to be noted that before making a spectrum request, a processing related to configure the SCR related to the usage of the spectrum of the second communication network in a sharing manner by the first communication network is conducted, i.e. the SCR is established between the respective communication networks and the involved network elements are configured to be able to use the SCR.

Furthermore, similarly to the SCR configuration, a processing related to configure a function for enabling the processing for service coordination and network coordination according to service coordination and network coordination rules agreed between the first communication network and the second communication network according in a spectrum sharing incentive agreement is conducted in advance to the processing of the request for using a part of the spectrum of the second communication network. The spectrum sharing incentive agreement defines rules for a compensation by communication load reduction enabled by the first communication network for a spectrum grant provided by the second communication network, wherein the service coordination information is based on the spectrum sharing incentive agreement.

In S420, a response to the request for using a part of the spectrum of the second communication network is received and processed. The response indicates which part of the spectrum of the second communication network is granted to the request.

5

Fig. 7 shows a flow chart of a processing conducted in a communication network control element (e.g. of OPB, such as OPB\_AP3 50) acting as a target cell controlling part with regard to a control of a communication using spectrum cooperation relationship with service coordination and network coordination according to some example versions of the disclosure.

10

In S500, network coordination information and/or configuration information based on network coordination information related to a request for using a part of a spectrum of a second communication network by a first communication network on the basis of a SCR configuration are received and processed.

15

Generally, the network coordination information indicates identification information identifying communication areas or cells of the first and second communication networks usable for the offered measures and configuration information required for using the offered measures. For example, the network coordination information comprises an indication of an identification and parameters of the part of the first communication network usable as a communication relay (e.g. RF channels, PCI, ECGI of OPA cells that are offered to be accessed by UEs of OPB). Alternatively or additionally, the network coordination information comprises an indication (e.g. ECGI) of a communication area or cell of the second communication network with which a spectrum cooperation relationship is configured with the indicated part of the first communication network usable as a communication relay. Alternatively or additionally, the network coordination information comprises an indication of UE context information to be used for communication elements of the second communication network for accessing the part of the first communication network acting as a communication relay (e.g. reserved C-RNTIs, RACH preambles for UEs to be switched, which are to be used to access the indicated serving cell). Alternatively or additionally, the network coordination information comprises an indication

20

25

30

of connection parameters required for getting access to the part of the first communication network acting as a communication relay (for example, conditions for the UE to access the indicated serving cell, such as thresholds for downlink measurements like RSRP and/or RSRQ thresholds). The configuration information based on network coordination  
5 information indicates a subset of this information required for conducting the further processing.

For example, an information indicating may be received and processed which is related to a configuration that a communication area or cell of the second communication network  
10 (i.e. the communication area or cell where the communication network control element (e.g. of OPB, such as OPB\_AP3 50) acting as a target cell controlling part is located) is used as an anchor point for the part of the first communication network acting as the communication relay for accessing the second communication network on the basis of the SCR. Furthermore, information about a (coming) switch of a communication connection  
15 (i.e. handover) of a selected UE to the part of the first communication network acting as the communication relay is provided for preparing to serve the selected UEs by the target cell control element.

It is to be noted that before processing the network coordination information, a processing  
20 related to configure the SCR related to the usage of the spectrum of the second communication network in a sharing manner by the first communication network is conducted, i.e. the SCR is established between the respective communication networks and the involved network elements are configured to be able to use the SCR.

In S510, a radio bearer connection via a SCR link to a part of the first communication network to be used as a communication relay is established. For example, on the basis of the processing result of the network coordination information or the configuration information related to the network coordination information, the bearer establishment is initiated or triggered so as to prepare the communication path between the communication  
30 relay and the anchor point. According to some example versions of the disclosure, in the bearer establishment procedure, also UE context information regarding the UE to be switched to the part of the first communication network acting as the communication relay is provided, when available.

In S520, the communication between the selected UE being switched to the part of the first communication network acting as the communication relay and the communication network is established and conducted. That is, for example, data from the UE are received via the SCR link from the part of the first communication network used as the communication relay, and the received data from the UE of the second communication network are forwarded to a core network of the second communication network. On the other hand, data directed to the switched UE of the second communication network are received from the core network of the second communication network, and the data directed to the UE are forwarded via the SCR link to the part of the first communication network used as the communication relay.

Fig. 8 shows a flow chart of a processing conducted in a communication network control element (of OPA, such as OPA\_eNB 20) acting as a serving cell controlling part with regard to a control of a communication using a spectrum sharing based on a spectrum cooperation relationship with service coordination and network coordination according to some example versions of the disclosure.

In S600, a processing for establishing a communication connection to a communication element (e.g. UE) of another (i.e. the second) communication network is conducted. The establishment of the communication connection to the communication element of the other (second) communication network is based on UE specific context information assigned by the own (first) communication network to communication elements of the other (second) communication network for accessing a part of a first communication network which has to act as a communication relay allowing the second communication network to reduce a communication load by using the communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network. For example, the UE specific context information comprises reserved RACH preambles or the like. The identification of the UE specific context information assigned by the first communication network to UEs of the second communication network (i.e. for accessing a part of a first communication network which has to act as a communication relay allowing the second communication network to reduce a communication load by using the communication relay as compensation for

allowing to use a part of the spectrum of the second communication network by the first communication network) is based on predefined network coordination information being used for a request for using a part of a spectrum of the second communication network by the first communication network. As described above, the network coordination information indicating identification information identifying communication areas or cells of the first and second communication networks usable for measures to reduce the communication load of the second communication network, and configuration information required for using the measures. In other words, based on the identified reserved RACH preamble and/or C-RNTI, for example, the serving cell is able to recognize that the accessing UE is to be served as a communication relay only wherein the SCR link towards a part of the second network (target cell of OPB) is used for communication of the UE to and from the core network of OPB.

It is to be noted that before the processing for establishing the communication connection, a processing related to configure the SCR related to the usage of the spectrum of the second communication network in a sharing manner by the first communication network is conducted, i.e. the SCR is established between the respective communication networks and the involved network elements are configured to be able to use the SCR.

In S610, a processing for establishing a radio bearer connection via a SCR link to an anchor node of the second communication network is conducted.

In S620, the communication between the UE being switched to the part of the first communication network acting as the communication relay and the anchor node of the second communication network is established and conducted. That is, for example, data from the communication element of the second communication network are received via the established communication connection. In the function as the communication relay, the received data from the communication element of the second communication network are forwarded over the established radio bearer connection via the SCR link to the anchor node of the second communication network. Otherwise, data directed to the communication element of the second communication network are received from the anchor node of the second communication network over the established radio bearer

connection via the SCR link, and in the function as the communication relay, the data directed to the communication element are forwarded via the established communication connection to the communication element of the second communication network.

5 It is to be noted that the order of S600 and S610 may be different. That is, according to one option, the processing for establishing the radio bearer connection via the SCR link to the anchor node of the second communication network is conducted before conducting the processing for establishing the communication connection to the communication element of the second communication network. In this case, the establishment of the radio  
10 bearer connection may be triggered by the anchor node of the second communication network, wherein UE specific context information may be received during the radio bearer establishment and correspondingly processed (as a preparation for the processing for establishing the communication connection to the UE, wherein the identification of the UE specific context information is simplified). On the other hand, according to another option,  
15 the processing for establishing the communication connection to the communication element of the second communication network is conducted before conducting the processing for establishing the radio bearer connection via the spectrum cooperation relationship link to the anchor node of the second communication network. In this case, the processing for establishing the radio bearer connection via the spectrum cooperation  
20 relationship link is triggered e.g. by the serving cell side. In addition, when the communication connection establishment to the communication element (UE) is executed, information identifying a communication area or cell of the second communication network to be used as the anchor point of the second communication network may be received and processed.

25 Fig. 9 shows a flow chart of a processing conducted in a communication element (UE being selected to be switched to OPA) with regard to a control of a communication using a spectrum sharing based on a spectrum cooperation relationship with service coordination and network coordination according to some example versions of the disclosure.

30 In S700, a processing for establishing a communication connection between a communication element (e.g. UE) and an indicated serving cell of another (i.e. the first) communication network is conducted. The establishment of the communication

connection to the communication network control element of the other (first) communication network is based on UE specific context information indicated in a connection switching command received from an own communication network control element, which serves for accessing a part of the first communication network which has to act as a communication relay allowing the second communication network to reduce a communication load by using the communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network. For example, the UE specific context information includes a reserved RACH preamble or the like. According to some further example versions of the disclosure, also information regarding a target cell to be used as an anchor point for the part of the first communication network acting as a communication relay into the own communication network is provided.

In S720, the communication between the UE being switched to the part of the first communication network acting as the communication relay and the anchor node of the second communication network is established and conducted. That is, for example, data are sent to the own communication network (e.g. OPB core network) via the established communication connection to the part of the first communication network acting as the communication relay (e.g. OPA\_eNB 20). Vice versa, data are received from the own network (i.e. from the anchor node of the second communication network) via the established communication connection to the part of the first communication network acting as the communication relay (e.g. OPA\_eNB 20).

It is to be noted that in addition to the above described processing, the communication element may also conduct, before accessing the part of the first communication network acting as the communication relay (e.g. OPA\_eNB 20), measurements for determining a communication quality towards the part of the first communication network acting as the communication relay (e.g. OPA\_eNB 20). This measurement is triggered, for example, by a corresponding instruction indicating the part of the first communication network acting as the communication relay (e.g. OPA\_eNB 20) as a neighboring cell.

In Fig. 10, a diagram illustrating a configuration of a communication network control element, such as of the OPB\_eNB 30, is shown, which is configured to implement the communication procedure as a spectrum request receiving element as described in connection with some example versions of the disclosure. It is to be noted that the communication network control element like the OPB\_eNB 30 shown in Fig. 10 may comprise several further elements or functions besides those described herein below. Furthermore, even though reference is made to an eNB, the communication network control element may be also another device having a similar function, such as a chipset, a chip, a module etc., which can also be part of a communication network control element or attached as a separate element to a communication network control element, or the like. It should be understood that each block and any combination thereof may be implemented by various means or their combinations, such as hardware, software, firmware, one or more processors and/or circuitry.

The communication network control element shown in Fig. 10 may comprise a processing function, control unit or processor 31, such as a CPU or the like, which are suitable for executing instructions given by programs or the like related to the communication procedure. The processor 31 may comprise one or more processing portions dedicated to specific processing as described below, or the processing may be run in a single processor. Portions for executing such specific processing may be also provided as discrete elements or within one or more further processors or processing portions, such as in one physical processor like a CPU or in several physical entities, for example. Reference signs 32 and 33 denote transceiver or input/output (I/O) units (interfaces) connected to the processor 31. The I/O units 32 may be used for communicating with one or more communication elements, such as UE 10, or via an SCR link, for example an air interface. The I/O units 33 may be used for communicating with one or more other network elements of the OPB network, such as other communication network control elements, like neighboring cells, APs of small cells, etc.. The I/O units 32 and 33 may be a combined unit comprising communication equipment towards several network elements, or may comprise a distributed structure with a plurality of different interfaces for different network elements. Reference sign 34 denotes a memory usable, for example, for storing data and programs to be executed by the processor 31 and/or as a working storage of the processor 31.

The processor 31 is configured to execute processing related to the above described communication procedure. In particular, the processor 31 comprises a sub-portion 310 as a processing portion which is usable as a SCR configuration portion. The portion 310 may be configured to perform processing according to S10 and S110 of Figs. 1 and 3.

5 Furthermore, the processor 31 comprises a sub-portion 311 usable as a service coordination and network coordination function. The portion 311 may be configured to perform processing according to S15 and S115 of Figs. 1 and 3. Furthermore, the processor 31 comprises a sub-portion 312 usable as a portion for processing a spectrum request. The portion 312 may be configured to perform a processing according to S300 of

10 Fig. 5. In addition, the processor 31 comprises a sub-portion 313 usable as a portion for service and network coordination. The portion 313 may be configured to perform a processing according to S310, S320 and S330 of Fig. 5. Moreover, the processor 31 comprises a sub-portion 314 usable as a portion for executing a spectrum granting and spectrum releasing function. The portion 314 may be configured to perform a processing

15 according to S340 of Fig. 5.

In Fig. 11, a diagram illustrating a configuration of a communication network control element or access network element, such as of the OPA\_AP 140, is shown, which is configured to implement the communication procedure as a spectrum requesting element

20 as described in connection with some example versions of the disclosure. It is to be noted that the communication network control element like the OPA\_AP1 40 shown in Fig. 11 may comprise several further elements or functions besides those described herein below. Furthermore, even though reference is made to a communication network control element or access network element, the communication network control element or access

25 network element may be also another device having a similar function, such as a chipset, a chip, a module etc., which can also be part of a communication network control element or access network element or attached as a separate element to a communication network control element or access network element, or the like. It should be understood that each block and any combination thereof may be implemented by various means or

30 their combinations, such as hardware, software, firmware, one or more processors and/or circuitry.

The communication network control element or access network element shown in Fig. 11 may comprise a processing function, control unit or processor 41, such as a CPU or the

like, which are suitable for executing instructions given by programs or the like related to the communication procedure. The processor 41 may comprise one or more processing portions dedicated to specific processing as described below, or the processing may be run in a single processor. Portions for executing such specific processing may be also provided as discrete elements or within one or more further processors or processing portions, such as in one physical processor like a CPU or in several physical entities, for example. Reference signs 42 and 43 denote transceiver or input/output (I/O) units (interfaces) connected to the processor 41. The I/O units 42 may be used for communicating with one or more communication elements, such as UE 10, or via an SCR link, for example an air interface. The I/O units 43 may be used for communicating with one or more other network elements of the OPA network, such as a communication network control elements like the OPA\_eNB 20. The I/O units 42 and 43 may be a combined unit comprising communication equipment towards several network elements, or may comprise a distributed structure with a plurality of different interfaces for different network elements. Reference sign 44 denotes a memory usable, for example, for storing data and programs to be executed by the processor 41 and/or as a working storage of the processor 41.

The processor 41 is configured to execute processing related to the above described communication procedure. In particular, the processor 41 comprises a sub-portion 410 as a processing portion which is usable as a SCR configuration portion. The portion 410 may be configured to perform processing according to S10 and S110 of Figs. 1 and 3. Furthermore, the processor 41 comprises a sub-portion 411 usable as a service coordination and network coordination function. The portion 411 may be configured to perform processing according to S15 and S115 of Figs. 1 and 3. Furthermore, the processor 41 comprises a sub-portion 412 usable as a portion for executing a processing related to a spectrum request. The portion 412 may be configured to perform a processing according to S400 and S420 of Fig. 6. In addition, the processor 41 comprises a sub-portion 413 usable as a portion for service and network coordination. The portion 413 may be configured to perform a processing according to S410 of Fig. 6.

In Fig. 12, a diagram illustrating a configuration of a communication network control element or access network element, such as of the OPB\_AP3 50, is shown, which is configured to implement the communication procedure as a target element or node as

described in connection with some example versions of the disclosure. It is to be noted that the communication network control element or access network element like the OPB\_AP3 50 shown in Fig. 12 may comprise several further elements or functions besides those described herein below. Furthermore, even though reference is made to a communication network control element or access network element, the communication network control element or access network element may be also another device having a similar function, such as a chipset, a chip, a module etc., which can also be part of a communication network control element or access network element or attached as a separate element to a communication network control element or access network element, or the like. It should be understood that each block and any combination thereof may be implemented by various means or their combinations, such as hardware, software, firmware, one or more processors and/or circuitry.

The communication network control element or access network element shown in Fig. 12 may comprise a processing function, control unit or processor 51, such as a CPU or the like, which are suitable for executing instructions given by programs or the like related to the communication procedure. The processor 51 may comprise one or more processing portions dedicated to specific processing as described below, or the processing may be run in a single processor. Portions for executing such specific processing may be also provided as discrete elements or within one or more further processors or processing portions, such as in one physical processor like a CPU or in several physical entities, for example. Reference signs 52 and 53 denote transceiver or input/output (I/O) units (interfaces) connected to the processor 51. The I/O units 52 may be used for communicating with one or more communication elements, such as UE 10, or via an SCR link, for example an air interface. The I/O units 53 may be used for communicating with one or more other network elements of the OPB network, such as communication network control elements like the OPB\_eNB 30 or 70. The I/O units 52 and 53 may be a combined unit comprising communication equipment towards several network elements, or may comprise a distributed structure with a plurality of different interfaces for different network elements. Reference sign 54 denotes a memory usable, for example, for storing data and programs to be executed by the processor 51 and/or as a working storage of the processor 51.

The processor 51 is configured to execute processing related to the above described communication procedure. In particular, the processor 51 comprises a sub-portion 510 as a processing portion which is usable as a SCR configuration portion. The portion 510 may be configured to perform processing according to S10 and S110 of Figs. 1 and 3.

5 Furthermore, the processor 51 comprises a sub-portion 511 usable as a service coordination and network coordination function. The portion 511 may be configured to perform processing according to S15 and S115 of Figs. 1 and 3 and S500 according to Fig. 7. Furthermore, the processor 51 comprises a sub-portion 512 usable as a portion for executing a processing related to a bearer establishment. The portion 512 may be configured to perform a processing according to S510 of Fig. 7. In addition, the processor 51 comprises a sub-portion 513 usable as a portion for service and network coordination. The portion 513 may be configured to perform a processing according to S520 of Fig. 7.

In Fig. 13, a diagram illustrating a configuration of a communication network control element, such as of the OPA\_eNB 20, is shown, which is configured to implement the communication procedure as a serving cell communication network control element as described in connection with some example versions of the disclosure. It is to be noted that the communication network control element like the OPA\_eNB 20 shown in Fig. 13 may comprise several further elements or functions besides those described herein below.

20 Furthermore, even though reference is made to an eNB, the communication network control element may be also another device having a similar function, such as a chipset, a chip, a module etc., which can also be part of a communication network control element or attached as a separate element to a communication network control element, or the like. It should be understood that each block and any combination thereof may be implemented by various means or their combinations, such as hardware, software, firmware, one or more processors and/or circuitry.

The communication network control element shown in Fig. 13 may comprise a processing function, control unit or processor 21, such as a CPU or the like, which are suitable for executing instructions given by programs or the like related to the communication procedure. The processor 21 may comprise one or more processing portions dedicated to specific processing as described below, or the processing may be run in a single processor. Portions for executing such specific processing may be also provided as discrete elements or within one or more further processors or processing portions, such as

in one physical processor like a CPU or in several physical entities, for example. Reference signs 22 and 23 denote transceiver or input/output (I/O) units (interfaces) connected to the processor 21. The I/O units 22 may be used for communicating with one or more communication elements, such as UE 10, or via an SCR link, for example an air interface. The I/O units 23 may be used for communicating with one or more other network elements of the OPA network, such as other communication network control elements, like neighboring cells, APs of small cells, etc.. The I/O units 22 and 23 may be a combined unit comprising communication equipment towards several network elements, or may comprise a distributed structure with a plurality of different interfaces for different network elements. Reference sign 24 denotes a memory usable, for example, for storing data and programs to be executed by the processor 21 and/or as a working storage of the processor 21.

The processor 21 is configured to execute processing related to the above described communication procedure. In particular, the processor 21 comprises a sub-portion 210 as a processing portion which is usable as a SCR configuration portion. The portion 210 may be configured to perform processing according to S10 and S110 of Figs. 1 and 3. Furthermore, the processor 21 comprises a sub-portion 211 usable as a network coordination function. The portion 211 may be configured to perform processing according to S15 and S115 of Figs. 1 and 3 and S600 of Fig. 8. Furthermore, the processor 21 comprises a sub-portion 212 usable as a portion for establishing a bearer connection with a target cell. The portion 212 may be configured to perform a processing according to S610 of Fig. 8. In addition, the processor 21 comprises a sub-portion 213 usable as a communication portion. The portion 213 may be configured to perform a processing according to S620 of Fig. 8.

In Fig. 14, a diagram illustrating a configuration of a communication element, such as of the UE 10, is shown, which is configured to implement the communication procedure as a spectrum request receiving element as described in connection with some example versions of the disclosure. It is to be noted that the communication element like the UE 10 shown in Fig. 14 may comprise several further elements or functions besides those described herein below. Furthermore, even though reference is made to terminal device or UE, the communication element may be also another device having a similar function, such as a chipset, a chip, a module etc., which can also be part of a communication

element or attached as a separate element to a communication element, or the like. It should be understood that each block and any combination thereof may be implemented by various means or their combinations, such as hardware, software, firmware, one or more processors and/or circuitry.

5

The communication element shown in Fig. 14 may comprise a processing function, control unit or processor 11, such as a CPU or the like, which are suitable for executing instructions given by programs or the like related to the communication procedure. The processor 11 may comprise one or more processing portions dedicated to specific processing as described below, or the processing may be run in a single processor. Portions for executing such specific processing may be also provided as discrete elements or within one or more further processors or processing portions, such as in one physical processor like a CPU or in several physical entities, for example. Reference sign 12 denotes transceiver or input/output (I/O) units (interfaces) connected to the processor 11. The I/O units 12 may be used for communicating with one or more communication networks, such as OPA or OPB, for example an air interface. The I/O units 12 may be a combined unit comprising communication equipment towards several network elements, or may comprise a distributed structure with a plurality of different interfaces for different network elements. Reference sign 14 denotes a memory usable, for example, for storing data and programs to be executed by the processor 11 and/or as a working storage of the processor 11.

The processor 11 is configured to execute processing related to the above described communication procedure. In particular, the processor 11 comprises a sub-portion 110 as a processing portion which is usable as a switching instruction processing portion. The portion 110 may be configured to perform processing according to S700 of Fig. 9. Furthermore, the processor 11 comprises a sub-portion 111 usable as a switching execution portion. Furthermore, the processor 11 comprises a sub-portion 112 usable as a communication. The portions 111 and 112 may be configured to perform a processing according to S720 of Fig. 9.

According to a further example version of the disclosure, there is provided an apparatus comprising processing means for receiving and processing a request for using a part of a spectrum of a second communication network by a first communication network on the basis of a spectrum cooperation relationship configuration, processing means for receiving and processing service coordination information and network coordination information related to the request for using a part of the spectrum, the service coordination information indicating measures offered by the first communication network allowing the second communication network to reduce a communication load by using a part of the first communication network as a communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network, and the network coordination information indicating identification information identifying communication areas or cells of the first and second communication networks usable for the offered measures and configuration information required for using the offered measures, and processing means for conducting a processing for service coordination and network coordination for reducing the communication load in the second communication network by using a part of the first communication network as a communication relay, on the basis of the processing result of the service coordination information and the network coordination information.

According to a further example version of the disclosure, there is provided an apparatus comprising requesting means for requesting for using a part of a spectrum of a second communication network on the basis of a spectrum cooperation relationship configuration between a first communication network and the second communication network, and informing means for providing service coordination information and network coordination information related to the request for using a part of the spectrum of the second communication network, the service coordination information indicating measures offered by the first communication network allowing the second communication network to reduce a communication load by using a part of the first communication network as a communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network, and the network coordination information indicating identification information identifying communication areas or cells of the first and second communication networks usable for the offered measures and configuration information required for using the offered measures.

According to a further example version of the disclosure, there is provided an apparatus comprising processing means for receiving and processing at least one of network coordination information and configuration information based on network coordination information related to a request for using a part of a spectrum of a second communication network by a first communication network on the basis of a spectrum cooperation relationship configuration, the network coordination information indicating identification information identifying communication areas or cells of the first and second communication networks usable for measures offered by the first communication network allowing the second communication network to reduce a communication load by using a part of the first communication network as a communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network, and configuration information required for using the offered measures, and processing means for conducting a processing for establishing a radio bearer connection via a spectrum cooperation relationship link to a part of the first communication network to be used as a communication relay on the basis of the processing result of the network coordination information or the configuration information related to the network coordination information.

According to a further example version of the disclosure, there is provided an apparatus comprising processing means for conducting a processing for establishing a communication connection to a communication element of a second communication network, wherein the establishment of the communication connection to the communication element of the second communication network is based on communication element specific context information assigned by the first communication network to communication elements of the second communication network for accessing a part of a first communication network which has to act as a communication relay allowing the second communication network to reduce a communication load by using the communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network, processing means for conducting a processing for establishing a radio bearer connection via a spectrum cooperation relationship link to an anchor node of the second communication network, processing means for receiving receive data from the communication element of the second communication network via the established communication connection and, as the communication relay, for forwarding of the received data from the communication element

of the second communication network over the established radio bearer connection via the spectrum cooperation relationship link to the anchor node of the second communication network, and processing means for receiving data directed to the communication element of the second communication network from the anchor node of the second communication network over the established radio bearer connection via the spectrum cooperation relationship link and for forwarding, as the communication relay, the data directed to the communication element via the established communication connection to the communication element of the second communication network.

It should be appreciated that

- an access technology via which signaling is transferred to and from a network element may be any suitable present or future technology, such as WLAN (Wireless Local Access Network), WiMAX (Worldwide Interoperability for Microwave Access), LTE, LTE-A, Bluetooth, Infrared, and the like may be used; Additionally, embodiments may also apply wired technologies, e.g. IP based access technologies like cable networks or fixed lines. - a user device (also called UE, user equipment, user terminal, terminal device, etc.) illustrates one type of an apparatus to which resources on the air interface may be allocated and assigned, and thus any feature described herein with a user device may be implemented with a corresponding apparatus, such as a relay node. An example of such a relay node is a layer 3 relay (self-backhauling relay) towards the base station or eNB. The user device typically refers to a portable computing device that includes wireless mobile communication devices operating with or without a subscriber identification module (SIM), including, but not limited to, the following types of devices: a mobile station (mobile phone), smartphone, personal digital assistant (PDA), handset, device using a wireless modem (alarm or measurement device, etc.), laptop and/or touch screen computer, tablet, game console, notebook, and multimedia device. It should be appreciated that a user device may also be a nearly exclusive uplink only device, of which an example is a camera or video camera loading images or video clips to a network. It should be appreciated that a device may be regarded as an apparatus or as an assembly of more than one apparatus, whether functionally in cooperation with each other or functionally independently of each other but in a same device housing.

- embodiments suitable to be implemented as software code or portions of it and being run using a processor are software code independent and can be specified using any known

or future developed programming language, such as a high-level programming language, such as objective-C, C, C++, C#, Java, etc., or a low-level programming language, such as a machine language, or an assembler, - implementation of embodiments, is hardware independent and may be implemented using any known or future developed hardware technology or any hybrids of these, such as a microprocessor or CPU (Central Processing Unit), MOS (Metal Oxide Semiconductor), CMOS (Complementary MOS), BiMOS (Bipolar MOS), BiCMOS (Bipolar CMOS), ECL (Emitter Coupled Logic), and/or TTL (Transistor-Transistor Logic).

- embodiments may be implemented as individual devices, apparatuses, units or means or in a distributed fashion, for example, one or more processors may be used or shared in the processing, or one or more processing sections or processing portions may be used and shared in the processing, wherein one physical processor or more than one physical processor may be used for implementing one or more processing portions dedicated to specific processing as described,

- an apparatus may be implemented by a semiconductor chip, a chipset, or a (hardware) module comprising such chip or chipset;

- embodiments may also be implemented as any combination of hardware and software, such as ASIC (Application Specific IC (Integrated Circuit)) components, FPGA (Field-programmable Gate Arrays) or CPLD (Complex Programmable Logic Device) components or DSP (Digital Signal Processor) components.

- embodiments may also be implemented as computer program products, comprising a computer usable medium having a computer readable program code embodied therein, the computer readable program code adapted to execute a process as described in embodiments, wherein the computer usable medium may be a non-transitory medium.

Computer program products, also called programs or computer programs, including software routines, applets and macros, may be stored in any apparatus-readable data storage medium and they comprise program instructions to perform one or more particular tasks. A computer program product may comprise one or more computer-executable components which, when the program is run, are configured to carry out embodiments.

The one or more computer-executable components may be at least one software code or portions of it.

Although the present invention has been described herein before with reference to particular embodiments thereof, the present invention is not limited thereto and various modifications can be made thereto.

## CLAIMS

1. An apparatus comprising

at least one processor,

5 and

at least one memory for storing instructions to be executed by the processor,  
wherein

the at least one memory and the instructions are configured to, with the at least one processor, cause the apparatus at least:

10 to receive and process a request for using a part of a spectrum of a second communication network by a first communication network on the basis of a spectrum cooperation relationship configuration,

to receive and process service coordination information and network coordination information related to the request for using a part of the spectrum, the service coordination  
15 information indicating measures offered by the first communication network allowing the second communication network to reduce a communication load by using a part of the first communication network as a communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network, and the network coordination information indicating identification information  
20 identifying communication areas or cells of the first and second communication networks usable for the offered measures and configuration information required for using the offered measures, and

to conduct a processing for service coordination and network coordination for reducing the communication load in the second communication network by using a part of  
25 the first communication network as a communication relay, on the basis of the processing result of the service coordination information and the network coordination information.

2. The apparatus according to claim 1, wherein the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus  
30 at least:

to decide which part of the spectrum of the second communication network is granted to the request,

to cause to transmit a response to the request for using a part of the spectrum of the second communication network,

5            wherein the decision which part of the spectrum of the second communication network is granted and the transmission of the response to the request are executed before or after conducting the processing for service coordination and network coordination .

10        3. The apparatus according to claim 1 or 2, wherein the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus at least:

             to conduct a processing related to configure the spectrum cooperation relationship related to the usage of the spectrum of the second communication network in a sharing  
15        manner by the first communication network.

4. The apparatus according to any of claims 1 to 3, wherein the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus at least:

20            to conduct a processing related to configure a function for enabling the processing for the service coordination and network coordination according to service coordination and network coordination rules agreed between the first communication network and the second communication network according in a spectrum sharing incentive agreement in  
25        advance to a request for using a part of the spectrum of the second communication network, the spectrum sharing incentive agreement defining rules for a compensation by communication load reduction enabled by the first communication network for a spectrum grant provided by the second communication network,

             wherein the service coordination information is based on the spectrum sharing incentive agreement.

30

5. The apparatus according to any of claims 1 to 4, wherein

the network coordination information comprises at least one of

an indication of an identification and parameters of the part of the first communication network usable as a communication relay,

5 an indication of a communication area or cell of the second communication network with which a spectrum cooperation relationship is configured,

an indication of context information to be used for communication elements of the second communication network for accessing the part of the first communication network acting as a communication relay, and

10 an indication of connection parameters required for getting access to the part of the first communication network acting as a communication relay.

6. The apparatus according to any of claims 1 to 5, wherein the processing for service coordination and network coordination for reducing the communication load in the second communication network by using a part of the first communication network as a communication relay comprises

determining, on the basis of the processing result of the network coordination information, a communication area or cell of the second communication network involved in usage of the part of the first communication network as a communication relay,

20 providing configuration data based on the received network coordination information to communication network control elements of the determined communication area or cell of the second communication network, the configuration data being related to the usage of the part of the first communication network as a communication relay.

25 7. The apparatus according to any of claims 1 to 6, wherein the processing for service coordination and network coordination for reducing the communication load in the second communication network by using a part of the first communication network as a communication relay comprises

initiating, on the basis of the network coordination information, a neighboring cell measurement on the basis of the identification information identifying communication areas or cells of the first communication network usable for the offered measures by at least one communication element of the second communication network,

5 receiving and processing a measurement report of the at least one communication element of the second communication network,

selecting at least one communication element on the basis of the measurement report and the network coordination information as using a part of the first communication network as a communication relay, and

10 instructing the at least one selected communication element to switch a communication connection to the part of the first communication network acting as a communication relay.

15 8. The apparatus according to claim 7, wherein the instruction to the at least one selected communication element further comprises information indicating a communication area or cell of the second communication network to be used as an anchor point for the part of the first communication network acting as the communication relay for accessing the second communication network on the basis of the spectrum cooperation relationship.

20 9. The apparatus according to any of claims 1 to 8, wherein the processing for service coordination and network coordination for reducing the communication load in the second communication network by using a part of the first communication network as a communication relay comprises

25 informing a communication area or cell of the second communication network to be used as an anchor point for the part of the first communication network acting as the communication relay for accessing the second communication network on the basis of the spectrum cooperation relationship about a switch of a communication connection of at least one selected communication element to the part of the first communication network acting as a communication relay.

30

10. The apparatus according to any of claims 1 to 9, wherein the apparatus is comprised in a communication network control element or an operation and maintenance element of the second communication network, wherein the first communication network is controlled by another communication network control element or operation and maintenance  
5 element, wherein the first and the second communication networks are cellular based wireless communication networks to which one or more communication elements comprising a user equipment or terminal device are connectable.

11. An apparatus comprising

10 at least one processor,

and

at least one memory for storing instructions to be executed by the processor,  
wherein

the at least one memory and the instructions are configured to, with the at least  
15 one processor, cause the apparatus at least:

to request for using a part of a spectrum of a second communication network on the basis of a spectrum cooperation relationship configuration between a first communication network and the second communication network, and

to provide service coordination information and network coordination information  
20 related to the request for using a part of the spectrum of the second communication network, the service coordination information indicating measures offered by the first communication network allowing the second communication network to reduce a communication load by using a part of the first communication network as a communication relay as compensation for allowing to use a part of the spectrum of the  
25 second communication network by the first communication network, and the network coordination information indicating identification information identifying communication areas or cells of the first and second communication networks usable for the offered measures and configuration information required for using the offered measures.

12. The apparatus according to claim 11, wherein the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus at least:

to receive and process a response to the request for using a part of the spectrum of the second communication network, wherein the response indicates which part of the spectrum of the second communication network is granted to the request.

13. The apparatus according to claim 11 or 12, wherein the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus at least:

to conduct a processing related to configure the spectrum cooperation relationship related to the usage of the spectrum of the second communication network in a sharing manner by the first communication network.

14. The apparatus according to any of claims 11 to 13, wherein the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus at least:

to conduct a processing related to configure a function for enabling the provision of the service coordination information and network coordination information according to service coordination and network coordination rules agreed between the first communication network and the second communication network according in a spectrum sharing incentive agreement in advance to a request for using a part of the spectrum of the second communication network, the spectrum sharing incentive agreement defining rules for a compensation by communication load reduction enabled by the first communication network for a spectrum grant provided by the second communication network,

wherein the service coordination information is based on the spectrum sharing incentive agreement.

15. The apparatus according to any of claims 11 to 14, wherein

the network coordination information comprises at least one of

an indication of an identification and parameters of the part of the first communication network usable as a communication relay,

5 an indication of a communication area or cell with of the second communication network which a spectrum cooperation relationship is configured,

an indication of context information to be used for communication elements of the second communication network for accessing the part of the first communication network acting as a communication relay, and

10 an indication of connection parameters required for getting access to the part of the first communication network acting as a communication relay.

16. The apparatus according to any of claims 11 to 15, wherein the apparatus is comprised in a communication network control element or access point control element of the first communication network, wherein the second communication network is controlled  
15 by a communication network control element or operation and maintenance element, wherein the first and the second communication networks are cellular based wireless communication networks to which one or more communication elements comprising a user equipment or terminal device are connectable.

20 17. An apparatus comprising

at least one processor,

and

at least one memory for storing instructions to be executed by the processor, wherein

25 the at least one memory and the instructions are configured to, with the at least one processor, cause the apparatus at least:

to receive and process at least one of network coordination information and configuration information based on network coordination information related to a request for using a part of a spectrum of a second communication network by a first

communication network on the basis of a spectrum cooperation relationship configuration, the network coordination information indicating identification information identifying communication areas or cells of the first and second communication networks usable for measures offered by the first communication network allowing the second communication network to reduce a communication load by using a part of the first communication network as a communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network, and configuration information required for using the offered measures, and

to conduct a processing for establishing a radio bearer connection via a spectrum cooperation relationship link to a part of the first communication network to be used as a communication relay on the basis of the processing result of the network coordination information or the configuration information related to the network coordination information.

18. The apparatus according to claim 17, wherein the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus at least:

to receive data from a communication element of the second communication network via the spectrum cooperation relationship link from the part of the first communication network used as the communication relay and to cause forwarding of the received data from the communication element of the second communication network to a core network of the second communication network, and

to receive data directed to the communication element of the second communication network from the core network of the second communication network and to cause forwarding the data directed to the communication element via the spectrum cooperation relationship link to the part of the first communication network used as the communication relay.

19. The apparatus according to claim 17 or 18, wherein the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus at least:

to conduct a processing related to configure the spectrum cooperation relationship between the first communication network and the second communication network related to the usage of the spectrum of the second communication network in a sharing manner by the first communication network.

5

20. The apparatus according to any of claims 17 to 19, wherein the network coordination information comprises at least one of

an indication of an identification and parameters of the part of the first communication network usable as a communication relay,

10 an indication of a communication area or cell of the second communication network with which a spectrum cooperation relationship is configured,

an indication of context information to be used for communication elements of the second communication network for accessing the part of the first communication network acting as a communication relay, and

15 an indication of connection parameters required for getting access to the part of the first communication network acting as a communication relay, and

the configuration information related to the network coordination information comprises data being related to the usage of the part of the first communication network as a communication relay.

20

21. The apparatus according to any of claims 17 to 20, wherein the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus at least:

25 to receive and process an information indicating that a communication area or cell of the second communication network is used as an anchor point for the part of the first communication network acting as the communication relay for accessing the second communication network on the basis of the spectrum cooperation relationship, and an information about a switch of a communication connection of at least one selected communication element to the part of the first communication network acting as the  
30 communication relay.

22. The apparatus according to any of claims 17 to 21, wherein the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus at least:

5           to trigger, in the processing for establishing the radio bearer connection via the spectrum cooperation relationship link to the part of the first communication network to be used as a communication relay, the establishment of the bearer connection via the spectrum cooperation relationship link.

10   23. The apparatus according to claim 22, wherein the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus at least:

          to provide context information regarding at least one communication element of the second communication network to be switched to the part of the first communication  
15   network acting as the communication relay during the establishment of the bearer connection .

24. The apparatus according to any of claims 17 to 23, wherein the apparatus is comprised in a communication network control element or access point control element of  
20   the second communication network, wherein the first communication network is controlled by a communication network control element or operation and maintenance element, wherein the first and the second communication networks are cellular based wireless communication networks to which one or more communication elements comprising a user equipment or terminal device are connectable.

25

25. An apparatus comprising

at least one processor,

and

at least one memory for storing instructions to be executed by the processor, wherein

the at least one memory and the instructions are configured to, with the at least one processor, cause the apparatus at least:

5           to conduct a processing for establishing a communication connection to a communication element of a second communication network, wherein the establishment of the communication connection to the communication element of the second communication network is based on communication element specific context information assigned by the first communication network to communication elements of the second  
10 communication network for accessing a part of a first communication network which has to act as a communication relay allowing the second communication network to reduce a communication load by using the communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network,

15           to conduct a processing for establishing a radio bearer connection via a spectrum cooperation relationship link to an anchor node of the second communication network,

          to receive data from the communication element of the second communication network via the established communication connection and to cause, as the communication relay, forwarding of the received data from the communication element of  
20 the second communication network over the established radio bearer connection via the spectrum cooperation relationship link to the anchor node of the second communication network, and

          to receive data directed to the communication element of the second communication network from the anchor node of the second communication network over  
25 the established radio bearer connection via the spectrum cooperation relationship link and to cause forwarding, as the communication relay, the data directed to the communication element via the established communication connection to the communication element of the second communication network.

30   26. The apparatus according to claim 25, wherein the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus at least:

to conduct a processing related to configure the spectrum cooperation relationship between the first communication network and the second communication network related to the usage of the spectrum of the second communication network in a sharing manner by the first communication network.

5

27. The apparatus according to claim 25 or 26, wherein the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus at least:

10 to identify the communication element specific context information assigned by the first communication network to communication elements of the second communication network for accessing a part of a first communication network which has to act as a communication relay allowing the second communication network to reduce a communication load by using the communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first  
15 communication network on the basis of predefined network coordination information being included in a request for using a part of a spectrum of the second communication network by the first communication network, the network coordination information indicating identification information identifying communication areas or cells of the first and second communication networks usable for measures to reduce the communication load of the  
20 second communication network, and configuration information required for using the measures.

28. The apparatus according to any of claims 25 to 27, wherein the at least one memory and the instructions are further configured to, with the at least one processor, cause the  
25 apparatus at least:

to conduct the processing for establishing the radio bearer connection via the spectrum cooperation relationship link to the anchor node of the second communication network before conducting the processing for establishing the communication connection to the communication element of the second communication network, wherein the  
30 processing for establishing the radio bearer connection is triggered by the anchor node of the second communication network, and

to receive and process context information provided during the radio bearer establishment, the context information being related to at least one communication element of the second communication network establishing a communication connection for using a part of a first communication network as a communication relay.

5

29. The apparatus according to any of claims 25 to 27, wherein the at least one memory and the instructions are further configured to, with the at least one processor, cause the apparatus at least:

10 to conduct the processing for establishing the communication connection to the communication element of the second communication network before conducting the processing for establishing the radio bearer connection via the spectrum cooperation relationship link to the anchor node of the second communication network,

to trigger and conduct the processing for establishing the radio bearer connection via the spectrum cooperation relationship link, and

15 to receive and process information identifying a communication area or cell of the second communication network to be used as the anchor point of the second communication network.

20 30. The apparatus according to any of claims 25 to 29, wherein the apparatus is comprised in a communication network control element or access point control element of the first communication network, wherein the second communication network is controlled by a communication network control element or operation and maintenance element, wherein the first and the second communication networks are cellular based wireless communication networks to which one or more communication elements comprising a  
25 user equipment or terminal device are connectable.

31. A method comprising

30 receiving and processing a request for using a part of a spectrum of a second communication network by a first communication network on the basis of a spectrum cooperation relationship configuration,

receiving and processing service coordination information and network coordination information related to the request for using a part of the spectrum, the service coordination information indicating measures offered by the first communication network allowing the second communication network to reduce a communication load by using a part of the first communication network as a communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network, and the network coordination information indicating identification information identifying communication areas or cells of the first and second communication networks usable for the offered measures and configuration information required for using the offered measures, and

conducting a processing for service coordination and network coordination for reducing the communication load in the second communication network by using a part of the first communication network as a communication relay, on the basis of the processing result of the service coordination information and the network coordination information.

32. The method according to claim 31, further comprising

deciding which part of the spectrum of the second communication network is granted to the request,

causing to transmit a response to the request for using a part of the spectrum of the second communication network,

wherein the decision which part of the spectrum of the second communication network is granted and the transmission of the response to the request are executed before or after conducting the processing for service coordination and network coordination .

33. The method according to claim 31 or 32, further comprising

conducting a processing related to configure the spectrum cooperation relationship related to the usage of the spectrum of the second communication network in a sharing manner by the first communication network.

34. The method according to any of claims 31 to 33, further comprising

conducting a processing related to configure a function for enabling the processing for the service coordination and network coordination according to service coordination and network coordination rules agreed between the first communication network and the second communication network according in a spectrum sharing incentive agreement in advance to a request for using a part of the spectrum of the second communication network, the spectrum sharing incentive agreement defining rules for a compensation by communication load reduction enabled by the first communication network for a spectrum grant provided by the second communication network,

wherein the service coordination information is based on the spectrum sharing incentive agreement.

35. The method according to any of claims 31 to 34, wherein

the network coordination information comprises at least one of

an indication of an identification and parameters of the part of the first communication network usable as a communication relay,

an indication of a communication area or cell of the second communication network with which a spectrum cooperation relationship is configured,

an indication of context information to be used for communication elements of the second communication network for accessing the part of the first communication network acting as a communication relay, and

an indication of connection parameters required for getting access to the part of the first communication network acting as a communication relay.

36. The method according to any of claims 31 to 35, wherein the processing for service coordination and network coordination for reducing the communication load in the second communication network by using a part of the first communication network as a communication relay comprises

determining, on the basis of the processing result of the network coordination information, a communication area or cell of the second communication network involved in usage of the part of the first communication network as a communication relay,

providing configuration data based on the received network coordination  
5 information to communication network control elements of the determined communication area or cell of the second communication network, the configuration data being related to the usage of the part of the first communication network as a communication relay.

37. The method according to any of claims 31 to 36, wherein the processing for service  
10 coordination and network coordination for reducing the communication load in the second communication network by using a part of the first communication network as a communication relay comprises

initiating, on the basis of the network coordination information, a neighboring cell  
measurement on the basis of the identification information identifying communication  
15 areas or cells of the first communication network usable for the offered measures by at least one communication element of the second communication network,

receiving an processing a measurement report of the at least one communication  
element of the second communication network,

selecting at least one communication element on the basis of the measurement  
20 report and the network coordination information as using a part of the first communication network as a communication relay, and

instructing the at least one selected communication element to switch a  
communication connection to the part of the first communication network acting as a  
communication relay.

25  
38. The method according to claim 37, wherein the instruction to the at least one selected communication element further comprises information indicating a communication area or cell of the second communication network to be used as an anchor point for the part of the first communication network acting as the communication relay for accessing the second  
30 communication network on the basis of the spectrum cooperation relationship.

39. The method according to any of claims 31 to 38, wherein the processing for service coordination and network coordination for reducing the communication load in the second communication network by using a part of the first communication network as a communication relay comprises

informing a communication area or cell of the second communication network to be used as an anchor point for the part of the first communication network acting as the communication relay for accessing the second communication network on the basis of the spectrum cooperation relationship about a switch of a communication connection of at least one selected communication element to the part of the first communication network acting as a communication relay.

40. The method according to any of claims 31 to 39, wherein the method is implemented in a communication network control element or an operation and maintenance element of the second communication network, wherein the first communication network is controlled by another communication network control element or operation and maintenance element, wherein the first and the second communication networks are cellular based wireless communication networks to which one or more communication elements comprising a user equipment or terminal device are connectable.

41. A method comprising

requesting for using a part of a spectrum of a second communication network on the basis of a spectrum cooperation relationship configuration between a first communication network and the second communication network, and

providing service coordination information and network coordination information related to the request for using a part of the spectrum of the second communication network, the service coordination information indicating measures offered by the first communication network allowing the second communication network to reduce a communication load by using a part of the first communication network as a communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network, and the network

coordination information indicating identification information identifying communication areas or cells of the first and second communication networks usable for the offered measures and configuration information required for using the offered measures.

5 42. The method according to claim 41, further comprising

receiving and processing a response to the request for using a part of the spectrum of the second communication network, wherein the response indicates which part of the spectrum of the second communication network is granted to the request.

10 43. The method according to claim 41 or 42, further comprising

conducting a processing related to configure the spectrum cooperation relationship related to the usage of the spectrum of the second communication network in a sharing manner by the first communication network.

15 44. The method according to any of claims 41 to 43, further comprising

conducting a processing related to configure a function for enabling the provision of the service coordination information and network coordination information according to service coordination and network coordination rules agreed between the first communication network and the second communication network according in a spectrum sharing incentive agreement in advance to a request for using a part of the spectrum of the second communication network, the spectrum sharing incentive agreement defining rules for a compensation by communication load reduction enabled by the first communication network for a spectrum grant provided by the second communication network,

25 wherein the service coordination information is based on the spectrum sharing incentive agreement.

45. The method according to any of claims 41 to 44, wherein

the network coordination information comprises at least one of

an indication of an identification and parameters of the part of the first communication network usable as a communication relay,

an indication of a communication area or cell with of the second communication network which a spectrum cooperation relationship is configured,

5 an indication of context information to be used for communication elements of the second communication network for accessing the part of the first communication network acting as a communication relay, and

an indication of connection parameters required for getting access to the part of the first communication network acting as a communication relay.

10

46. The method according to any of claims 41 to 45, wherein the method is implemented in a communication network control element or access point control element of the first communication network, wherein the second communication network is controlled by a communication network control element or operation and maintenance element, wherein  
15 the first and the second communication networks are cellular based wireless communication networks to which one or more communication elements comprising a user equipment or terminal device are connectable.

47. A method comprising

20 receiving and processing at least one of network coordination information and configuration information based on network coordination information related to a request for using a part of a spectrum of a second communication network by a first communication network on the basis of a spectrum cooperation relationship configuration, the network coordination information indicating identification information identifying  
25 communication areas or cells of the first and second communication networks usable for measures offered by the first communication network allowing the second communication network to reduce a communication load by using a part of the first communication network as a communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network, and  
30 configuration information required for using the offered measures, and

conducting a processing for establishing a radio bearer connection via a spectrum cooperation relationship link to a part of the first communication network to be used as a communication relay on the basis of the processing result of the network coordination information or the configuration information related to the network coordination information.

48. The method according to claim 47, further comprising

receiving data from a communication element of the second communication network via the spectrum cooperation relationship link to the part of the first communication network used as the communication relay and causing forwarding of the received data from the communication element of the second communication network to a core network of the second communication network, and

receiving data directed to the communication element of the second communication network from the core network of the second communication network and causing forwarding the data directed to the communication element via the spectrum cooperation relationship link to the part of the first communication network used as the communication relay.

49. The method according to claim 47 or 48, further comprising

conducting a processing related to configure the spectrum cooperation relationship between the first communication network and the second communication network related to the usage of the spectrum of the second communication network in a sharing manner by the first communication network.

50. The method according to any of claims 47 to 49, wherein the network coordination information comprises at least one of

an indication of an identification and parameters of the part of the first communication network usable as a communication relay,

an indication of a communication area or cell of the second communication network with which a spectrum cooperation relationship is configured,

an indication of context information to be used for communication elements of the second communication network for accessing the part of the first communication network acting as a communication relay, and

5 an indication of connection parameters required for getting access to the part of the first communication network acting as a communication relay, and

the configuration information related to the network coordination information comprises data being related to the usage of the part of the first communication network as a communication relay.

10 51. The method according to any of claims 47 to 50, further comprising

receiving and processing an information indicating that a communication area or cell of the second communication network is used as an anchor point for the part of the first communication network acting as the communication relay for accessing the second communication network on the basis of the spectrum cooperation relationship, and an  
15 information about a switch of a communication connection of at least one selected communication element to the part of the first communication network acting as the communication relay.

52. The method according to any of claims 47 to 51, further comprising

20 triggering, in the processing for establishing the radio bearer connection via the spectrum cooperation relationship link to the part of the first communication network to be used as a communication relay, the establishment of the bearer connection via the spectrum cooperation relationship link.

25 53. The method according to claim 52, further comprising

providing context information regarding at least one communication element of the second communication network to be switched to the part of the first communication network acting as the communication relay during the establishment of the bearer connection.

54. The method according to any of claims 47 to 53, wherein the method is implemented in a communication network control element or access point control element of the second communication network, wherein the first communication network is controlled by a communication network control element or operation and maintenance element, wherein the first and the second communication networks are cellular based wireless communication networks to which one or more communication elements comprising a user equipment or terminal device are connectable.

55. A method comprising

conducting a processing for establishing a communication connection to a communication element of a second communication network, wherein the establishment of the communication connection to the communication element of the second communication network is based on communication element specific context information assigned by the first communication network to communication elements of the second communication network for accessing a part of a first communication network which has to act as a communication relay allowing the second communication network to reduce a communication load by using the communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network,

conducting a processing for establishing a radio bearer connection via a spectrum cooperation relationship link to an anchor node of the second communication network,

receiving data from the communication element of the second communication network via the established communication connection and causing, as the communication relay, forwarding of the received data from the communication element of the second communication network over the established radio bearer connection via the spectrum cooperation relationship link to the anchor node of the second communication network, and

receiving data directed to the communication element of the second communication network from the anchor node of the second communication network over the established radio bearer connection via the spectrum cooperation relationship link and causing forwarding, as the communication relay, the data directed to the communication

element via the established communication connection to the communication element of the second communication network.

56. The method according to claim 55, further comprising

5       conducting a processing related to configure the spectrum cooperation relationship between the first communication network and the second communication network related to the usage of the spectrum of the second communication network in a sharing manner by the first communication network.

10   57. The method according to claim 55 or 56, further comprising

          identifying the communication element specific context information assigned by the first communication network to communication elements of the second communication network for accessing a part of a first communication network which has to act as a communication relay allowing the second communication network to reduce a communication load by using the communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network on the basis of predefined network coordination information being used for a request for using a part of a spectrum of the second communication network by the first communication network, the network coordination information indicating identification information identifying communication areas or cells of the first and second communication networks usable for measures to reduce the communication load of the second communication network, and configuration information required for using the measures.

25   58. The method according to any of claims 55 to 57, further comprising

          conducting the processing for establishing the radio bearer connection via the spectrum cooperation relationship link to the anchor node of the second communication network before conducting the processing for establishing the communication connection to the communication element of the second communication network, wherein the processing for establishing the radio bearer connection is triggered by the anchor node of the second communication network, and

receiving and processing context information provided during the radio bearer establishment, the context information being related to at least one communication element of the second communication network establishing a communication connection for using a part of a first communication network as a communication relay.

5

59. The method according to any of claims 55 to 57, further comprising

conducting the processing for establishing the communication connection to the communication element of the second communication network before conducting the processing for establishing the radio bearer connection via the spectrum cooperation relationship link to the anchor node of the second communication network,

10

triggering and conducting the processing for establishing the radio bearer connection via the spectrum cooperation relationship link, and

15

receiving and processing information identifying a communication area or cell of the second communication network to be used as the anchor point of the second communication network.

20

60. The method according to any of claims 55 to 59, wherein the method is implemented in a communication network control element or access point control element of the first communication network, wherein the second communication network is controlled by a communication network control element or operation and maintenance element, wherein the first and the second communication networks are cellular based wireless communication networks to which one or more communication elements comprising a user equipment or terminal device are connectable.

25

61. A computer program product for a computer, comprising software code portions for performing the steps of any of claims 31 to 40, any of claims 41 to 46, any of claims 47 to 54 or any of claims 55 to 60, when said product is run on the computer.

62. A computer program product, comprising a computer usable medium having a computer readable program code embodied therein, the computer readable program code adapted to execute a process comprising:

5 to receive and process a request for using a part of a spectrum of a second communication network by a first communication network on the basis of a spectrum cooperation relationship configuration,

10 to receive and process service coordination information and network coordination information related to the request for using a part of the spectrum, the service coordination information indicating measures offered by the first communication network allowing the second communication network to reduce a communication load by using a part of the first communication network as a communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network, and the network coordination information indicating identification information identifying communication areas or cells of the first and second communication networks  
15 usable for the offered measures and configuration information required for using the offered measures, and

20 to conduct a processing for service coordination and network coordination for reducing the communication load in the second communication network by using a part of the first communication network as a communication relay, on the basis of the processing result of the service coordination information and the network coordination information.

63. A computer program product, comprising a computer usable medium having a computer readable program code embodied therein, the computer readable program code adapted to execute a process comprising:

25 to request for using a part of a spectrum of a second communication network on the basis of a spectrum cooperation relationship configuration between a first communication network and the second communication network, and

30 to provide service coordination information and network coordination information related to the request for using a part of the spectrum of the second communication network, the service coordination information indicating measures offered by the first communication network allowing the second communication network to reduce a communication load by using a part of the first communication network as a

communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network, and the network coordination information indicating identification information identifying communication areas or cells of the first and second communication networks usable for the offered  
5 measures and configuration information required for using the offered measures.

64. A computer program product, comprising a computer usable medium having a computer readable program code embodied therein, the computer readable program code adapted to execute a process comprising:

10 to receive and process at least one of network coordination information and configuration information based on network coordination information related to a request for using a part of a spectrum of a second communication network by a first communication network on the basis of a spectrum cooperation relationship configuration, the network coordination information indicating identification information identifying  
15 communication areas or cells of the first and second communication networks usable for measures offered by the first communication network allowing the second communication network to reduce a communication load by using a part of the first communication network as a communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network, and  
20 configuration information required for using the offered measures, and

to conduct a processing for establishing a radio bearer connection via a spectrum cooperation relationship link to a part of the first communication network to be used as a communication relay on the basis of the processing result of the network coordination information or the configuration information related to the network coordination  
25 information.

65. A computer program product, comprising a computer usable medium having a computer readable program code embodied therein, the computer readable program code adapted to execute a process comprising:

30 to conduct a processing for establishing a communication connection to a communication element of a second communication network, wherein the establishment of the communication connection to the communication element of the second

communication network is based on communication element specific context information assigned by the first communication network to communication elements of the second communication network for accessing a part of a first communication network which has to act as a communication relay allowing the second communication network to reduce a communication load by using the communication relay as compensation for allowing to use a part of the spectrum of the second communication network by the first communication network,

to conduct a processing for establishing a radio bearer connection via a spectrum cooperation relationship link to an anchor node of the second communication network,

to receive data from the communication element of the second communication network via the established communication connection and to cause, as the communication relay, forwarding of the received data from the communication element of the second communication network over the established radio bearer connection via the spectrum cooperation relationship link to the anchor node of the second communication network, and

to receive data directed to the communication element of the second communication network from the anchor node of the second communication network over the established radio bearer connection via the spectrum cooperation relationship link and to cause forwarding, as the communication relay, the data directed to the communication element via the established communication connection to the communication element of the second communication network.

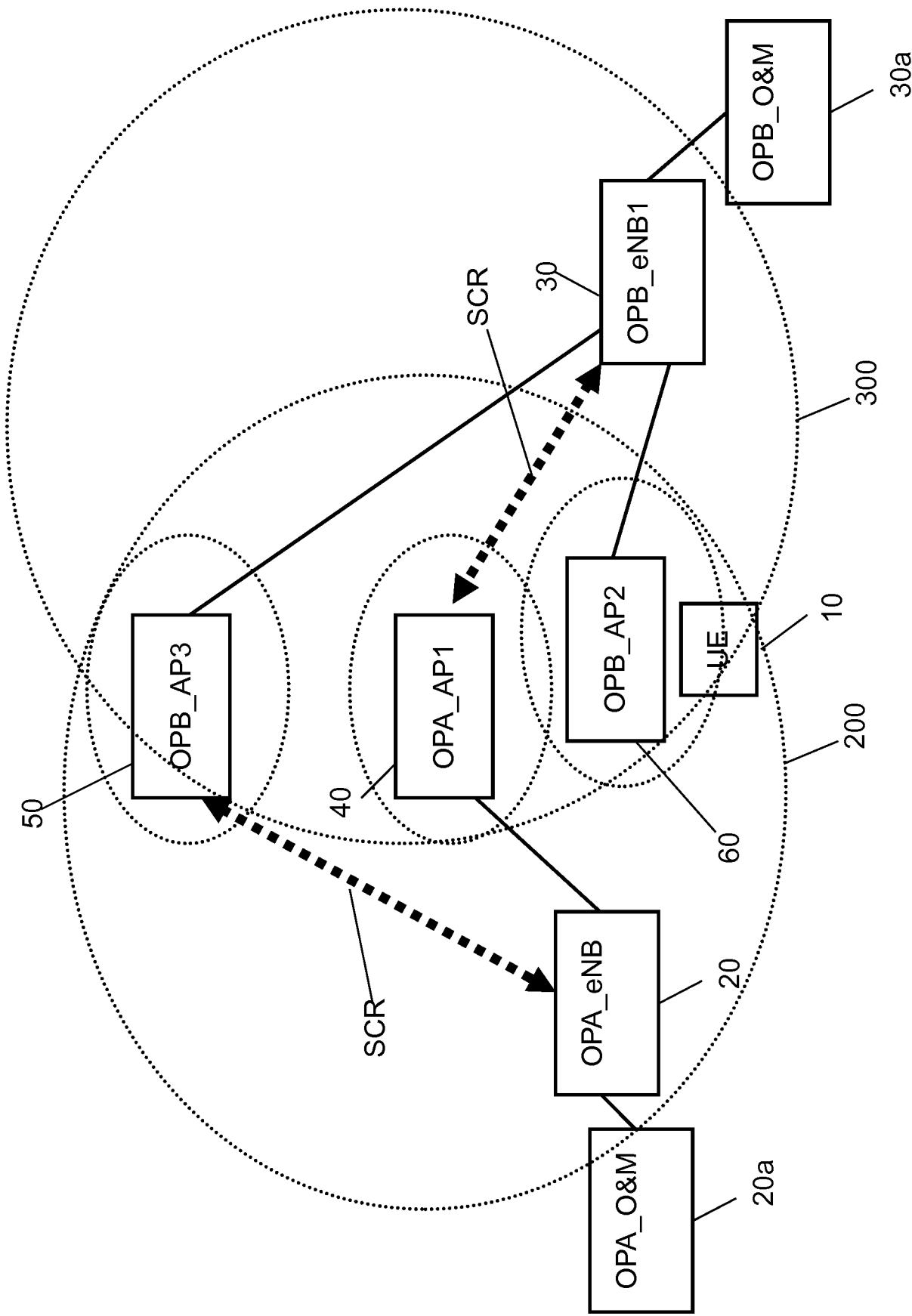


Fig. 1

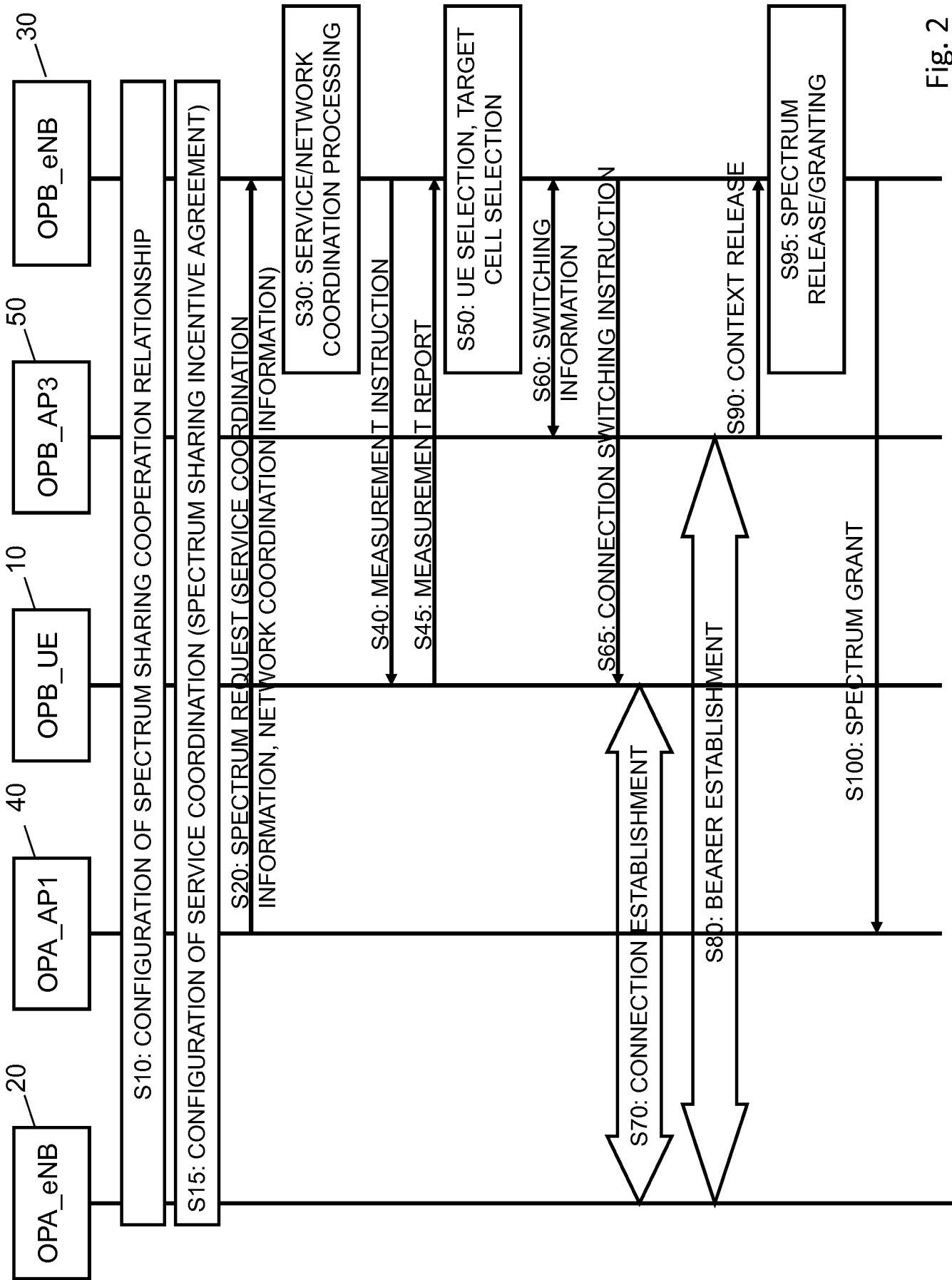


Fig. 2

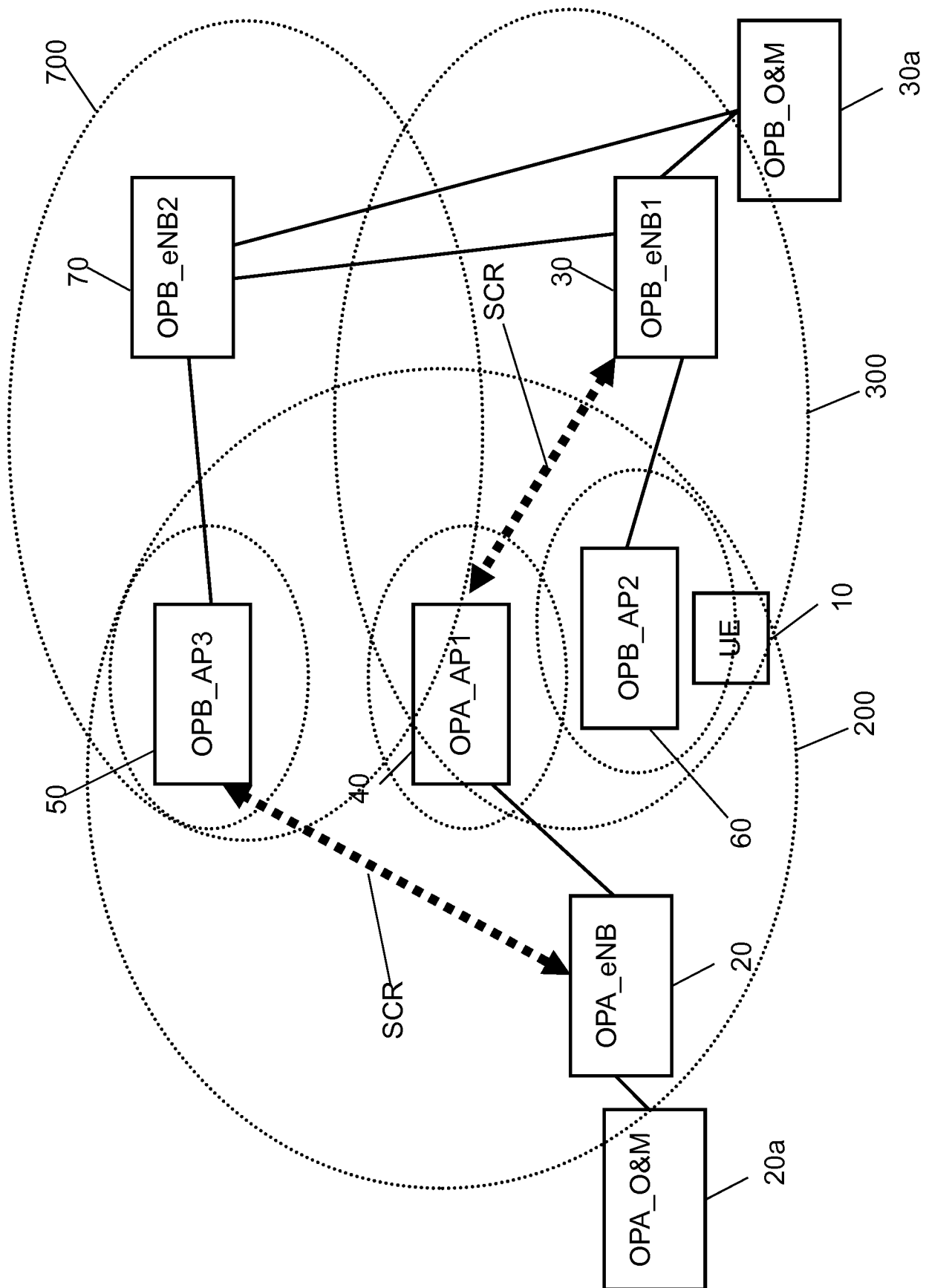


Fig. 3

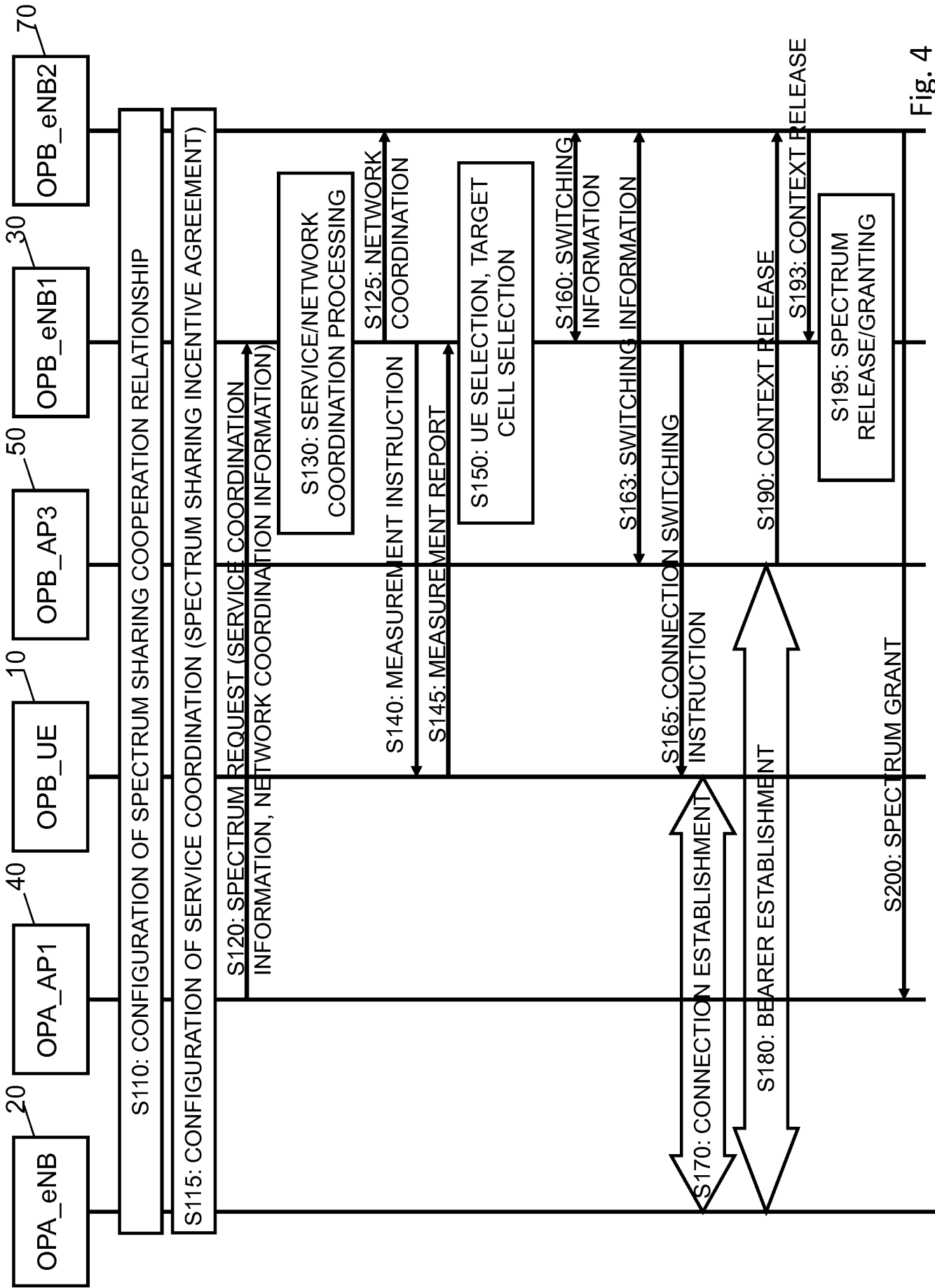


Fig. 4

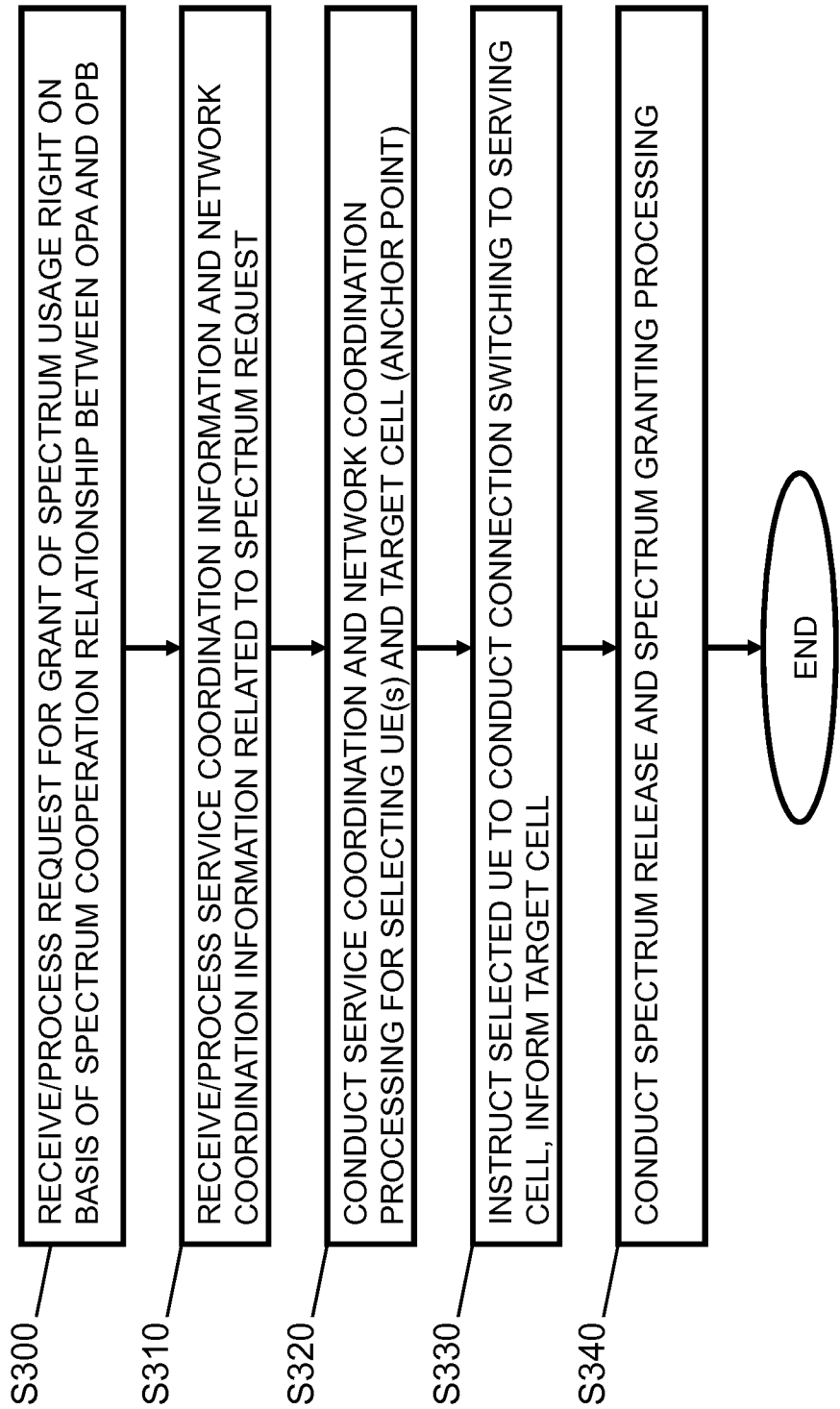


Fig. 5



Fig. 6

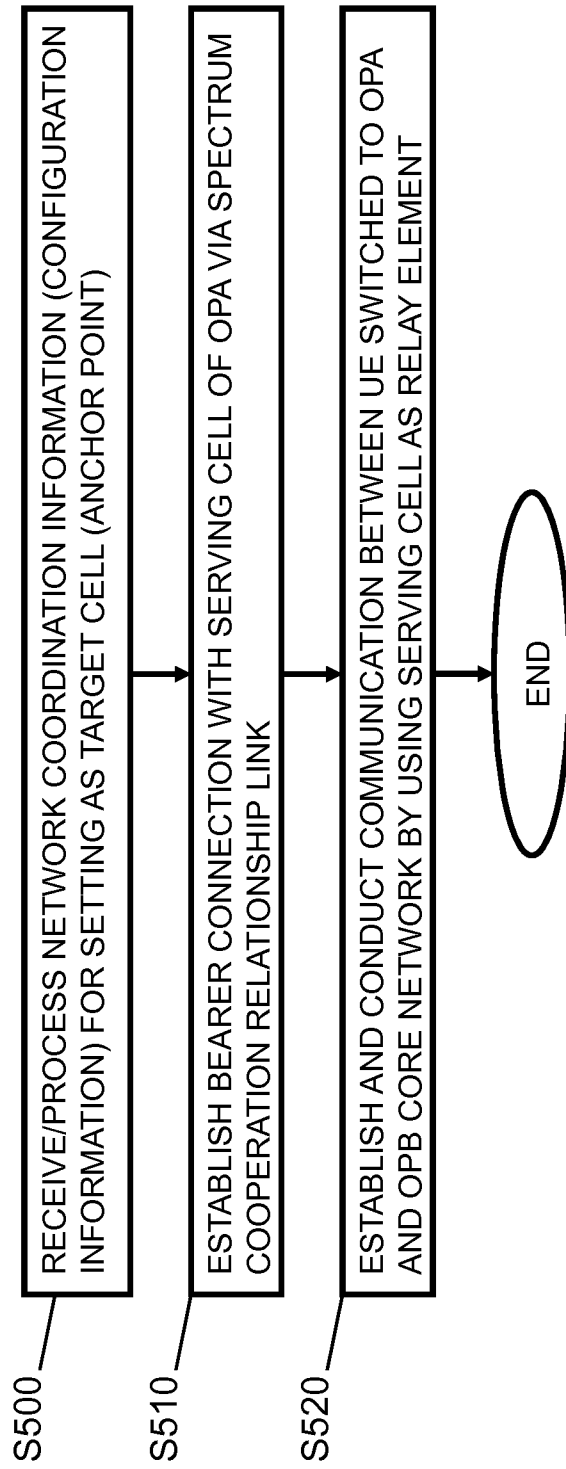


Fig. 7

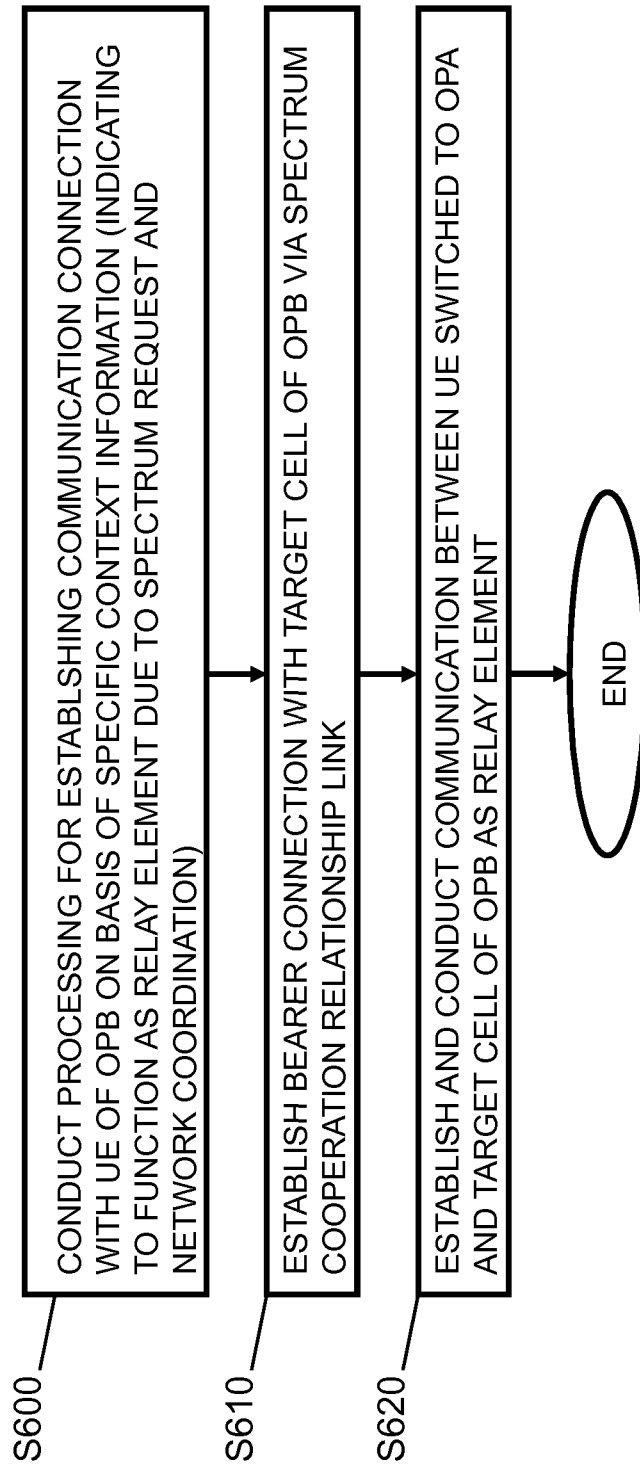


Fig. 8

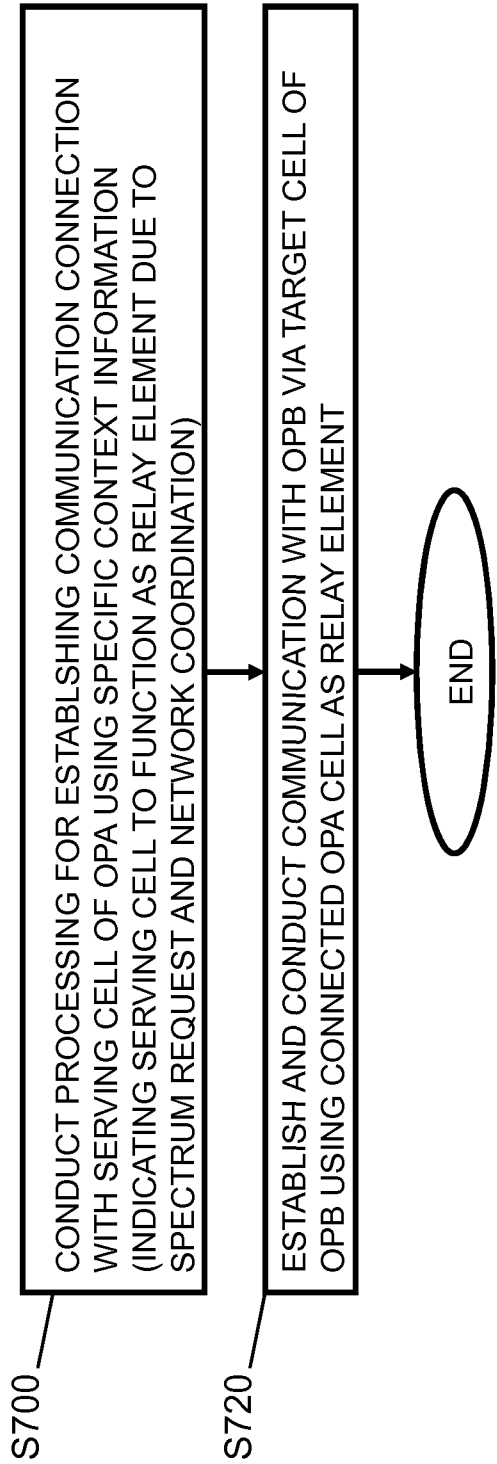


Fig. 9

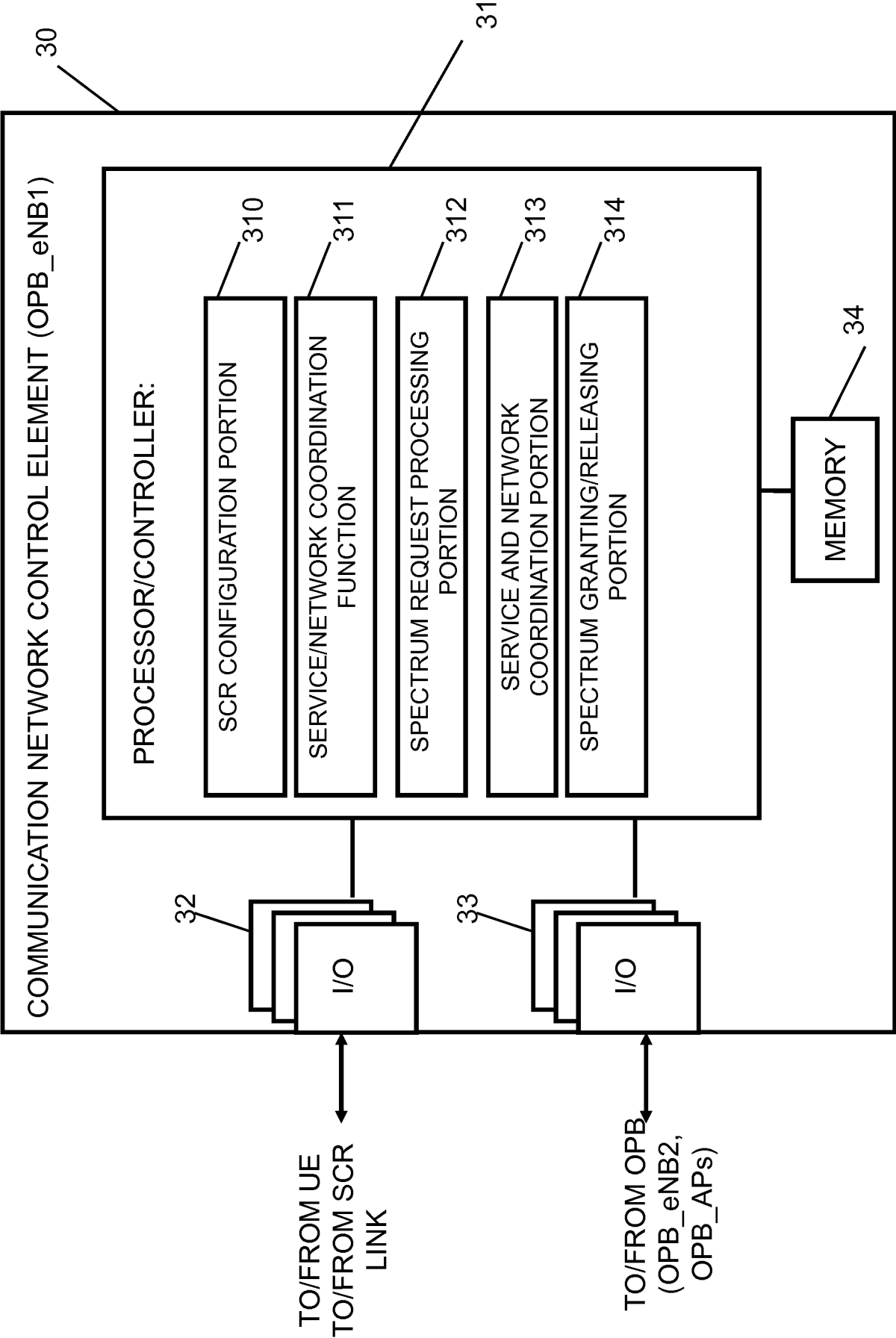


Fig. 10

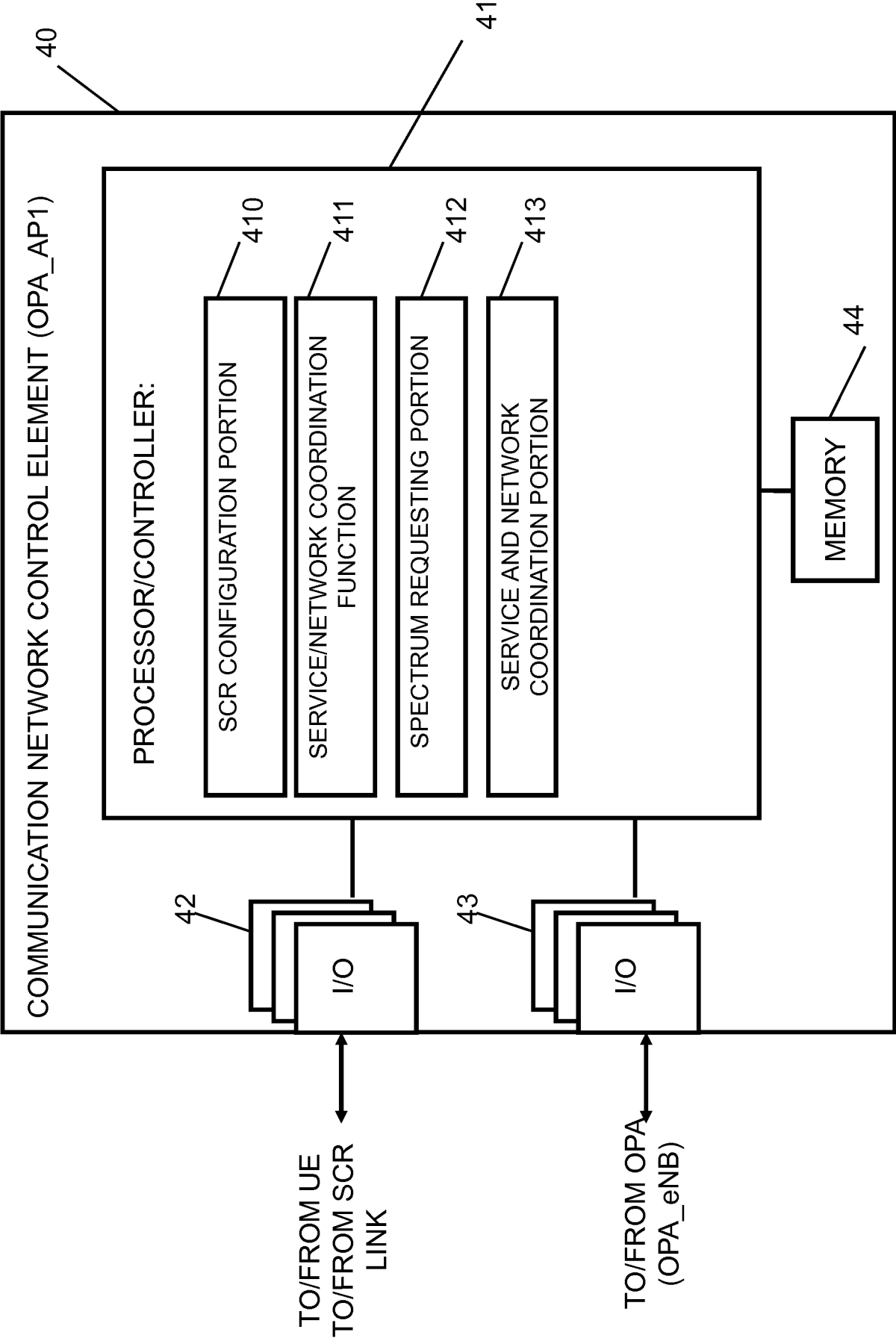


Fig. 11

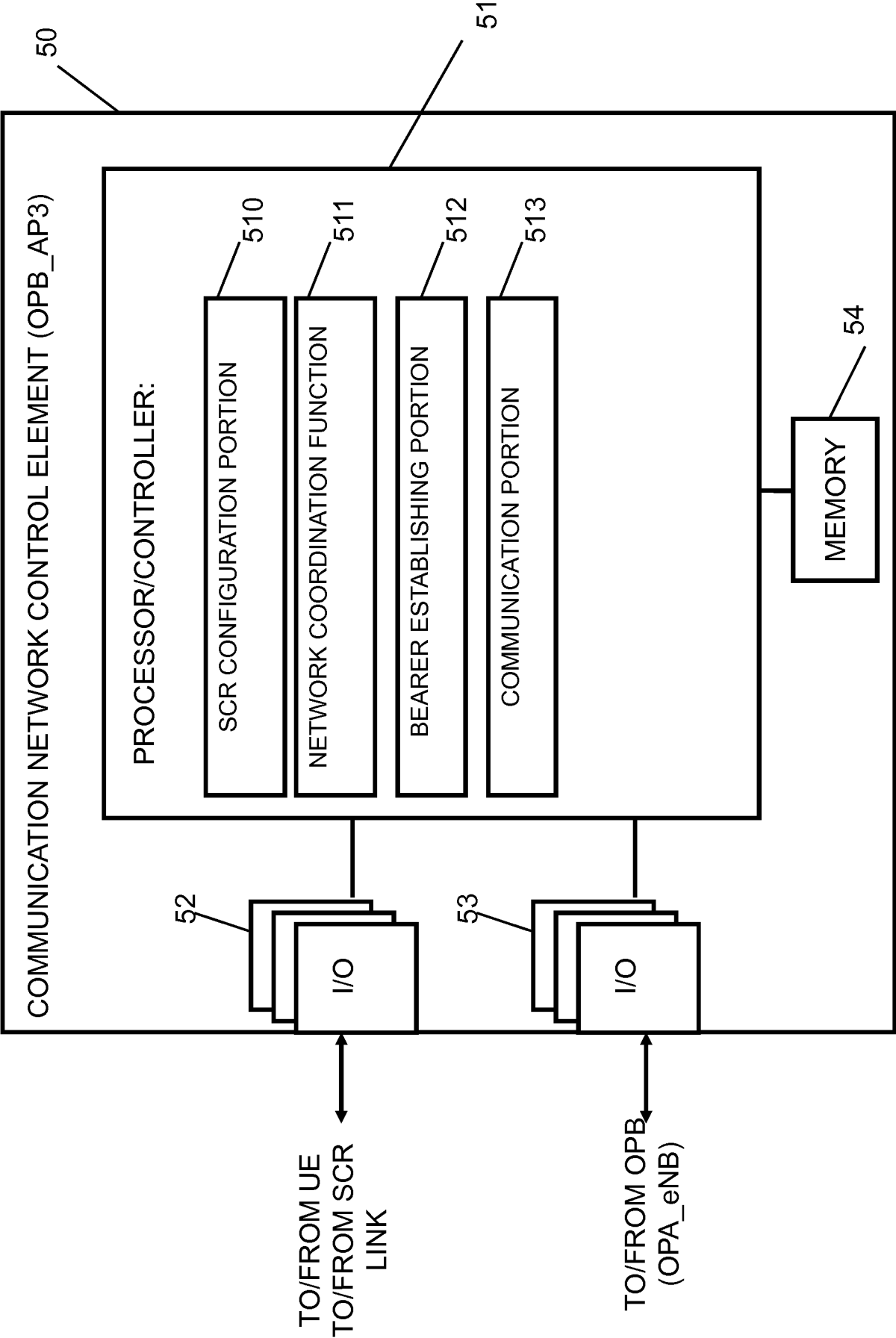


Fig. 12

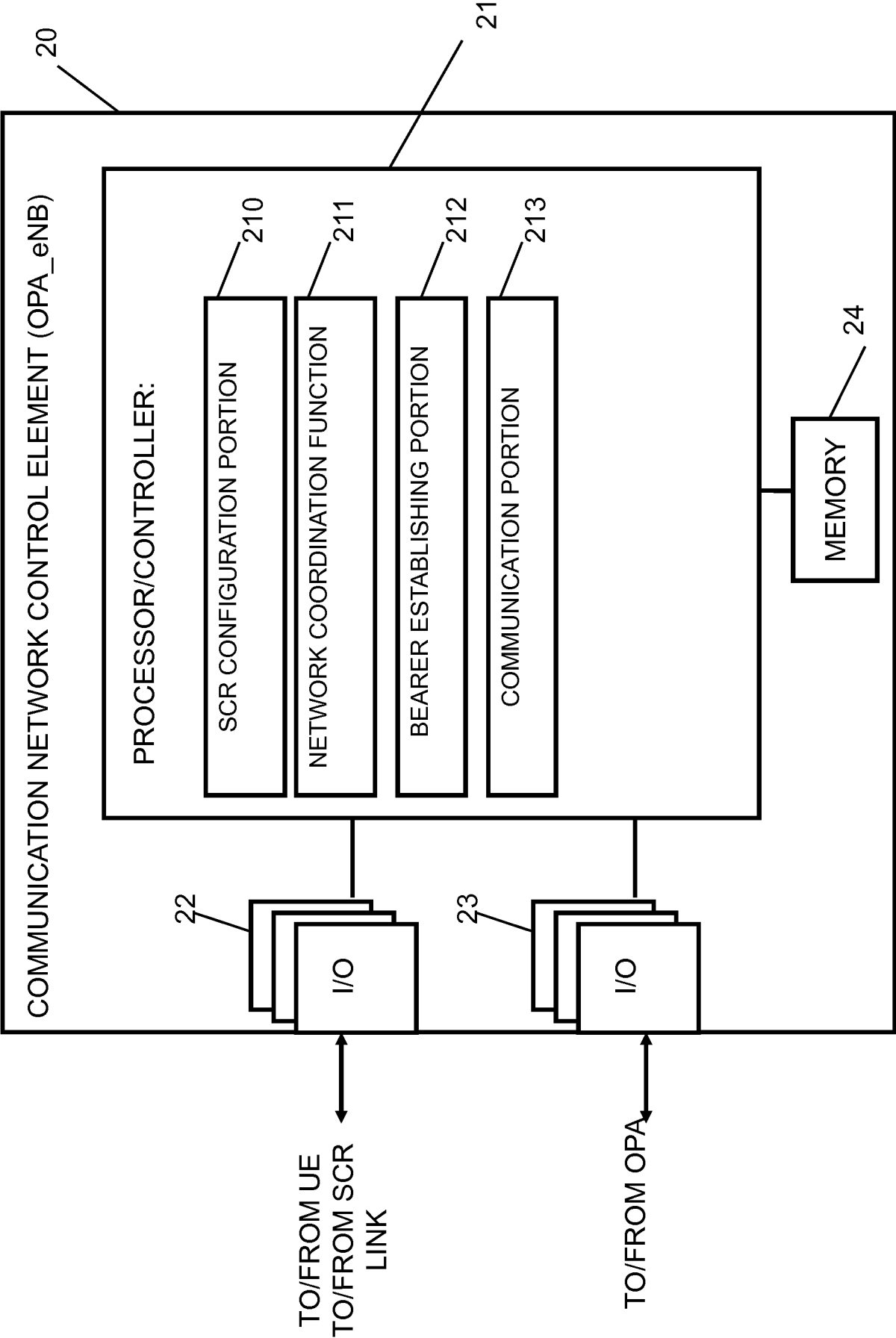


Fig. 13

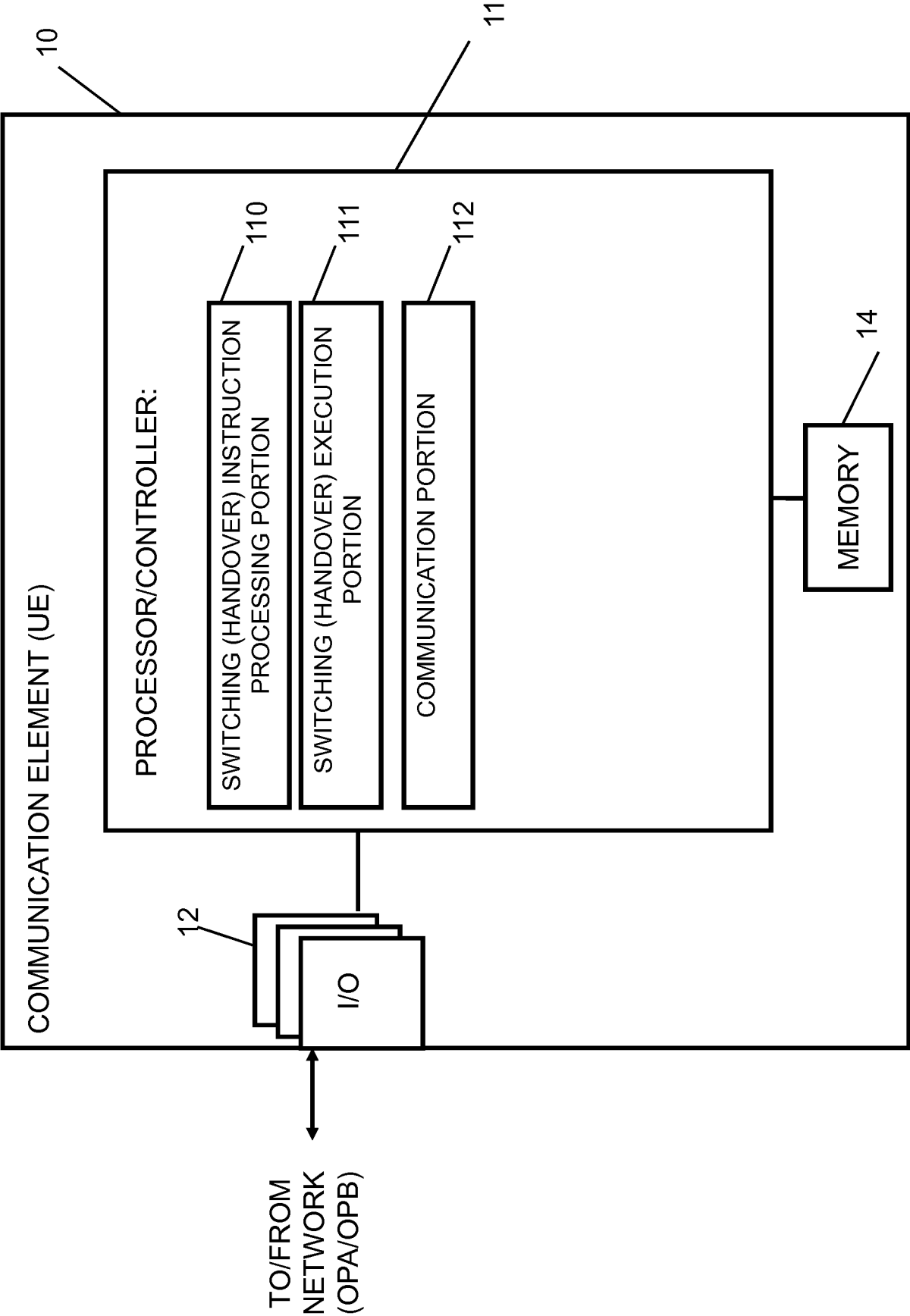


Fig. 14

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/EP2013/066997

## Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2. ☒ claims Nos, 17-30, 47-61, 64, 65  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:  
see FURTHER INFORMATION sheet PCT/ISA/210
  
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
  
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
  
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos. :
  
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos. :

### Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☒ No protest accompanied the payment of additional search fees.

## INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2013/066997

## A. CLASSIFICATION OF SUBJECT MATTER

INV. H04W16/14

ADD. H04W84/04 H04W92/10 H04W92/20

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

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

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

EPO-Internal , WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                 | Relevant to claim No.    |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| X         | US 2013/090124 AI (PANCHAL JIGNESH S [US] ET AL) 11 April 2013 (2013-04-11)<br><br>abstract<br>paragraph [0006] - paragraph [0009]<br>paragraph [0018] - paragraph [0119]<br>figures<br><br>-----  | 1-16,<br>31-46,<br>62,63 |
| A         | US 2006/154668 AI (LI JUN [US] ET AL) 13 July 2006 (2006-07-13)<br><br>abstract<br>paragraph [0004] - paragraph [0007]<br>paragraph [0014] - paragraph [0020]<br>figures<br><br>-----<br><br>-/- . | 1-16,<br>31-46,<br>62,63 |



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

"&amp;" document member of the same patent family

Date of the actual completion of the international search

30 July 2014

Date of mailing of the international search report

07/08/2014

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040,  
Fax: (+31-70) 340-3016

Authorized officer

Agui I ar Cabarrus , E

## INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2013/066997

| C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT |                                                                                                                                                                                                                                                                                                                                                                                                                       |                          |
|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| Category*                                            | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                                                                                                                                                                                                                    | Relevant to claim No.    |
| A                                                    | <p>US 2013/095826 AI (VRBASKI MI RA [CA] ET AL) 18 April 2013 (2013-04-18)</p> <p>abstract<br/> paragraph [0004] - paragraph [0016]<br/> paragraph [0026] - paragraph [0043]<br/> figures</p> <p>-----</p>                                                                                                                                                                                                            | 1-16,<br>31-46,<br>62,63 |
| A                                                    | <p>KLAUS HUGL: "Meeting the Challenges for Future wireless Communication Needs", INTERNET CITATION, 8 May 2012 (2012-05-08), pages 1-18, XP002693254,<br/> Retrieved from the Internet:<br/> URL: <a href="http://www.ove.at/akademie/kol112/KlausHugl_BonekKolloquium.pdf">http://www.ove.at/akademie/kol112/KlausHugl_BonekKolloquium.pdf</a><br/> [retrieved on 2013-03-04]<br/> page 5 - page 17</p> <p>-----</p> | 1-16,<br>31-46,<br>62,63 |
| A                                                    | <p>wo 2010/133239 AI (ERICSSON TELEFON AB LM [SE]; PERKHUN HEIKO [DE]; VORWERK MARC [DE]; M) 25 November 2010 (2010-11-25)<br/> abstract<br/> page 3, line 34 - page 7, line 24<br/> page 9, line 29 - page 22, line 2<br/> figures</p> <p>-----</p>                                                                                                                                                                  | 1-16,<br>31-46,<br>62,63 |
| A                                                    | <p>wo 2011/020514 AI (ERICSSON TELEFON AB LM [SE]; LOPEZ NIETO ANA MARIA [ES]; CASTRO FABIA) 24 February 2011 (2011-02-24)<br/> abstract<br/> page 8, line 2 - page 9, line 9<br/> page 10, line 4 - page 16, line 36<br/> figures</p> <p>-----</p>                                                                                                                                                                   | 1-16,<br>31-46,<br>62,63 |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2013/066997

| Patent document<br>cited in search report |            |    | Publication<br>date | Patent family<br>member(s) |             |    | Publication<br>date |
|-------------------------------------------|------------|----|---------------------|----------------------------|-------------|----|---------------------|
| US                                        | 2013090124 | AI | 11-04-2013          | US                         | 2013090124  | AI | 11-04-2013          |
|                                           |            |    |                     | US                         | 2014056254  | AI | 27-02-2014          |
| -----                                     |            |    |                     |                            |             |    |                     |
| US                                        | 2006154668 | AI | 13-07 -2006         | NONE                       |             |    |                     |
| -----                                     |            |    |                     |                            |             |    |                     |
| US                                        | 2013095826 | AI | 18-04 -2013         | CN                         | 103891347   | A  | 25-06-2014          |
|                                           |            |    |                     | EP                         | 2769580     | AI | 27-08-2014          |
|                                           |            |    |                     | KR                         | 20140078668 | A  | 25-06-2014          |
|                                           |            |    |                     | US                         | 2013095826  | AI | 18-04-2013          |
|                                           |            |    |                     | WO                         | 2013056368  | AI | 25-04-2013          |
| -----                                     |            |    |                     |                            |             |    |                     |
| Wo                                        | 2010133239 | AI | 25-11 -2010         | EP                         | 2433406     | AI | 28-03-2012          |
|                                           |            |    |                     | JP                         | 5367909     | B2 | 11-12-2013          |
|                                           |            |    |                     | JP                         | 2012527799  | A  | 08-11-2012          |
|                                           |            |    |                     | US                         | 2012185578  | AI | 19-07-2012          |
|                                           |            |    |                     | WO                         | 2010133239  | AI | 25-11-2010          |
| -----                                     |            |    |                     |                            |             |    |                     |
| Wo                                        | 2011020514 | AI | 24-02 -2011         | EP                         | 2467971     | AI | 27-06-2012          |
|                                           |            |    |                     | JP                         | 5523569     | B2 | 18-06-2014          |
|                                           |            |    |                     | JP                         | 2013502786  | A  | 24-01-2013          |
|                                           |            |    |                     | US                         | 2012210003  | AI | 16-08-2012          |
|                                           |            |    |                     | WO                         | 2011020514  | AI | 24-02-2011          |
| -----                                     |            |    |                     |                            |             |    |                     |

## FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 17-30, 47-61, 64, 65

Although claims 1, 11, 17 and 25 have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is sought and in respect of the terminology used for the features of that subject-matter.

The aforementioned claims therefore lack conciseness, Article 6 PCT. Moreover, lack of clarity of the claims as a whole arises, since the plurality of independent claims makes it difficult, if not impossible, to determine the matter for which protection is sought, and places an undue burden on others seeking to establish the extent of the protection.

The same objection applies for the independent method claims 31, 41, 47 and 55 and for the independent computer program claims 61 to 65.

The Applicant was requested in a communication dated 10.04.2014 to state whether apparatus claim 1 or claim 11 or claim 17 or claim 25 and method claim 31 or claim 41 or claim 47 or claim 55 and computer program claim 61 or claim 62 or claim 63 or claim 64 or claim 65 together with their dependent claims should be subject of the search.

Since the Applicant did not answer, no search report was established for claims 17 to 30, 47 to 61, 64 and 65, Article 17(2) (a) (ii) PCT.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guidelines C-IV, 7.2), should the problems which led to the Article 17(2) declaration be overcome.