

(51) International Patent Classification:
H04W 72/08 (2009.01)(21) International Application Number:
PCT/CN2013/071546(22) International Filing Date:
7 February 2013 (07.02.2013)

(25) Filing Language: English

(26) Publication Language: English

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(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, KM, 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, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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

[Continued on next page]

(54) Title: POWER SAVING MANAGEMENT IN MULTIPLE CONNECTION TYPE COMMUNICATION

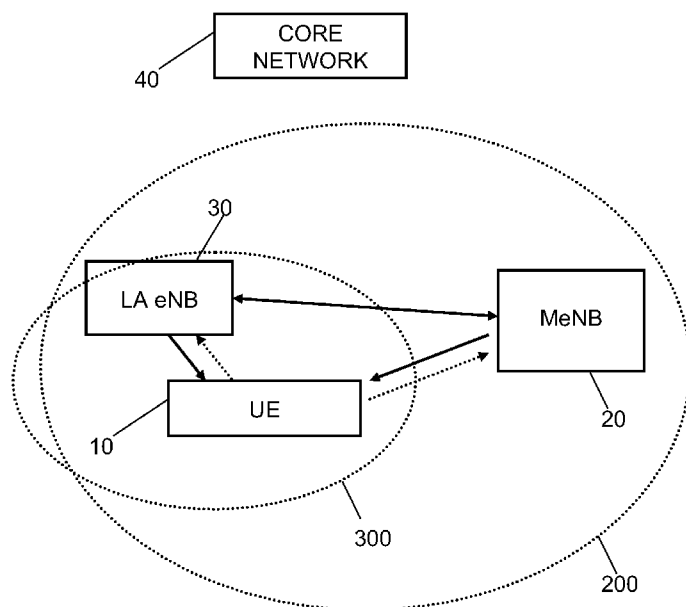


Fig. 1

(57) Abstract: There is proposed a mechanism for managing a power saving mode in a multiple connection type communication, such as a dual connection type communication with a first link between a UE and a macro cell and a second link between the UE and a LA cell. A power saving management procedure is proposed where for one link of the multiple connection type communication, such as the second link, a power saving mode is to be entered by the UE. In the power saving management procedure, a power saving control measure to be used for the second link is set by using information related to a power saving control measure used for the first link and/or a signaling conducted on the first link.



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, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

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

POWER SAVING MANAGEMENT IN MULTIPLE CONNECTION TYPE COMMUNICATION

5 DESCRIPTION

BACKGROUND OF THE INVENTION

Field of the invention

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The present invention relates to a power saving management in multiple connection type communication scenarios. In particular, the present invention is directed to apparatuses, methods and computer program products by means of which power saving modes for network elements in a multiple connection type communication scenario, such as a dual connection type communication with a first link between a UE and a macro cell and a second link between the UE and a LA cell are provided.

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Related background Art

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Prior art which is related to this technical field can e.g. be found in technical specifications according to 3GPP TS 36.300 (e.g. version 11.4.0), 3GPP TS 36.331 (e.g. version 11.2.0) and 3GPP TS 36.321 (e.g. version 11.1.0).

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

BS:	base station
CA:	carrier aggregation
30 CPU:	central processing unit
CSI:	channel state information
DL:	downlink
DRB:	(user) data radio bearer
DTX:	discontinuous transmission
35 eNB:	evolved node B

LA: local area
 LAeNB: LA eNB (eNB controlling LA cell)

LTE: Long Term Evolution
 5 LTE-A: LTE Advanced
 MAC: medium access control
 MeNB: macro eNB (eNB controlling macro cell)
 MME: mobility management entity
 PDCCH: physical downlink control channel
 10 PDSCH: physical downlink shared channel
 RB: resource blocks
 RF: radio frequency
 Scell: secondary cell
 SFN: system frame number
 15 S-GW: serving gateway
 SRB: signaling resource block
 UE: user equipment
 UL: uplink

20 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) communication networks like the Universal Mobile
 25 Telecommunications System (UMTS), enhanced communication networks based e.g. on LTE, 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 Evolutions (EDGE), or other wireless communication system, such as the
 30 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
 35 Generation Partnership 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.

5 A new development of communication network systems is the implementation of heterogeneous networks consisting of e.g. a "normal" communication cell (referred to as macro cell) and plural small cells (referred to as Scells or LA cells) which allow a better coverage and possibly outsourcing options for a communication originally conducted in the macro cell to one of the LA cells, which may be connected to the network e.g. by a
10 backhaul network offering higher capacity, or the like. Communication conducted in the small cells can also be seen as local area communication.

By means of the implementation of the heterogeneous networks, which results also in a reduction of cell sizes, the growing demand for wireless
15 data service expected in the future can be served. Among those advanced technologies proposed to meet the challenging request, reducing the cell size is one of the most prominent one.

On approach using the heterogeneous network structure is a so-called dual
20 connection type communication which is in particular useful in LA network environments (also referred to as inter-eNB CA, U-C plane split, multi-stream etc.). In the dual connection type communication, a UE is connected to macro cell (i.e. to a MeNB) and to a LA cell (i.e. LAeNB) simultaneously. By means of this, a distribution of traffic and load for a communication
25 connection is possible. For example, the MeNB is configured to represent a main control instance, e.g. for transmission of system information, basic RRC signalling, for controlling mobility issues of the UE (which allows e.g. to avoid unnecessary handover procedures and reduces such a signalling load when the UE is moving among different LA cells), and the like. On the other
30 hand, MeNB is able to offload a great amount of data transmission towards the LA cell. Hence, the UE can be provided with a high data rate in the LA cell while at the same time a comparable low transmission power (due to the probably smaller distance to the LAeNB compared to the MeNB) is sufficient.

35 When implementing the dual connection type communication, it is also

necessary to consider power efficiency issues, which is required for achieving a higher capacity and reliability. For example, when the dual connection type communication is established in the UE side, the UE is able to offload a great amount of traffic to the LA side, which requires less power than using the macro link. At the same time, the macro link can be switched e.g. in an IDLE or long DRX mode to save power. That is, dual connection is inherently more power efficient than single macro link when there is high traffic load.

However, the situation may be different when the UE has low load or when there is even no traffic. In this case, the dual connection type communication requires a high amount of extra power compare to the single connection type communication. Such an extra power consumption for the dual connection type communication limits the benefit thereof and is such not desired.

SUMMARY OF THE INVENTION

Examples of embodiments of the invention provide an apparatus, method and computer program product by means of which an enhanced power saving management in multiple connection type communication scenarios is provided. Specifically, according to some examples of embodiments of the invention, an apparatus, method and computer program product are provided by means of which power saving modes for network elements in a multiple connection type communication scenario, such as a dual connection type communication with a first link between a UE and a macro cell and a second link between the UE and a LA cell are provided which allow to avoid an unnecessary power waste.

This is achieved by the measures defined in the appended claims.

According to an example of an embodiment of the proposed solution, there is provided, for example, an apparatus comprising at least one processor; and at least one memory including computer program code; wherein the at least one memory and the computer program code are configured, with the

at least one processor, to cause the apparatus at least to perform a power saving management control function configured to control a power saving management procedure usable for a multiple connection type communication, the multiple connection type communication including simultaneously at least a first link between a communication element and a first communication network control element and a second link between the communication element and a second communication network control element, wherein the power saving management procedure comprises setting a power saving control measure to be used for the second link by using at least one of information related to a power saving control measure used for the first link and a signaling conducted on the first link.

Furthermore, according to an example of an embodiment of the proposed solution, there is provided, for example, a method comprising controlling a power saving management procedure usable for a multiple connection type communication, the multiple connection type communication including simultaneously at least a first link between a communication element and a first communication network control element and a second link between the communication element and a second communication network control element, wherein the power saving management procedure comprises setting a power saving control measure to be used for the second link by using at least one of information related to a power saving control measure used for the first link and a signaling conducted on the first link.

In addition, according to an example of an embodiment of the proposed solution, there is provided, for example 63. An apparatus comprising at least one processor; and at least one memory including computer program code; wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus at least to perform a power saving management function configured to conduct a power saving management procedure usable for a multiple connection type communication, the multiple connection type communication including simultaneously at least a first link between a communication element and a first communication network control element and a second link between the communication element and a second communication network control element, wherein the power saving management procedure comprises

setting a power saving control measure to be used for the second link by using at least one of information related to a power saving control measure used for the first link and a signaling conducted on the first link, wherein the power saving management function is further configured to execute the power saving control measure set by the power saving management procedure.

Moreover, according to an example of an embodiment of the proposed solution, there is provided, for example a method comprising conducting a power saving management procedure usable for a multiple connection type communication, the multiple connection type communication including simultaneously at least a first link between a communication element and a first communication network control element and a second link between the communication element and a second communication network control element, wherein the power saving management procedure comprises setting a power saving control measure to be used for the second link by using at least one of information related to a power saving control measure used for the first link and a signaling conducted on the first link the method further comprising executing the power saving control measure set by the power saving management procedure.

In addition, according to some examples of embodiments, 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.

According to some example embodiments of the invention, it is possible to provide an improved power saving management in multiple connection type communication scenarios. Specifically, according to some examples of embodiments of the invention, a multiple connection type communication scenario, such as a dual connection type communication, the power

efficiency of the UE in e.g. a dual connection type communication can be improved. Furthermore, it is possible to decrease an impact on the core network side when conducting a power saving management according to some examples of embodiments of the invention, while at the same time an excessive control signaling overhead between involved communication network control elements, such as between a MeNB and a LAeNB can be avoided.

The above and still further objects, features and advantages of the some embodiments of the invention will become more apparent upon referring to the description and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a diagram illustrating a communication network configuration where some examples of embodiments of the invention are implemented.

Fig. 2 shows an example signaling diagram illustrating a power saving management procedure according to some examples of embodiments of the invention.

Fig. 3 shows an example signaling diagram illustrating a power saving management procedure according to some examples of embodiments of the invention.

Fig. 4 shows an example signaling diagram illustrating a power saving management procedure according to some examples of embodiments of the invention.

Fig. 5 shows an example signaling diagram illustrating a power saving management procedure according to some examples of embodiments of the invention.

Figs. 6A and 6B shows a diagram illustrating a DRX pattern in a dual connection type communication, wherein Fig. 6A illustrates a comparative

example and Fig. 6B illustrates a result of a power saving management procedure according to some examples of embodiments of the invention.

Fig. 7 shows an example signaling diagram illustrating a power saving management procedure according to some examples of embodiments of the invention.

Fig. 8 shows a flowchart illustrating a power management control processing conducted by a communication network control element according to some examples of embodiments of the invention.

Fig. 9 shows a flowchart illustrating a power management processing conducted by a communication element according to some examples of embodiments of the invention.

Fig. 10 shows a block circuit diagram of a communication network control element including processing portions conducting functions according to some examples of embodiments of the invention.

Fig. 11 shows a block circuit diagram of a communication network control element including processing portions conducting functions according to some examples of embodiments of the invention.

Fig. 12 shows a block circuit diagram of a communication element including processing portions conducting functions according to some examples of embodiments of the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

In the following, some examples and some embodiments of the present invention are described with reference to the drawings. For illustrating the present invention, some examples and embodiments will be described in connection with a cellular communication network based on a 3GPP LTE or LTE-A system wherein a heterogeneous network configuration comprising a

macro cell controlled by a communication network control element, such as an eNB (referred to hereinafter as macro eNB or MeNB), and one or more small cells or LA cells located in the macro cell coverage area and constituted by a base station or transceiver element, such as an eNB (referred to hereinafter as local area eNB or LAeNB) is employed. However, it is to be noted that the present invention is not limited to an application using such types of communication systems, but is also applicable in other types of communication systems, such as a 3GPP based UMTS communication system, an LTE based communication system, a WCDMA system etc..

A basic system architecture of a communication network where some examples of embodiments of the invention are applicable may comprise a commonly known architecture of one or more communication systems comprising a wired or wireless access network subsystem and a core network. Such an architecture may comprise one or more access network control elements, radio access network elements, access service network gateways or base transceiver stations, such as a base station or eNB, which control a coverage area also referred to as a (macro or LA) cell and with which a communication element or terminal device 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, is capable to communicate via one or more links, bearers, channels etc. for transmitting several types of data. Furthermore, core network elements such as gateway network elements, policy and charging control network elements, mobility management entities 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 connections may be employed for a communication to or from a communication element like a UE or a

communication network control element like an eNB etc., besides those described in detail herein below.

Furthermore, the described network elements, such as communication elements like UEs, communication network control elements like base stations, access nodes, eNBs, 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 and/or algorithms, correspondingly used devices, nodes or network elements may comprise several means and components (not shown) which are required for control, processing and communication/signaling functionality. Such means may comprise, for example, one or more processor units including one or more processing portions for executing instructions, programs and for processing data, memory means for storing instructions, programs and data, for serving as a work area of the processor or processing portion and the like (e.g. ROM, RAM, EEPROM, and the like), input means for inputting data and instructions by software (e.g. floppy disc, CD-ROM, EEPROM, and the like), user interface means for providing monitor and manipulation possibilities to a user (e.g. a screen, a keyboard and the like), interface means for establishing links and/or connections under the control of the processor unit or portion (e.g. wired and wireless interface means, an antenna, etc.) and the like. 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 logical division of the referred processing tasks performed by one or more processors.

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

connection between the communication element (UE) and the network (i.e. the communication network control element or eNB and/or the core network) which are omitted here for the sake of simplicity.

5 In Fig. 1, a communication network configuration is illustrated in which some examples of embodiments of the invention are implementable. The network according to Fig. 1 is for example based on 3GPP LTE or LTE-A specifications and forms a heterogeneous network including a primary serving cell (macro cell) and one or more small cells (LA cells, only one is
10 shown in Fig. 1). 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 therebetween are known to those skilled in the art so that a detailed description thereof is omitted here for the sake of simplicity.

15 As shown in Fig. 1, in the exemplary communication network, a macro cell 200 is formed by a macro cell controller i.e. by a communication network control element such as MeNB 20. The MeNB 20 provides, for example, a connection to a core network 40 of the communication network.

20 In the macro cell 200, one or more small cells or LA cells 300 are located. Each LA cell is controlled by an own communication network control element, such as an LAeNB 30. In the example of Fig. 1, one LA cell is depicted, but the number is not limited thereto and can be greater than one.

25 The eNB 20 and the LA nodes 30 are connected with each other, for example, by a backhaul network, so as to enable the eNBs to directly communicate with each other. Even though not shown in Fig. 1, according to some examples of embodiments of the invention, in case plural LA cells
30 are provided, the respective control nodes (i.e. the respective LAeNBs are also connected with each other via a corresponding interface), or the LA control nodes are connected by using a central node, such as the MeNB 20, as a relay. Furthermore, according to some examples of embodiments of the invention, the eNBs are connected via other interface types, such as
35 wireless interfaces, or the like.

As further shown in Fig. 1, a communication element or terminal device UE 10 is located in the communication network so as to be able to establish simultaneously a connection or link towards the macro cell (i.e. to the MeNB 20) and a connection or link towards the LA cell (i.e. to the LAeNB 30), so as to communicate in a dual connection type communication mode. That is, the UE 10 is configured to communicate with the network via the MeNB 20 and the LAeNB 30 by using, for example, an air interface.

One possible mechanism to save power on the UE side, i.e. one possible power saving control measure is the so-called discontinuous reception mode or DRX. As commonly known by those skilled in the art, in a DRX cycle, a certain time period is defined as an on-duration in which the UE is active and listens to control channels and the like, which is followed by a certain time period in which the UE is inactive and saves correspondingly power. For example, the configuration of the DRX mode is controlled via MAC layer processing.

In a communication network configuration as shown in the example of Fig. 1, where e.g. a dual connection type communication is established, there are separated RRC and MAC layers among the macro link and the LA link. Consequently, in a comparative example, the DRX configuration for the macro link of the UE 10 is controlled by MeNB 20, while the DRX configuration for the LA link of the UE 10 is controlled by the LAeNB 30.

According to some examples of embodiments of the invention, which are described in the following with reference to Figs. 2 to 6A/B, a power saving management procedure is provided which is based on the DRX mechanism wherein a coordination of the two independent DRX configurations in the macro cell and the LA cell, respectively, achieves a decrease in power consumption on the UE side..

According to some examples of embodiments of the invention, for example in case it is determined that a traffic load is low on the LA link, a coordination of DRX patterns for all of the links, i.e. the LA link and the macro link, is conducted by a communication network control element. That

is, according to some examples of embodiments of the invention, the DRX pattern on the LA link and the DRX pattern on the macro link are aligned to each other. By means of this measure, the UE 10 is able to save power by turning off, for example, all shared components during the inactive duration of the (common or coordinated) DRX cycles.

According to some examples of embodiments of the invention, a coordination of the DRX patterns or configurations involves a corresponding signaling between the MeNB 20 and the LAeNB 30, e.g. over air or through backhaul interface, and also a signaling to the UE 10 resulting in a coordinated DRX pattern or configuration among the MeNB 20, the LAeNB 30 and the UE 10. For example, as one result of the coordination, on-durations of a macro link DRX pattern and of a LA link DRX pattern are aligned.

Fig. 2 shows an example signaling diagram illustrating a power saving management procedure according to some examples of embodiments of the invention, where a coordination of the DRX patterns or configurations is conducted.

In step S10, when a dual connection type communication is established, the MeNB 20 sends a request to the LAeNB 30 for obtaining information regarding the LA link DRX setting. Alternatively, according to some examples of embodiments of the invention, the request can also be directed to the UE 10 which is provided with the information by means of a corresponding DRX configuration process with the LAeNB 30.

According to some examples of embodiments of the invention, the information regarding the LA link DRX setting comprises an indication related to the DRX pattern, such as a SFN number offset or DL timing difference.

After the information regarding the LA link DRX setting is obtained, in step S20, the MeNB 20 conducts a coordination processing, for example by aligning the DRX patterns of the macro link and the LA link on the basis of

the obtained information. That is, an aligned or coordinated DRX pattern for both links is generated.

5 In step S30, the MeNB 20 informs the UE 10 and/or the LAeNB 30 about the coordinated DRX pattern, i.e. it sends information indicating the DRX configuration to the LAeNB 30 and/or the UE 10.

10 Then, in step S40, the LAeNB 30 is configured to schedule a transmission of control data or the like via a control channel, such as the PDCCH, or a shared channel, such as the PDSCH, according to the informed DRX pattern, i.e. during the (coordinated) on-duration.

15 Fig. 3 shows a further example signaling diagram illustrating a power saving management procedure according to some examples of embodiments of the invention. As the example according to Fig. 2, Fig. 3 is related to an example where a coordination of the DRX patterns or configurations is conducted. However, in the example according to Fig. 3, the MeNB transmits its own DRX configurations (i.e. macro link related DRX pattern or the like) to the LAeNB 30, wherein then the LAeNB 30 generates or
20 configures an aligned DRX pattern.

Specifically, in step S110, when a dual connection type communication is established, the MeNB 20 sends an information regarding the macro link DRX setting to the UE 10 and the LAeNB 30. Alternatively or additionally,
25 the step S110 is executed also in a case where a change in power saving control measure parameters, such as the DRX configuration for the macro link, takes place in an already established dual connection type communication.

30 According to some examples of embodiments of the invention, the information regarding the macro link DRX setting comprises an indication related to the DRX pattern, such as a SFN number offset or DL timing difference.

After the information regarding the macro link DRX setting is received, in step S120, the LAeNB 30 conducts a coordination processing, for example by aligning the DRX patterns of the macro link and the LA link on the basis of the obtained information. That is, an aligned or coordinated DRX pattern for both links is generated.

In step S130, the LAeNB 30 informs the UE 10 (and optionally the MeNB 20) about the coordinated DRX pattern, i.e. it sends information indicating the DRX configuration to the UE 10.

Then, in step S140, the LAeNB 30 is configured to schedule a transmission of control data or the like via a control channel, such as the PDCCH, or a shared channel, such as the PDSCH, according to the informed DRX pattern, i.e. during the (coordinated) on-duration.

Fig. 4 shows a further example signaling diagram illustrating a power saving management procedure according to some examples of embodiments of the invention. As the example according to Fig. 2 or Fig. 3, Fig. 4 is related to an example where a coordination of the DRX patterns or configurations is conducted. However, in the example according to Fig. 4, it is assumed that the MeNB 20 establishes a dual connection type communication without configuring a DRX pattern on the LA link. Thus, the LAeNB 30 requests information related to the DRX pattern on the macro link from the MeNB 20 or the UE 10, so as to enable the LAeNB 30 to configure an aligned DRX pattern on the LA link.

Specifically, in step S210, a dual connection type communication is established by the MeNB 20.

In step S220, the LAeNB 30 requests information regarding the macro link DRX setting. The request is sent to the MeNB 20. Alternatively or additionally, the request in step S220 is sent to the UE 10.

According to some examples of embodiments of the invention, the information regarding the macro link DRX setting comprises an indication related to the DRX pattern, such as a SFN number offset or DL timing difference.

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After the information regarding the macro link DRX setting is obtained in step S220, in step S230, the LAeNB 30 conducts a coordination processing, for example by aligning the DRX patterns of the macro link and the LA link on the basis of the obtained information. That is, an aligned or coordinated DRX pattern for both links is generated.

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In step S340, the LAeNB 30 informs the UE 10 (and optionally the MeNB 20) about the coordinated DRX pattern, i.e. it sends information indicating the DRX configuration to the UE 10.

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Then, in step S250, the LAeNB 30 is configured to schedule a transmission of control data or the like via a control channel, such as the PDCCH, or a shared channel, such as the PDSCH, according to the informed DRX pattern, i.e. during the (coordinated) on-duration.

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Fig. 5 shows a further example signaling diagram illustrating a power saving management procedure according to some examples of embodiments of the invention. As the example according to Fig. 2, Fig. 3 or Fig. 4, Fig. 5 is related to an example where a coordination of the DRX patterns or configurations is conducted. However, in the example according to Fig. 5, it is assumed that the MeNB 20 and the LAeNB 30 configure a corresponding DRX pattern independently from each other, i.e. without a coordination. In this case, the UE 10 is configured to report this missing DRX pattern alignment or coordination and request a corresponding adjustment.

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According to some further examples of embodiments of the invention, the report and request are triggered by different events. For example, the report and request are triggered when the UE 10 intends to enter the DRX mode on both links. Alternatively, the report and request are triggered when

the UE 10 finds the unaligned DRX pattern or considers the alignment is necessary.

Specifically, with regard to the example shown in Fig. 5, when a dual connection type communication is established, the MeNB 20 informs the UE 10 about the DRX pattern on the macro link in step S310. Similarly, in step S315, the LAeNB 30 informs the UE 10 about the DRX pattern on the LA link.

In step S320, the UE determines that there is a missing coordination between the DRX patterns for the macro link and the LA link, respectively. Consequently, a corresponding report and a request for coordination of the DRX patterns are triggered, wherein a corresponding report and request message is sent in step S330 by the UE 10 to the MeNB 20 and/or the LAeNB 30.

According to some examples of embodiments of the invention, the report and request message in step S330 comprises information related to the respective DRX pattern, such as a corresponding SFN number offset or a corresponding DL timing difference.

After the report and request message in step S330 is received, the corresponding eNB, i.e. the MeNB 20 in step S340 or the LAeNB 30 in step S345, conducts a coordination processing, for example by aligning the DRX patterns of the macro link and the LA link so that an aligned or coordinated DRX pattern for both links is generated.

Even though not shown in Fig. 5, the corresponding eNB informs the UE 10 (and optionally the other eNB) about the coordinated DRX pattern, i.e. it sends information indicating the DRX configuration.

According to some examples of embodiments of the invention, in an example where a coordination of the DRX patterns or configurations is conducted, such as one of the examples shown in Figs. 2 to 5, in order to

assist in the DRX coordination, the UE10 is configured to report a DL timing difference between macro cell and the LA cell. This is useful in particular in a case where the macro cell and the LA cell are not synchronized.

5 For example, when the macro cell and the LA cell are synchronized, the aligned DRX can be achieved on the basis of an exchange of information about the DRX pattern of the respective link. That is, in case one eNB, for example the LAeNB 30, knows the DRX configuration of a UE in the macro link, it is able to calculate the aligned DRX pattern for UE.

10 However, in case the macro and LA cells are not synchronized, then the one eNB (e.g. the LAeNB 30) has to know the DL timing difference between the two eNBs before an aligned DRX pattern can be configured. For this purpose, according to some examples of embodiments of the invention, the
15 UE 10 provides information about the corresponding DL timing difference which is calculated, for example, on the UE side. Alternatively or additionally, the eNB in question (e.g. the LAeNB 30) listens to the DL timing of the other eNB (e.g. the MeNB 20) and derives the timing difference.

20 Figs. 6A and 6B shows a diagram illustrating a DRX pattern in a dual connection type communication, wherein Fig. 6A illustrates a comparative example and Fig. 6B illustrates a result of a power saving management procedure according to some examples of embodiments of the invention,
25 which are based e.g. on a processing according to one of Figs. 2 to 5.

As shown in Fig. 6A, a DRX pattern for a macro link (indicated in the upper half of Fig. 6A) and a DRX pattern for a LA link (indicated in the lower half of Fig. 6A) are independent from each other, i.e. they are not coordinated and
30 hence shifted with regard to each other, i.e. the respective on-durations (on duration #1 and #2 for the macro link DRX pattern and on duration #3 for the LA link DRX pattern) are at different timings. In this case, the UE 10 has to turn on at least one RF reception section during each of the on durations #1~3.

On the other hand, as shown in Fig. 6B, a DRX pattern for a macro link (indicated in the upper half of Fig. 6B) and a DRX pattern for a LA link (indicated in the lower half of Fig. 6B) are coordinated, e.g. according to a procedure indicated in any of Figs. 2 to 5. After the coordination, the DRX patterns are aligned. In this case, the UE 10 turns on two RF reception sections during on duration #1/3 and during on duration #2/4, i.e. to the same time. Consequently, as the UE 10 may enter a „deeper sleeping“ when all RF activity is turned off, the aligned DRX pattern provides a better opportunity for the UE 10 to enter deeper sleeping which in turn leads to a better power saving.

In the examples of embodiments according to Figs. 2 to 6, a DRX related power saving control measure is described. In the following, with regard to Fig. 7, another power saving control measure is described which is referred to also as semi-idle mode.

In the DRX based power saving control measure, it is possible that there is a power consumption due to a blind detection of PDCCH during the on duration. However, according to further examples of embodiments of the invention, the power consumption is avoided. This is based on the idea that it is unnecessary to detect the PDCCH if it is possible to predict that there is no traffic. This is useful in particular in a dual connection type communication since one link, i.e. the macro link, is usually always present to provide a continuous and reliable connection. Thus, a blind detection in the LA link becomes unnecessary when there is no traffic, so that a further power saving effect can be achieved.

Specifically, according to some examples of embodiments of the invention, a power saving management procedure is conducted where, when there is no traffic on the LA link, a further power saving mode for UE is configured in which mobility is maintained without requiring a PDCCH detection. By means of this, it is possible to achieve a comparable or even better power saving result than with the DRX coordination procedure.

According to some examples of embodiments of the invention, as the further power saving mode, a semi-idle mode is defined for the UE in the LA link. The semi-idle mode comprises, according to some examples of embodiments of the invention, for example one or more of the following measures:

- the UE and the LAeNB maintain the LA link, i.e. the LA link is not released (for example, the UE and the LAeNB do not release SRBs and LA configurations);
- the UE stops monitoring/detecting of the PDCCH;
- the UE stops UL transmissions;
- the UE performs mobility measurements on the LA link and reports measurement results to the MeNB (e.g. in case of a corresponding trigger event like quality loss, or periodically);
- the LAeNB does not inform the core network about a status change of the UE even if the semi-idle mode is entered (e.g. since the LA link is still maintained).

According to some examples of embodiments of the invention, the UE is configured to enter and/or leave this semi idle mode quickly, for example on the basis of an expiry of a timer or by means of a trigger like an instruction to enter the semi-idle mode.

Fig. 7 shows an example signaling diagram illustrating a power saving management procedure according to some examples of embodiments of the invention, where a semi-idle mode of the UE 10 is controlled.

In step S410, when a dual connection type communication is established, the MeNB 20 sends an instruction to the UE 10 to enter the semi-idle mode for the LA link.

Alternatively, according to some examples of embodiments of the invention, the LAeNB 30 sends an instruction to the UE 10 to enter the semi-idle mode for the LA link in step S415.

For example, the instruction in step S410 or S415 is given in case it is determined in the respective eNB that no DRBs are to be transmitted to the UE 10, at least for a predetermined time.

5 As a further alternative, according to some examples of embodiments of the invention, the instruction is provided by the expiry of a timer which is started, for example, when the last data is received via the LA link.

10 In step S420, the UE 10 decides whether to enter the semi-idle mode or not. For example, in case there are data to be transmitted in the UL direction, the entering into the semi-idle mode is denied. Otherwise, in case all conditions allow to enter the semi-idle mode, the UE conducts a corresponding process, e.g. stops UL transmissions and PDCCH detection, etc.. It is to be noted that according to some examples of embodiments of
15 the invention, in case an UL transmission is to be conducted, the UE 10 is configured to leave the semi-idle mode.

In step S430, the UE 10 sends a report regarding entering of the semi-idle mode to the MeNB 20.
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It is to be noted that the MeNB 20 send a corresponding indication to the LAeNB 30, or that the LAeNB 30 sends a corresponding indication to the MeNB 20, for example when the instruction to enter the semi-idle mode is sent to the UE 10.
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As indicated above, when the UE 10 decides to enter the semi-idle mode, the LA link is maintained, e.g. the SRBs are maintained. Correspondingly, also the LAeNB 30 maintains the LA link to the UE 10 (i.e. the SRBs are maintained). At the same time, according to some examples of
30 embodiments of the invention, a status change report to the core network indicating the status of the UE 10 is prohibited. Furthermore, according to some examples of embodiments of the invention, since the LAeNB 30 is informed about the semi-idle state of the UE 10, even if no data are received for a specific time (which may usually cause that the eNB assumes

a termination of the link to a UE) so that e.g. an enforced link termination would be executed, a corresponding measure is inhibited internally in the LAeNB 30, for example.

5 Furthermore, as indicated above, according to some examples of embodiments of the invention, the UE 10 conducts mobility measurement on the LA link during the semi-idle state, and sends a corresponding report (e.g. periodically or event triggered) to the MeNB 20 in step S430.

10 The MeNB 20 handles the UE's mobility. In case the MeNB 20 decides that e.g. a handover or the like is necessary for the UE 10 (e.g. since the UE 10 moves out of the LA cell 300), the MeNB 20 instructs, for example, a release of the LA link which is sent in step S445. In this case, the LAeNB 30 is also informed, for example.

15 Otherwise, in case the LA link is still maintained and it is determined that there are data to be transmitted to the UE 10 via the LA link, the LA link is to be restored. For example, when the LAeNB 30 monitors incoming data, e.g. new DRB is to be transmitted on the LA link, the LAeNB 30 informs the
20 MeNB 20 in step S450 and requests to restore the LA link. It is to be noted that the MeNB 20 is also able, according to some examples of embodiments of the invention, to determine that there are incoming data for the UE 10.

In step S460, the MeNB 20 sends an instruction to the UE 10 via the macro
25 link to restore the LA link, i.e. to stop the semi-idle mode.

Since the semi-idle mode only requires to perform mobility measurement and allows to stop monitoring of control channels like the PDCCH, a further power saving effect can be achieved.

30 It is to be noted that the semi-idle mode is preferable compared to a simple release of the LA link. Even though the immediate release would also result in a similar power saving, it is to be considered that a frequent releasing and establishing of the dual connection type communication is inefficient

and causes a large delay. The reason is that the core network side is involved in the releasing/establishing procedures, for example due to an update of an MME status, a path switch from S-GW, an RB release/establishment etc.. On the other hand, the semi-idle mode according to some examples of the embodiments allows the UE to quickly resume the LA connection without delay. Furthermore, the semi-idle mode and the transition to and from it is transparent to the core network. As the macro link maintains a reliable connection, the possible impact due to the UE mobility can be supported by the macro link.

Fig. 8 shows a flowchart illustrating a processing for controlling a power saving management procedure as shown e.g. in Figs. 2 to 7 according to some examples of embodiments of the invention. The method in Fig. 8 is executed, according to some examples of embodiments of the invention, in a communication network control element, such as the MeNB 20 or the LAeNB 30.

In step S500, the control of a power saving management procedure usable for a multiple (dual) connection type communication is started, e.g. for a macro link as a first link and for an LA link as the second link.

In step S510, for controlling the power saving management procedure, a power saving control measure to be used for the second link is set by using at least one of information related to a power saving control measure used for the first link and a signaling conducted on the first link.

According to some examples of embodiments of the invention, when the processing is made in the MeNB 20, for controlling the power saving management procedure, a parameter setting related to a DRX mode on the first link and a parameter setting related to a DRX mode on the second link are controlled. For example, according to some examples of embodiments of the invention, information related to the DRX mode on the second link is obtained and processed. The information related to the DRX mode on the second link is for example requested from the UE 10 or the LAeNB 30. Then, a coordinated DRX pattern for the first (and second) link is generated which

is then indicated to the UE 10 and the LAeNB 30. This corresponds e.g. to a processing according to Fig. 2.

5 According to some examples of embodiments of the invention, when the processing is made in the MeNB 20, for controlling the power saving management procedure, a parameter setting related to a DRX mode on the first link and a parameter setting related to a DRX mode on the second link are coordinated, wherein a DRX pattern for the first link is generated and transmitted to the UE and the LAeNB. The transmission of the DRX pattern to the LAeNB 30 comprises e.g. an instruction to generate a coordinated DRX pattern for the second link on the basis of the DRX pattern for the first link. This corresponds e.g. to a processing according to Fig. 3.

15 According to some examples of embodiments of the invention, the control of the power saving management procedure is started when the multiple (dual) connection type communication is established or when a parameter for the power saving control measure on the first link (e.g. a DRX configuration) is changed.

20 According to some examples of embodiments of the invention, the control of the power saving management procedure is started when a request for conducting a coordination of a parameter setting related to the DRX mode on the first link and a parameter setting related to the DRX mode on the second link is received. This corresponds e.g. to a processing according to Fig. 5.

30 According to some examples of embodiments of the invention, the generation of the coordinated DRX pattern comprises an alignment of on durations of the DRX pattern for the first link and the DRX pattern for the second link.

35 According to some examples of embodiments of the invention, when the processing is made in the MeNB 20, for controlling the power saving management procedure, an operation mode of the UE into or out of a semi-idle mode on the second link is controlled. In this case, according to some examples of embodiments of the invention, it is decided e.g. due to low

traffic that an operation mode of the UE is to be switched into the semi-idle mode, and a corresponding instruction is sent to the UE 10. According to some examples of embodiments of the invention, it is determined that the UE 10 has entered the semi-idle mode, and a corresponding information indicating that the UE 10 has entered the semi-idle mode is sent to the LAeNB 30. Alternatively, according to some examples of embodiments of the invention, for controlling the power saving management procedure, an operation mode of the UE 10 into or out of the semi-idle mode on the second link is controlled by receiving an information indicating that an operation mode of the UE 10 is switched into the semi-idle mode. This corresponds e.g. to a processing according to Fig. 7.

According to some examples of embodiments of the invention, when the processing is made in the MeNB 20, it is determined that the operation mode of the UE 10 is to be changed from the semi-idle mode on the second link to a normal communication mode on the second link, e.g. when data are to be transmitted to the UE 10 or a request for restoring the LA link from the LAeNB 30 is received. Then, an instruction to stop the semi-idle mode of the UE 10 and to restore a normal communication mode on the second link is issued. This corresponds e.g. to a processing according to Fig. 7.

According to some examples of embodiments of the invention, when the processing is made in the MeNB 20, mobility measurement reports related to the second link are received. When it is determined that the second link is to be released, an instruction to release the second link is issued. This corresponds e.g. to a processing according to Fig. 7.

According to some examples of embodiments of the invention, when the processing is made in the MeNB 20, the semi-idle mode of the communication element comprises at least one of stopping monitoring of a control channel signaling on the second link, stopping of a transmission in uplink direction, maintaining the second link by keeping signaling radio bearer settings and configuration data for second link, and conducting mobility measurements for the second link and transmitting results of the mobility measurement for the second link via the first link. Moreover, a

transmission of information regarding the status of the UE (i.e. the semi-idle mode) to a core network is prohibited. This corresponds e.g. to a processing according to Fig. 7.

5 According to some examples of embodiments of the invention, when the processing is made in the LAeNB 30, for controlling the power saving management procedure, a parameter setting related to a DRX mode on the first link and a parameter setting related to a DRX mode on the second link is controlled, information related to a DRX mode on the first link is obtained
10 and processed. The information related to the DRX mode on the first link is for example requested from the UE 10 or the MeNB 20. Then, a coordinated DRX pattern for the second (and first) link is generated, and information related to the coordinated DRX pattern is sent to the UE 10 and the MeNB 20. This corresponds e.g. to a processing according to Fig. 4.

15 According to some examples of embodiments of the invention, when the processing is made in the LAeNB 30, for controlling the power saving management procedure, a parameter setting related to a DRX mode on the first link and a parameter setting related to a DRX mode on the second link is controlled. For this, a request for information related to a DRX mode on
20 the second link is received and responded. Then, DRX configuration information related to a coordinated DRX pattern are received and used for communication. This corresponds e.g. to a processing according to Fig. 2.

25 According to some examples of embodiments of the invention, when the processing is made in the LAeNB 30, the control of the power saving management procedure is initiated when the multiple (dual) connection type communication is established or when a parameter for the power saving control measure (e.g. a DRX configuration) on the second link is changed.

30 According to some examples of embodiments of the invention, when the processing is made in the LAeNB 30, the control of the power saving management procedure is initiated when a request for conducting a coordination of a parameter setting related to the DRX mode on the first link
35 and a parameter setting related to the DRX mode on the second link is

received from the UE 10. This corresponds e.g. to a processing according to Fig. 5.

According to some examples of embodiments of the invention, when the processing is made in the LAeNB 30, the generation of the coordinated DRX pattern comprises an alignment of on durations of the DRX pattern for the first link and the DRX pattern for the second link.

According to some examples of embodiments of the invention, when the processing is made in the LAeNB 30, for controlling the power saving management procedure, an operation mode of the UE 10 into or out of a semi-idle mode on the second link is controlled. In this case, according to some examples of embodiments of the invention, it is decided e.g. due to low traffic that an operation mode of the UE is to be switched into the semi-idle mode, and a corresponding instruction is sent to the UE 10. According to some examples of embodiments of the invention, it is determined that the UE 10 has entered the semi-idle mode, and a corresponding information indicating that the UE 10 has entered the semi-idle mode is sent to the MeNB 20. Alternatively, according to some examples of embodiments of the invention, for controlling the power saving management procedure, an operation mode of the UE 10 into or out of the semi-idle mode on the second link is controlled by receiving information indicating that an operation mode of the UE 10 is switched into the semi-idle mode. Furthermore, the second link is maintained, e.g. by keeping signaling radio bearer settings and configuration data for second link. This corresponds e.g. to a processing according to Fig. 7.

According to some examples of embodiments of the invention, when the processing is made in the LAeNB 30, it is determined that the operation mode of the UE 10 is to be changed from the semi-idle mode on the second link to a normal communication mode on the second link, e.g. when data are to be transmitted to the UE 10. Then, a request is sent to the MeNB 20 to initiate a stop of the semi-idle mode of the UE 10 and to restore a normal communication mode on the second link. This corresponds e.g. to a processing according to Fig. 7.

According to some examples of embodiments of the invention, when the processing is made in the LAeNB 30, the semi-idle mode of the communication element comprises at least one of stopping monitoring of a control channel signaling on the second link, stopping of a transmission in uplink direction, maintaining the second link by keeping signaling radio bearer settings and configuration data for second link, and conducting mobility measurements for the second link and transmitting results of the mobility measurement for the second link via the first link. Moreover, a transmission of information regarding the status of the UE (i.e. the semi-idle mode) to a core network is prohibited. This corresponds e.g. to a processing according to Fig. 7.

Fig. 9 shows a flowchart illustrating a processing for conducting a power saving management procedure as shown e.g. in Figs. 2 to 7 according to some examples of embodiments of the invention. The method in Fig. 9 is executed, according to some examples of embodiments of the invention, in a communication element, such as the UE 10.

In step S600, a power saving management procedure usable for a multiple (dual) connection type communication is conducted, e.g. for a macro link as a first link and for an LA link as the second link.

In step S610, for conducting the power saving management procedure, a power saving control measure to be used for the second link is set by using at least one of information related to a power saving control measure used for the first link and a signaling conducted on the first link. The power saving control measure set in the power saving management procedure is then conducted or executed, i.e. the defined measures are enforced in the UE 10, for example.

According to some examples of embodiments of the invention, for conducting the power saving management procedure, a parameter setting related to a DRX mode on the first link and a parameter setting related to a DRX mode on the second link is used. Corresponding DRX patterns for the

first and second links are received and used. This corresponds e.g. to a processing according to Figs. 2 to 4.

According to some examples of embodiments of the invention, a request for information related to the DRX mode on at least one of the first link and the second link is received, wherein the requested information are sent to the requesting element. This corresponds e.g. to a processing according to Fig. 2 or Fig. 4.

According to some examples of embodiments of the invention, it is determined whether a parameter setting related to the DRX mode on the first link and a parameter setting related to the DRX mode on the second link are coordinated with each other. For example, coordination is determined when an alignment of on durations of the DRX pattern for the first link and the DRX pattern for the second link is detected. In case the it is determined that the parameter setting related to the DRX mode on the first link and the parameter setting related to the DRX mode on the second link are not coordinated with each other, a request for conducting a coordination of the parameter setting related to the DRX mode on the first link and the parameter setting related to the DRX mode on the second link is sent. This corresponds e.g. to a processing according to Fig. 5.

According to some examples of embodiments of the invention, for conducting the power saving management procedure, an operation mode of the UE 10 into or out of a semi-idle mode on the second link is controlled. In this case, according to some examples of embodiments of the invention, it is decided to switch an operation mode of the UE 10 into the semi-idle mode, and a corresponding instruction is sent to the UE 10. According to some examples of embodiments of the invention, the decision to switch the operation mode of the UE 10 into the semi-idle mode is made on the basis of an instruction received from the MeNB 20 or the LAeNB 30, or on the basis of a determination that a predetermined timer is elapsed. Furthermore, the second link is maintained, e.g. by keeping signaling radio bearer settings and configuration data for second link. This corresponds e.g. to a processing according to Fig. 7.

According to some examples of embodiments of the invention, information indicating that the communication element has entered the semi-idle mode is transmitted to the eNBs. This corresponds e.g. to a processing according to Fig. 7.

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According to some examples of embodiments of the invention, when the operation mode is switched to the semi-idle mode, mobility measurements for the second link are conducted. If it is determined that a report on the mobility measurements is to be transmitted to the MeNB 20, e.g. due to an event triggering the report or periodically, a transmission of results of the mobility measurement for the second link is done via the first link. This corresponds e.g. to a processing according to Fig. 7.

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According to some examples of embodiments of the invention, the semi-idle mode of the communication element further comprises at least one of stopping monitoring of a control channel signaling on the second link, and stopping of a transmission in uplink direction.

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According to some examples of embodiments of the invention, when an instruction is received via the first link to change the operation mode from the semi-idle mode on the second link to a normal communication mode on the second link, the semi-idle mode of the UE 10 is stopped, and a normal communication mode on the second link is restored. This corresponds e.g. to a processing according to Fig. 7.

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According to some examples of embodiments of the invention, an instruction to release the second link is received via the first link, wherein the second link is then released. This corresponds e.g. to a processing according to Fig. 7.

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In Fig. 10, a block circuit diagram illustrating a circuitry indicating a configuration of a communication network control element, such as the MeNB 20, is shown which is configured to implement the processing for conducting the power saving management control as described in connection with the some examples of embodiments of the invention. That is, a circuitry is shown which comprises at least one processor and at least

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one memory including a computer program code, the at least one memory and the computer program code being configured to, with the at least one processor, cause the MeNB 20 to perform functions described below, for example by executing a corresponding algorithm. It is to be noted that the communication network control element or MeNB 20 shown in Fig. 10 may comprise several further elements or functions besides those described herein below, which are omitted for the sake of simplicity as they are not essential for understanding the invention. 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 modem chipset, a chip, a module etc., which can also be part of a base station or eNB or attached as a separate element to a base station or eNB, or the like.

According to some examples of embodiments of the invention, the communication network control element or MeNB 20 comprises a processing function or processor 21, such as a CPU or the like, which executes instructions given by programs or the like related to the power saving management control. The processor 21 comprises 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 connected to the processor 21. The I/O unit 22 is used for communicating with a communication element like the UE 10. The I/O unit 23 is used for communicating with a communication network control element of an LA cell, like LAeNB 30. 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 power saving management control. In particular, the processor 21

comprises a sub-portion 211 as a processing portion which is usable as a power saving management control function. Furthermore, the processor 21 comprises a sub-portion 212 usable as a portion for conducting a processing related to a coordination of DRX patterns. That is, for example, the sub portion 212 is related to at least one function among a DRX information obtaining function, a DRX pattern processing function, a DRX pattern information function, a DRX pattern generation function, a coordination request receiving and processing function, and the like. The portion 212 is configured to perform a processing as described in connection with Figs. 2 to 5, for example. In addition, the processor 21 comprises a sub-portion 213 usable as a processing portion for conducting a processing related to the semi-idle mode control. That is, for example, the sub portion 213 is related to at least one function among an operation mode decision function, an instruction function for the semi-idle mode, a determination function for the semi-idle mode, an information function for the semi-idle mode, an operation mode information receiving function, and the like. The portion 213 is configured to perform a processing as described in connection with Fig. 7, for example. Moreover, the processor 21 comprises a sub-portion 214 usable as a processing portion for mobility management of the UE. That is, for example, the sub portion 214 is related to at least one function among a mobility information processing function and a link release information function. The portion 214 is configured to perform a processing as described in connection with Fig. 7, for example. Furthermore, the processor 21 comprises a sub-portion 215 usable as a processing portion for LA link restoring. That is, for example, the sub portion 215 is related to at least one function among an operation mode changing function and an operation mode changing instruction function. The portion 215 is configured to perform a processing as described in connection with Fig. 7, for example.

In Fig. 11, a block circuit diagram illustrating a circuitry indicating a configuration of a communication network control element, such as the LAeNB 30, is shown which is configured to implement the processing for conducting the power saving management control as described in connection with the some examples of embodiments of the invention. That

is, a circuitry is shown which comprises at least one processor and at least one memory including a computer program code, the at least one memory and the computer program code being configured to, with the at least one processor, cause the LAeNB 30 to perform functions described below, for example by executing a corresponding algorithm. It is to be noted that the communication network control element or LAeNB 30 shown in Fig. 11 may comprise several further elements or functions besides those described herein below, which are omitted for the sake of simplicity as they are not essential for understanding the invention. 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 modem chipset, a chip, a module etc., which can also be part of a base station or eNB or attached as a separate element to a base station or eNB, or the like.

According to some examples of embodiments of the invention, the communication network control element or LAeNB 30 comprises a processing function or processor 31, such as a CPU or the like, which executes instructions given by programs or the like related to the power saving management control. The processor 31 comprises 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 connected to the processor 31. The I/O unit 32 is used for communicating with a communication element like the UE 10. The I/O unit 33 is used for communicating with a communication network control element of a macro cell, like MeNB 20. 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 power saving management control. In particular, the processor 31 comprises a sub-portion 311 as a processing portion which is usable as a power saving management control function. Furthermore, the processor 31 comprises a sub-portion 312 usable as a portion for conducting a processing related to a coordination of DRX patterns. That is, for example, the sub portion 312 is related to at least one function among a DRX information obtaining function, a DRX pattern processing function, a DRX pattern information function, a DRX pattern request processing function, a DRX information providing function, a DRX configuration function, a DRX pattern processing function, a coordination request receiving and processing function, and the like. The portion 312 is configured to perform a processing as described in connection with Figs. 2 to 5, for example. In addition, the processor 31 comprises a sub-portion 313 usable as a processing portion for conducting a processing related to the semi-idle mode control. That is, for example, the sub portion 313 is related to at least one function among an operation mode decision function, an instruction function for the semi-idle mode, a determination function for the semi-idle mode, an information function for the semi-idle mode, an operation mode information receiving function, and the like. The portion 313 is configured to perform a processing as described in connection with Fig. 7, for example. Furthermore, the processor 31 comprises a sub-portion 314 usable as a processing portion for LA link restoring. That is, for example, the sub portion 314 is related to at least one function among an operation mode changing function and an operation mode changing request function. The portion 314 is configured to perform a processing as described in connection with Fig. 7, for example.

In Fig. 12, a block circuit diagram illustrating a circuitry indicating a configuration of a communication element, such as the UE 10, is shown which is configured to implement the processing for conducting the power saving management as described in connection with the some examples of embodiments of the invention. That is, a circuitry is shown which comprises at least one processor and at least one memory including a computer program code, the at least one memory and the computer program code

being configured to, with the at least one processor, cause the UE 10 to perform functions described below, for example by executing a corresponding algorithm. It is to be noted that the communication element or UE 10 shown in Fig. 12 may comprise several further elements or functions besides those described herein below, which are omitted for the sake of simplicity as they are not essential for understanding the invention. Furthermore, even though reference is made to an terminal device or UE, the communication element may be also another device having a similar function, such as a modem chipset, a chip, a module etc., which can also be part of the UE or attached as a separate element to the UE, or the like.

According to some examples of embodiments of the invention, the communication element or UE 10 comprises a processing function or processor 11, such as a CPU or the like, which executes instructions given by programs or the like related to the power saving management. The processor 11 comprises 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 12 and 13 denote transceiver or input/output (I/O) units connected to the processor 11. The I/O unit 12 is used for communicating with a communication network control element like the MeNB 20 (i.e. the first link). The I/O unit 13 is used for communicating with a communication network control element of an LA cell, like LAeNB 30 (i.e. the second link). The I/O units 12 and 13 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 power saving management. In particular, the processor 11 comprises a sub-portion 111 as a processing portion which is usable as a

power saving management function. Furthermore, the processor 11 comprises a sub-portion 112 usable as a portion for conducting a processing related to a coordination of DRX patterns. That is, for example, the sub portion 112 is related to at least one function among a DRX pattern processing function, a DRX information request processing function, a DRX information providing function, a parameter setting evaluation function, a coordination requesting function, and the like. The portion 112 is configured to perform a processing as described in connection with Figs. 2 to 5, for example. In addition, the processor 11 comprises a sub-portion 113 usable as a processing portion for conducting a processing related to the semi-idle mode control. That is, for example, the sub portion 113 is related to at least one function among an operation mode switching function and an information function for the semi-idle mode, and the like. The portion 113 is configured to perform a processing as described in connection with Fig. 7, for example. Furthermore, the processor 11 comprises a sub-portion 114 usable as a processing portion for mobility measurement in the semi-idle mode on the LA link. That is, for example, the sub portion 114 is related to at least one function among a mobility measurement conducting function and a mobility measurement reporting function. The portion 114 is configured to perform a processing as described in connection with Fig. 7, for example. Moreover, the processor 11 comprises a sub-portion 115 usable as a processing portion for LA link restoring or LA link releasing. That is, for example, the sub portion 115 is related to at least one function among an operation mode restoring function and a link releasing function. The portion 314 is configured to perform a processing as described in connection with Fig. 7, for example.

It is to be noted that the DRX coordination and the semi-idle mode can be also used in a combined manner. For example, first a DRX coordination scheme is conducted, and after some time, the semi-idle mode is used, or the like.

Furthermore, while the above described examples of embodiments are related to a dual connection type communication involving one macro link

and one LA link, it is also possible according to some further examples of embodiments of the invention to apply the above described power saving management procedure also in cases where more than two connections are established (multiple connection type communication), involving, for example, one macro link and two or more LA links. In this case, for example, the power saving control measure for each LA link is controlled separately in accordance with one of the above described schemes.

According to further examples of some embodiments of the invention, there is provided, for example, an apparatus comprising power saving management control means for controlling a power saving management procedure usable for a multiple connection type communication, the multiple connection type communication including simultaneously at least a first link between a communication element and a first communication network control element and a second link between the communication element and a second communication network control element, wherein the power saving management procedure comprises setting a power saving control measure to be used for the second link by using at least one of information related to a power saving control measure used for the first link and a signaling conducted on the first link.

In addition, according to further examples of some embodiments of the invention, there is provided, for example, an apparatus comprising power saving management means for conducting a power saving management procedure usable for a multiple connection type communication, the multiple connection type communication including simultaneously at least a first link between a communication element and a first communication network control element and a second link between the communication element and a second communication network control element, wherein the power saving management procedure comprises setting a power saving control measure to be used for the second link by using at least one of information related to a power saving control measure used for the first link and a signaling conducted on the first link, wherein the power saving management means further executes the power saving control measure set by the power saving management procedure.

For the purpose of the some embodiments of the present invention as described herein above, it should be noted that

- an access technology via which signaling is transferred to and from a network element may be any technology by means of which a network element or sensor node can access another network element or node (e.g. via a base station or generally an access node). Any 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; although the above technologies are mostly wireless access technologies, e.g. in different radio spectra, access technology in the sense of the present invention implies also wired technologies, e.g. IP based access technologies like cable networks or fixed lines but also circuit switched access technologies; access technologies may be distinguishable in at least two categories or access domains such as packet switched and circuit switched, but the existence of more than two access domains does not impede the invention being applied thereto,

- usable communication networks and transmission nodes may be or comprise any device, apparatus, unit or means by which a station, entity or other user equipment may connect to and/or utilize services offered by the access network; such services include, among others, data and/or (audio-) visual communication, data download etc.;

- a user equipment or communication network element may be any device, apparatus, unit or means which is usable as a user communication device and by which a system user or subscriber may experience services from an access network, such as a mobile phone, a wireless mobile terminal, a personal digital assistant PDA, a smart phone, a personal computer (PC), a laptop computer, a desktop computer or a device having a corresponding functionality, 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, wherein corresponding devices or terminals may be, for example, an LTE, an LTE-A, a TETRA (Terrestrial Trunked Radio), an UMTS, a GSM/EDGE etc. smart mobile terminal or the like;

- method steps likely to be implemented as software code portions and being run using a processor at a network element or terminal (as examples of devices, apparatuses and/or modules thereof, or as examples of entities including apparatuses and/or modules for it), are software code independent

and can be specified using any known or future developed programming language as long as the functionality defined by the method steps is preserved;

- generally, any method step is suitable to be implemented as software or by hardware without changing the idea of the invention in terms of the functionality implemented;

- method steps and/or devices, apparatuses, units or means likely to be implemented as hardware components at a terminal or network element, or any module(s) thereof, are hardware independent and can 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), TTL (Transistor-Transistor Logic), etc., using for example ASIC (Application Specific IC (Integrated Circuit)) components, FPGA (Field-programmable Gate Arrays) components, CPLD (Complex Programmable Logic Device) components or DSP (Digital Signal Processor) components; in addition, any method steps and/or devices, units or means likely to be implemented as software components may for example be based on any security architecture capable e.g. of authentication, authorization, keying and/or traffic protection;

- devices, apparatuses, units or means can be implemented as individual devices, apparatuses, units or means, but this does not exclude that they are implemented in a distributed fashion throughout the system, as long as the functionality of the device, apparatus, unit or means is preserved; for example, for executing operations and functions according to examples of embodiments of the invention, 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 represented by a semiconductor chip, a chipset, or a (hardware) module comprising such chip or chipset; this, however, does not exclude the possibility that a functionality of an apparatus or module, instead of being hardware implemented, be implemented as software in a

(software) module such as a computer program or a computer program product comprising executable software code portions for execution/being run on a processor;

- 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, for example.

Furthermore, as used in this application, the terms 'device' or 'circuitry' refer to all of the following: (a) hardware-only circuit implementations (such as implementations in only analog and/or digital circuitry) and (b) combinations of circuits and software (and/or firmware), such as (as applicable): (i) a combination of processor(s) or (ii) portions of processor(s)/software (including digital signal processor(s)), software, and memory(or memories) working together to cause an apparatus, such as a mobile phone or server, to perform various functions) and (c) circuits, such as a microprocessor (or plural microprocessors) or a portion of a microprocessor (or plural microprocessors), that requires/require software or firmware for operation, even if the software or firmware is not physically present. This definition of 'circuitry' applies to all uses of this term in this application, including in any claims. As a further example, as used in this application, the term "circuitry" would also cover an implementation of merely a processor (or multiple processors) or portion of a processor and its (or their) accompanying software and/or firmware. The term "circuitry" would also cover, for example and if applicable to the particular claim element, a baseband integrated circuit or applications processor integrated circuit for a mobile phone or a similar integrated circuit in server, a cellular network device, or other network device.

As described above, there is proposed a mechanism for managing a power saving mode in a multiple connection type communication, such as a dual connection type communication with a first link between a UE and a macro cell and a second link between the UE and a LA cell. A power saving management procedure is proposed where for one link of the multiple connection type communication, such as the second link, a power saving mode is to be entered by the UE. In the power saving management

procedure, a power saving control measure to be used for the second link is set by using information related to a power saving control measure used for the first link and/or a signaling conducted on the first link.

- 5 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.

WHAT IS CLAIMED IS:

1. An apparatus comprising

at least one processor; and

at least one memory including computer program code;

wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus at least to perform

a power saving management control function configured to control a power saving management procedure usable for a multiple connection type communication, the multiple connection type communication including simultaneously at least a first link between a communication element and a first communication network control element and a second link between the communication element and a second communication network control element,

wherein the power saving management procedure comprises setting a power saving control measure to be used for the second link by using at least one of information related to a power saving control measure used for the first link and a signaling conducted on the first link.

2. The apparatus according to claim 1, wherein the apparatus is functionally implemented in the first communication network control element.

3. The apparatus according to claim 2, wherein the power saving management control function is further configured, for controlling the power saving management procedure, to coordinate a parameter setting related to a discontinuous reception mode on the first link and a parameter setting related to a discontinuous reception mode on the second link, wherein the at least one memory and the computer program code are further configured, with the at least one processor, to cause the apparatus at least to perform

a discontinuous reception information obtaining function configured to obtain information related to a discontinuous reception mode on the second link,

a discontinuous reception pattern processing function configured to process the obtained information related to the discontinuous reception mode on the second link and to generate a coordinated discontinuous reception pattern for the first link, and

5 a discontinuous reception pattern information function configured to cause a transmission of an information related to the coordinated discontinuous reception pattern.

10 4. The apparatus according to claim 3, wherein the discontinuous reception information obtaining function is further configured to

cause a transmission of a request for the information related to the discontinuous reception mode on the second link, and to receive a signaling indicating the requested information from one of the communication element and the second communication network control element.

15 5. The apparatus according to claim 3 or 4, wherein the information related to the discontinuous reception mode on the second link comprises at least one of a system frame number offset and a downlink timing difference related to the second link.

20 6. The apparatus according to claim 2, wherein the power saving management control function is further configured, for controlling the power saving management procedure, to coordinate a parameter setting related to a discontinuous reception mode on the first link and a parameter setting related to a discontinuous reception mode on the second link, wherein the at least one memory and the computer program code are further configured, with the at least one processor, to cause the apparatus at least to perform

30 a discontinuous reception pattern generation function configured to generate a discontinuous reception pattern for the first link, and

a discontinuous reception pattern information function configured to cause a transmission of an information related to the generated discontinuous reception pattern and of an instruction causing to generate a coordinated discontinuous reception pattern for the second link on the basis of the generated discontinuous reception pattern for the first link.

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7. The apparatus according to any of claims 3 to 6, wherein the power saving management control function is further configured to initiate controlling of the power saving management procedure when the multiple connection type communication is established or when a parameter for the power saving control measure on the first link is changed.

8. The apparatus according to any of claims 3 to 7, wherein the at least one memory and the computer program code are further configured, with the at least one processor, to cause the apparatus at least to perform

a coordination request receiving and processing function configured to receive and process a request for conducting a coordination of a parameter setting related to the discontinuous reception mode on the first link and a parameter setting related to the discontinuous reception mode on the second link,

wherein the coordination request receiving and processing function is further configured to initiate the power saving management control function to start controlling of the power saving management procedure.

9. The apparatus according to any of claims 3 to 8, wherein the generation of the coordinated discontinuous reception pattern comprises an alignment of on durations of the discontinuous reception pattern for the first link and the discontinuous reception pattern for the second link.

10. The apparatus according to claim 2, wherein the power saving management control function is further configured, for controlling the power saving management procedure, to control an operation mode of the communication element being a semi-idle mode on the second link, wherein the at least one memory and the computer program code are further configured, with the at least one processor, to cause the apparatus at least to perform

an operation mode decision function configured to decide that an operation mode of the communication element is to be switched into the semi-idle mode,

an instruction function configured to cause a transmission of an instruction that the communication element has to enter the semi-idle mode,

a determination function configured to determine that the communication element has entered the semi-idle mode, and

an information function configured to cause a transmission of an information indicating that the communication element has entered the semi-idle mode.

11. The apparatus according to claim 2, wherein the power saving management control function is further configured, for controlling the power saving management procedure, to control an operation mode of the communication element being a semi-idle mode on the second link, wherein the at least one memory and the computer program code are further configured, with the at least one processor, to cause the apparatus at least to perform

an operation mode information receiving function configured to receive an information indicating that an operation mode of the communication element is switched into the semi-idle mode, and

a determination function configured to determine, on the basis of the received information, that the communication element has entered the semi-idle mode.

12. The apparatus according to claim 10 or 11, wherein the at least one memory and the computer program code are further configured, with the at least one processor, to cause the apparatus at least to perform

an operation mode changing function configured to determine that the operation mode of the communication element is to be changed from the semi-idle mode on the second link to a normal communication mode on the second link, and

an operation mode changing instruction function configured to cause a transmission, via the first link, of an instruction to stop the semi-idle mode of the communication element and to restore a normal communication mode on the second link.

13. The apparatus according to claim 12, wherein the operation mode changing function is further configured to determine that the operation mode of the communication element is to be changed from the semi-idle

mode on the second link to a normal communication mode on the second link on the basis of one of

receiving and processing an information from the second communication network element indicating that the operation mode of the communication element is to be changed, and

determining that data are to be transmitted via the second link to the communication element.

14. The apparatus according to any of claims 10 to 13, wherein the at least one memory and the computer program code are further configured, with the at least one processor, to cause the apparatus at least to perform

a mobility information processing function configured to receive and process a mobility measurement report related to the second link and to determine on the basis of the processing whether the second link is to be released, and

a link release information function configured to cause a transmission of an indication that the second link is to be released in case the mobility information processing function determines that the second link is to be released.

15. The apparatus according to any of claims 10 to 14, wherein the semi-idle mode of the communication element comprises at least one of

stopping monitoring of a control channel signaling on the second link, stopping of a transmission in uplink direction,

maintaining the second link by keeping signaling radio bearer settings and configuration data for second link, and

conducting mobility measurements for the second link and transmitting results of the mobility measurement for the second link via the first link, wherein the power saving management control function is further configured to prohibit a transmission of an information regarding the semi-idle mode of the communication network to a core network of a communication system.

16. The apparatus according to claim 1, wherein the apparatus is functionally implemented in the second communication network control element.

17. The apparatus according to claim 16, wherein the power saving management control function is further configured, for controlling the power saving management procedure, to coordinate a parameter setting related to a discontinuous reception mode on the first link and a parameter setting related to a discontinuous reception mode on the second link, wherein the at least one memory and the computer program code are further configured, with the at least one processor, to cause the apparatus at least to perform

a discontinuous reception information obtaining function configured to obtain information related to a discontinuous reception mode on the first link,

a discontinuous reception pattern processing function configured to process the obtained information related to the discontinuous reception mode on the first link and to generate a coordinated discontinuous reception pattern for the second link, and

a discontinuous reception pattern information function configured to cause a transmission of an information related to the coordinated discontinuous reception pattern.

18. The apparatus according to claim 17, wherein the discontinuous reception information obtaining function is further configured to

cause a transmission of a request for the information related to the discontinuous reception mode on the first link, and to receive a signaling indicating the requested information from one of the communication element and the first communication network control element.

19. The apparatus according to claim 17 or 18, wherein the information related to the discontinuous reception mode on the first link comprises at least one of a system frame number offset and a downlink timing difference related to the first link.

20. The apparatus according to claim 16, wherein the power saving management control function is further configured, for controlling the power saving management procedure, to coordinate a parameter setting related to a discontinuous reception mode on the first link and a parameter setting

related to a discontinuous reception mode on the second link, wherein the at least one memory and the computer program code are further configured, with the at least one processor, to cause the apparatus at least to perform

5 a discontinuous reception information request processing function configured to receive and process a request for information related to a discontinuous reception mode on the second link,

10 a discontinuous reception information providing function configured to cause a transmission of the requested information related to the discontinuous reception mode on the second link,

a discontinuous reception configuration function configured to receive and process configuration information related to a coordinated discontinuous reception pattern, and

15 a discontinuous reception pattern processing function configured to set the coordinated discontinuous reception pattern for the second link.

20 21. The apparatus according to claim 20, wherein the information related to the discontinuous reception mode on the second link comprises at least one of a system frame number offset and a downlink timing difference related to the second link.

25 22. The apparatus according to any of claims 17 to 21, wherein the power saving management control function is further configured to initiate controlling of the power saving management procedure when the multiple connection type communication is established or when a parameter for the power saving control measure on the second link is changed.

30 23. The apparatus according to any of claims 17 to 22, wherein the at least one memory and the computer program code are further configured, with the at least one processor, to cause the apparatus at least to perform

35 a coordination request receiving and processing function configured to receive and process a request for conducting a coordination of a parameter setting related to the discontinuous reception mode on the first link and a parameter setting related to the discontinuous reception mode on the second link,

wherein the coordination request receiving and processing function is further configured to initiate the power saving management control function to start controlling of the power saving management procedure.

24. The apparatus according to any of claims 17 to 23, wherein the generation of the coordinated discontinuous reception pattern comprises an alignment of on durations of the discontinuous reception pattern for the first link and the discontinuous reception pattern for the second link.

25. The apparatus according to claim 16, wherein the power saving management control function is further configured, for controlling the power saving management procedure, to control an operation mode of the communication element being a semi-idle mode on the second link, wherein the at least one memory and the computer program code are further configured, with the at least one processor, to cause the apparatus at least to perform

an operation mode decision function configured to decide that an operation mode of the communication element is to be switched into the semi-idle mode,

an instruction function configured to cause a transmission of an instruction that the communication element has to enter the semi-idle mode,

a determination function configured to determine that the communication element has entered the semi-idle mode, and

an information function configured to cause a transmission of an information indicating that the communication element has entered the semi-idle mode,

wherein the power saving management control function is further configured to maintain the second link by keeping signaling radio bearer settings and configuration data for second link.

26. The apparatus according to claim 25, wherein the operation mode decision function is configured to decide that the operation mode of the communication element is to be switched into the semi-idle mode on the basis of a determination that there are no data to be transmitted to the communication element via the second link.

27. The apparatus according to claim 16, wherein the power saving management control function is further configured, for controlling the power saving management procedure, to control an operation mode of the communication element being a semi-idle mode on the second link, wherein the at least one memory and the computer program code are further configured, with the at least one processor, to cause the apparatus at least to perform

an operation mode information receiving function configured to receive an information indicating that an operation mode of the communication element is switched into the semi-idle mode, and

a determination function configured to determine, on the basis of the received information, that the communication element has entered the semi-idle mode,

wherein the power saving management control function is further configured to maintain the second link by keeping signaling radio bearer settings and configuration data for second link.

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

an operation mode changing function configured to determine that the operation mode of the communication element is to be changed from the semi-idle mode on the second link to a normal communication mode on the second link, and

an operation mode changing request function configured to cause a transmission of a request to the first communication network control element to initiate a stop of the semi-idle mode of the communication element and to restore a normal communication mode on the second link.

29. The apparatus according to claim 28, wherein the operation mode changing function is further configured to determine that the operation mode of the communication element is to be changed from the semi-idle mode on the second link to a normal communication mode on the second link on the basis of a determination that data are to be transmitted via the second link to the communication element.

30. The apparatus according to any of claims 25 to 29, wherein the semi-idle mode of the communication element comprises at least one of
stopping monitoring of a control channel signaling on the second link,
5 stopping of a transmission in uplink direction,
maintaining the second link by keeping signaling radio bearer settings and configuration data for second link, and
conducting mobility measurements for the second link and
transmitting results of the mobility measurement for the second link via the
10 first link,
wherein the power saving management control function is further configured to prohibit a transmission of an information regarding the semi-idle mode of the communication network to a core network of a communication system.

31. The apparatus according to any of claims 1 to 30, wherein
the first communication network control element controls a macro cell and comprises at least one of a base station of a cellular network, an evolved node B of a Long Term Evolution or Long Term Evolution Advanced
20 communication network, and an access node,
the second communication network control element controls a local area cell and comprises at least one of a base station of a cellular network, an evolved node B of a Long Term Evolution or Long Term Evolution Advanced communication network, and an access node, and
25 the communication element comprises at least one of a terminal device or user equipment communicating with the first and second communication network control elements via the first link and the second link, respectively.

32. A method comprising
controlling a power saving management procedure usable for a multiple connection type communication, the multiple connection type communication including simultaneously at least a first link between a communication element and a first communication network control element
35 and a second link between the communication element and a second communication network control element,

wherein the power saving management procedure comprises
setting a power saving control measure to be used for the
second link by using at least one of information related to a power saving
control measure used for the first link and a signaling conducted on the first
link.

33. The method according to claim 32, wherein the method is functionally
implemented in the first communication network control element.

34. The method according to claim 33, further comprising
coordinating, for controlling the power saving management
procedure, a parameter setting related to a discontinuous reception mode
on the first link and a parameter setting related to a discontinuous reception
mode on the second link, wherein the method further comprises

obtaining information related to a discontinuous reception mode on
the second link,

processing the obtained information related to the discontinuous
reception mode on the second link,

generating a coordinated discontinuous reception pattern for the first
link, and

causing a transmission of an information related to the coordinated
discontinuous reception pattern.

35. The method according to claim 34, further comprising

causing a transmission of a request for the information related to the
discontinuous reception mode on the second link, and

receiving and processing a signaling indicating the requested
information from one of the communication element and the second
communication network control element.

36. The method according to claim 35 or 36, wherein the information
related to the discontinuous reception mode on the second link comprises at
least one of a system frame number offset and a downlink timing difference
related to the second link.

37. The method according to claim 33, further comprising

coordinating, for controlling the power saving management procedure, a parameter setting related to a discontinuous reception mode on the first link and a parameter setting related to a discontinuous reception mode on the second link,

5 wherein the method further comprises
generating a discontinuous reception pattern for the first link, and
causing a transmission of an information related to the generated discontinuous reception pattern and of an instruction causing to generate a coordinated discontinuous reception pattern for the second link on the basis
10 of the generated discontinuous reception pattern for the first link.

38. The method according to any of claims 34 to 37, further comprising
initiating controlling of the power saving management procedure when the multiple connection type communication is established or when a
15 parameter for the power saving control measure on the first link is changed.

39. The method according to any of claims 34 to 38, further comprising
receiving and processing a request for conducting a coordination of a parameter setting related to the discontinuous reception mode on the first
20 link and a parameter setting related to the discontinuous reception mode on the second link, and
initiating controlling of the power saving management procedure.

40. The method according to any of claims 34 to 39, wherein the generation
25 of the coordinated discontinuous reception pattern comprises an alignment of on durations of the discontinuous reception pattern for the first link and the discontinuous reception pattern for the second link.

41. The method according to claim 33, further comprising
30 controlling, for controlling the power saving management procedure, an operation mode of the communication element being a semi-idle mode on the second link,
the method further comprising
deciding that an operation mode of the communication element is to
35 be switched into the semi-idle mode,

causing a transmission of an instruction that the communication element has to enter the semi-idle mode,

determining that the communication element has entered the semi-idle mode, and

5 causing a transmission of an information indicating that the communication element has entered the semi-idle mode.

42. The method according to claim 33, further comprising

10 controlling, for controlling the power saving management procedure, an operation mode of the communication element being a semi-idle mode on the second link,

the method further comprising

receiving an information indicating that an operation mode of the communication element is switched into the semi-idle mode, and

15 determining, on the basis of the received information, that the communication element has entered the semi-idle mode.

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

20 determining that the operation mode of the communication element is to be changed from the semi-idle mode on the second link to a normal communication mode on the second link, and

causing a transmission, via the first link, of an instruction to stop the semi-idle mode of the communication element and to restore a normal communication mode on the second link.

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44. The method according to claim 43, wherein the determination that the operation mode of the communication element is to be changed from the semi-idle mode on the second link to a normal communication mode on the second link is based on one of

30 receiving and processing an information from the second communication network element indicating that the operation mode of the communication element is to be changed, and

determining that data are to be transmitted via the second link to the communication element.

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

receiving and processing a mobility measurement report related to the second link

determining, on the basis of the processing, whether the second link is to be released, and

5 in case it is determined that the second link is to be released, causing a transmission of an indication that the second link is to be released.

46. The method according to any of claims 41 to 45, wherein the semi-idle mode of the communication element comprises at least one of

10 stopping monitoring of a control channel signaling on the second link,
stopping of a transmission in uplink direction,
maintaining the second link by keeping signaling radio bearer settings and configuration data for second link, and

conducting mobility measurements for the second link and
15 transmitting results of the mobility measurement for the second link via the first link,

wherein the method further comprises
prohibiting a transmission of an information regarding the semi-idle mode of the communication network to a core network of a communication
20 system.

47. The method according to claim 32, wherein the method is functionally implemented in the second communication network control element.

25 48. The method according to claim 47, further comprising
coordinating, for controlling the power saving management procedure, a parameter setting related to a discontinuous reception mode on the first link and a parameter setting related to a discontinuous reception mode on the second link, wherein the method further comprises

30 obtaining information related to a discontinuous reception mode on the first link,

processing the obtained information related to the discontinuous reception mode on the first link

35 generating a coordinated discontinuous reception pattern for the second link, and

causing a transmission of an information related to the coordinated discontinuous reception pattern.

49. The method according to claim 48, further comprising

causing a transmission of a request for the information related to the discontinuous reception mode on the first link, and

receiving and processing a signaling indicating the requested information from one of the communication element and the first communication network control element.

50. The method according to claim 48 or 49, wherein the information related to the discontinuous reception mode on the first link comprises at least one of a system frame number offset and a downlink timing difference related to the first link.

51. The method according to claim 47, further comprising

coordinating, for controlling the power saving management procedure, a parameter setting related to a discontinuous reception mode on the first link and a parameter setting related to a discontinuous reception mode on the second link, wherein the method further comprises

receiving and processing a request for information related to a discontinuous reception mode on the second link,

causing a transmission of the requested information related to the discontinuous reception mode on the second link,

receiving and processing configuration information related to a coordinated discontinuous reception pattern, and

setting the coordinated discontinuous reception pattern for the second link.

52. The method according to claim 51, wherein the information related to the discontinuous reception mode on the second link comprises at least one of a system frame number offset and a downlink timing difference related to the second link.

53. The method according to any of claims 48 to 52, further comprising initiating the controlling of the power saving management procedure when

the multiple connection type communication is established or when a parameter for the power saving control measure on the second link is changed.

5 54. The method according to any of claims 48 to 53, further comprising receiving and processing a request for conducting a coordination of a parameter setting related to the discontinuous reception mode on the first link and a parameter setting related to the discontinuous reception mode on the second link, and

10 initiating the power saving management control function to start controlling of the power saving management procedure.

15 55. The method according to any of claims 48 to 54, wherein the generation of the coordinated discontinuous reception pattern comprises an alignment of on durations of the discontinuous reception pattern for the first link and the discontinuous reception pattern for the second link.

20 56. The method according to claim 47, further comprising controlling, for controlling the power saving management procedure, an operation mode of the communication element being a semi-idle mode on the second link, wherein the method further comprises

deciding that an operation mode of the communication element is to be switched into the semi-idle mode,

25 causing a transmission of an instruction that the communication element has to enter the semi-idle mode,

determining that the communication element has entered the semi-idle mode,

causing a transmission of an information indicating that the communication element has entered the semi-idle mode, and

30 maintaining the second link by keeping signaling radio bearer settings and configuration data for second link.

35 57. The method according to claim 56, wherein the decision that the operation mode of the communication element is to be switched into the semi-idle mode is based on a determination that there are not data to be transmitted to the communication element via the second link.

58. The method according to claim 47, further comprising
controlling, for controlling the power saving management procedure,
an operation mode of the communication element being a semi-idle mode
5 on the second link, wherein the method further comprises
receiving an information indicating that an operation mode of the
communication element is switched into the semi-idle mode,
determining, on the basis of the received information, that the
communication element has entered the semi-idle mode, and
10 maintaining the second link by keeping signaling radio bearer settings
and configuration data for second link.

59. The method according to any of claims 56 to 58, further comprising
determining that the operation mode of the communication element is
15 to be changed from the semi-idle mode on the second link to a normal
communication mode on the second link, and
causing a transmission of a request to the first communication
network control element to initiate a stop of the semi-idle mode of the
communication element and to restore a normal communication mode on
20 the second link.

60. The method according to claim 59, further comprising
determining that the operation mode of the communication element is
to be changed from the semi-idle mode on the second link to a normal
25 communication mode on the second link on the basis of a determination
that data are to be transmitted via the second link to the communication
element.

61. The method according to any of claims 56 to 60, wherein the semi-idle
30 mode of the communication element comprises at least one of
stopping monitoring of a control channel signaling on the second link,
stopping of a transmission in uplink direction,
maintaining the second link by keeping signaling radio bearer settings
and configuration data for second link, and

conducting mobility measurements for the second link and transmitting results of the mobility measurement for the second link via the first link,

wherein the method further comprises prohibiting a transmission of an information regarding the semi-idle mode of the communication network to a core network of a communication system.

62. The method according to any of claims 32 to 61, wherein

the first communication network control element controls a macro cell and comprises at least one of a base station of a cellular network, an evolved node B of a Long Term Evolution or Long Term Evolution Advanced communication network, and an access node,

the second communication network control element controls a local area cell and comprises at least one of a base station of a cellular network, an evolved node B of a Long Term Evolution or Long Term Evolution Advanced communication network, and an access node, and

the communication element comprises at least one of a terminal device or user equipment communicating with the first and second communication network control elements via the first link and the second link, respectively.

63. An apparatus comprising

at least one processor; and

at least one memory including computer program code;

wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus at least to perform

a power saving management function configured to conduct a power saving management procedure usable for a multiple connection type communication, the multiple connection type communication including simultaneously at least a first link between a communication element and a first communication network control element and a second link between the communication element and a second communication network control element,

wherein the power saving management procedure comprises

setting a power saving control measure to be used for the second link by using at least one of information related to a power saving control measure used for the first link and a signaling conducted on the first link,

5 wherein the power saving management function is further configured to execute the power saving control measure set by the power saving management procedure.

10 64. The apparatus according to claim 63, wherein the power saving management function is further configured, for conducting the power saving management procedure, to use a parameter setting related to a discontinuous reception mode on the first link and a parameter setting related to a discontinuous reception mode on the second link, wherein the at least one memory and the computer program code are further
15 configured, with the at least one processor, to cause the apparatus at least to perform

a discontinuous reception pattern processing function configured to receive and process a discontinuous reception pattern for the first link and a discontinuous reception pattern for the second link, and to use the
20 discontinuous reception patterns for the first link and the second link.

65. The apparatus according to claim 64, wherein the at least one memory and the computer program code are further configured, with the at least one processor, to cause the apparatus at least to perform

25 a discontinuous reception information request processing function configured to receive and process a request for information related to the discontinuous reception mode on at least one of the first link and the second link, and

a discontinuous reception information providing function configured to
30 cause a transmission of the requested information.

66. The apparatus according to claim 65, wherein the information related to the discontinuous reception mode on at least one of the first link and the second link comprises at least one of a system frame number offset and a
35 downlink timing difference related to the at least one of the first link and the second link.

67. The apparatus according to any of claims 64 to 66, wherein the at least one memory and the computer program code are further configured, with the at least one processor, to cause the apparatus at least to perform

5 a parameter setting evaluation function configured to determine whether a parameter setting related to the discontinuous reception mode on the first link and a parameter setting related to the discontinuous reception mode on the second link are coordinated with each other,

10 a coordination requesting function configured, in case the parameter setting evaluation function determines that the parameter setting related to the discontinuous reception mode on the first link and the parameter setting related to the discontinuous reception mode on the second link are not coordinated with each other, to cause a transmission of a request for conducting a coordination of the parameter setting related to the
15 discontinuous reception mode on the first link and the parameter setting related to the discontinuous reception mode on the second link.

68. The apparatus according to claim 67, wherein the parameter setting related to the discontinuous reception mode on the first link and the
20 parameter setting related to the discontinuous reception mode on the second link are determined to be coordinated with each other when an alignment of on durations of the discontinuous reception pattern for the first link and the discontinuous reception pattern for the second link is detected.

69. The apparatus according to claim 63, wherein the power saving management function is further configured, for conducting the power saving management procedure, to control an operation mode of the communication element being a semi-idle mode on the second link, wherein the at least one memory and the computer program code are further configured, with the at
30 least one processor, to cause the apparatus at least to perform

 an operation mode switching function configured to decide to switch an operation mode of the communication element into the semi-idle mode,

 wherein the power saving management function is further configured to maintain the second link by keeping signaling radio bearer settings and
35 configuration data for second link.

70. The apparatus according to claim 69, wherein the at least one memory and the computer program code are further configured, with the at least one processor, to cause the apparatus at least to perform

an information function configured to cause a transmission of an information indicating that the communication element has entered the semi-idle mode.

71. The apparatus according to claim 69 or 70, wherein the at least one memory and the computer program code are further configured, with the at least one processor, to cause the apparatus at least to perform, when the operation mode is switched to the semi-idle mode

a mobility measurement conducting function configured to conduct mobility measurements for the second link, and

a mobility measurement reporting function configured to cause a transmission of results of the mobility measurement for the second link via the first link.

72. The apparatus according to any of claims 69 to 71, wherein the operation mode switching function is further configured to decide to switch the operation mode of the communication element into the semi-idle mode on the basis of one of

an instruction received from one of the first and second communication network control elements to change the operation mode of the communication element into the semi-idle mode, and

a determination that a predetermined timer is elapsed.

73. The apparatus according to any of claims 69 to 72, wherein the semi-idle mode of the communication element further comprises at least one of

stopping monitoring of a control channel signaling on the second link,

stopping of a transmission in uplink direction, and

maintaining the second link by keeping signaling radio bearer settings and configuration data for second link.

74. The apparatus according to claim 69 to 73, wherein the at least one memory and the computer program code are further configured, with the at least one processor, to cause the apparatus at least to perform

an operation mode restoring function configured to receive and process an instruction received via the first link to change the operation mode from the semi-idle mode on the second link to a normal communication mode on the second link, and to stop the semi-idle mode of the communication element and to restore a normal communication mode on the second link.

75. The apparatus according to any of claims 69 to 74, wherein the at least one memory and the computer program code are further configured, with the at least one processor, to cause the apparatus at least to perform a link releasing function configured to receive, via the first link, and process an instruction to release the second link, and to cause a release of the second link.

76. The apparatus according to any of claims 63 to 76, wherein the apparatus is functionally implemented in the communication element, wherein the first communication network control element controls a macro cell and comprises at least one of a base station of a cellular network, an evolved node B of a Long Term Evolution or Long Term Evolution Advanced communication network, and an access node, the second communication network control element controls a local area cell and comprises at least one of a base station of a cellular network, an evolved node B of a Long Term Evolution or Long Term Evolution Advanced communication network, and an access node, and the communication element comprises at least one of a terminal device or user equipment communicating with the first and second communication network control elements via the first link and the second link, respectively.

77. A method comprising conducting a power saving management procedure usable for a multiple connection type communication, the multiple connection type communication including simultaneously at least a first link between a communication element and a first communication network control element

and a second link between the communication element and a second communication network control element,

wherein the power saving management procedure comprises

setting a power saving control measure to be used for the second link by using at least one of information related to a power saving control measure used for the first link and a signaling conducted on the first link

the method further comprising executing the power saving control measure set by the power saving management procedure.

78. The method according to claim 77, further comprising using, for conducting the power saving management procedure, a parameter setting related to a discontinuous reception mode on the first link and a parameter setting related to a discontinuous reception mode on the second link, wherein the method further comprises

receiving and processing a discontinuous reception pattern for the first link and a discontinuous reception pattern for the second link, and

using the discontinuous reception patterns for the first link and the second link.

79. The method according to claim 78, further comprising

receiving and processing a request for information related to the discontinuous reception mode on at least one of the first link and the second link, and

causing a transmission of the requested information.

80. The method according to claim 79, wherein the information related to the discontinuous reception mode on at least one of the first link and the second link comprises at least one of a system frame number offset and a downlink timing difference related to the at least one of the first link and the second link.

81. The method according to any of claims 78 to 80, further comprising

determining whether a parameter setting related to the discontinuous reception mode on the first link and a parameter setting related to the

discontinuous reception mode on the second link are coordinated with each other, and

in case the it is determined that the parameter setting related to the discontinuous reception mode on the first link and the parameter setting related to the discontinuous reception mode on the second link are not coordinated with each other, causing a transmission of a request for conducting a coordination of the parameter setting related to the discontinuous reception mode on the first link and the parameter setting related to the discontinuous reception mode on the second link.

82. The method according to claim 81, wherein the parameter setting related to the discontinuous reception mode on the first link and the parameter setting related to the discontinuous reception mode on the second link are determined to be coordinated with each other when an alignment of on durations of the discontinuous reception pattern for the first link and the discontinuous reception pattern for the second link is detected.

83. The method according to claim 77, further comprising

controlling, for conducting the power saving management procedure, an operation mode of the communication element being a semi-idle mode on the second link, wherein the method further comprises

deciding to switch an operation mode of the communication element into the semi-idle mode, and

maintaining the second link by keeping signaling radio bearer settings and configuration data for second link.

84. The method according to claim 83, further comprising

causing a transmission of an information indicating that the communication element has entered the semi-idle mode.

85. The method according to claim 83 or 84, further comprising, when the operation mode is switched to the semi-idle mode,

conducting mobility measurements for the second link, and

causing a transmission of results of the mobility measurement for the second link via the first link.

86. The method according to any of claims 83 to 85, further comprising
deciding to switch the operation mode of the communication element
into the semi-idle mode on the basis of one of
an instruction received from one of the first and second
communication network control elements to change the operation mode of
the communication element into the semi-idle mode, and
a determination that a predetermined timer is elapsed.

87. The method according to any of claims 83 to 86, wherein the semi-idle
mode of the communication element further comprises at least one of
stopping monitoring of a control channel signaling on the second link,
stopping of a transmission in uplink direction, and
maintaining the second link by keeping signaling radio bearer settings
and configuration data for second link.

88. The method according to claim 83 to 87, further comprising
receiving and processing an instruction received via the first link to
change the operation mode from the semi-idle mode on the second link to a
normal communication mode on the second link, and
stopping the semi-idle mode of the communication element and
restoring a normal communication mode on the second link.

89. The method according to any of claims 83 to 88, further comprising
receiving, via the first link, and processing an instruction to release
the second link, and
causing a release of the second link.

90. The method according to any of claims 77 to 89, wherein
the method is functionally implemented in the communication
element, wherein
the first communication network control element controls a macro cell
and comprises at least one of a base station of a cellular network, an
evolved node B of a Long Term Evolution or Long Term Evolution Advanced
communication network, and an access node,
the second communication network control element controls a local
area cell and comprises at least one of a base station of a cellular network,

an evolved node B of a Long Term Evolution or Long Term Evolution Advanced communication network, and an access node, and

the communication element comprises at least one of a terminal device or user equipment communicating with the first and second communication network control elements via the first link and the second link, respectively.

91. A computer program product for a computer, comprising software code portions for performing the steps of any of claims 32 to 62, or of claims 77 to 90, when said product is run on the computer.

92. The computer program product according to claim 91, further comprising a computer-readable medium on which said software code portions are stored.

93. The computer program product according to claim 91, wherein the computer program product is 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.

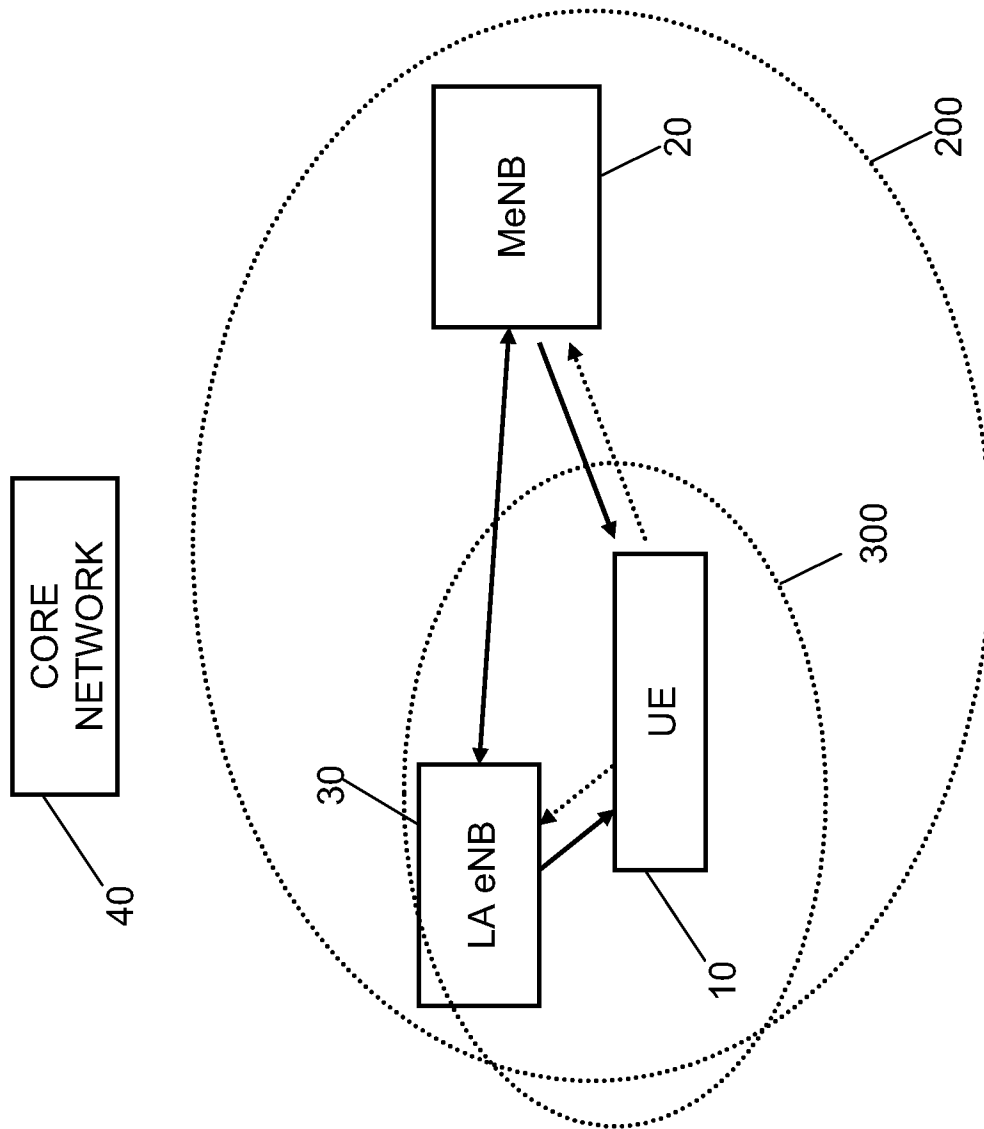


Fig. 1

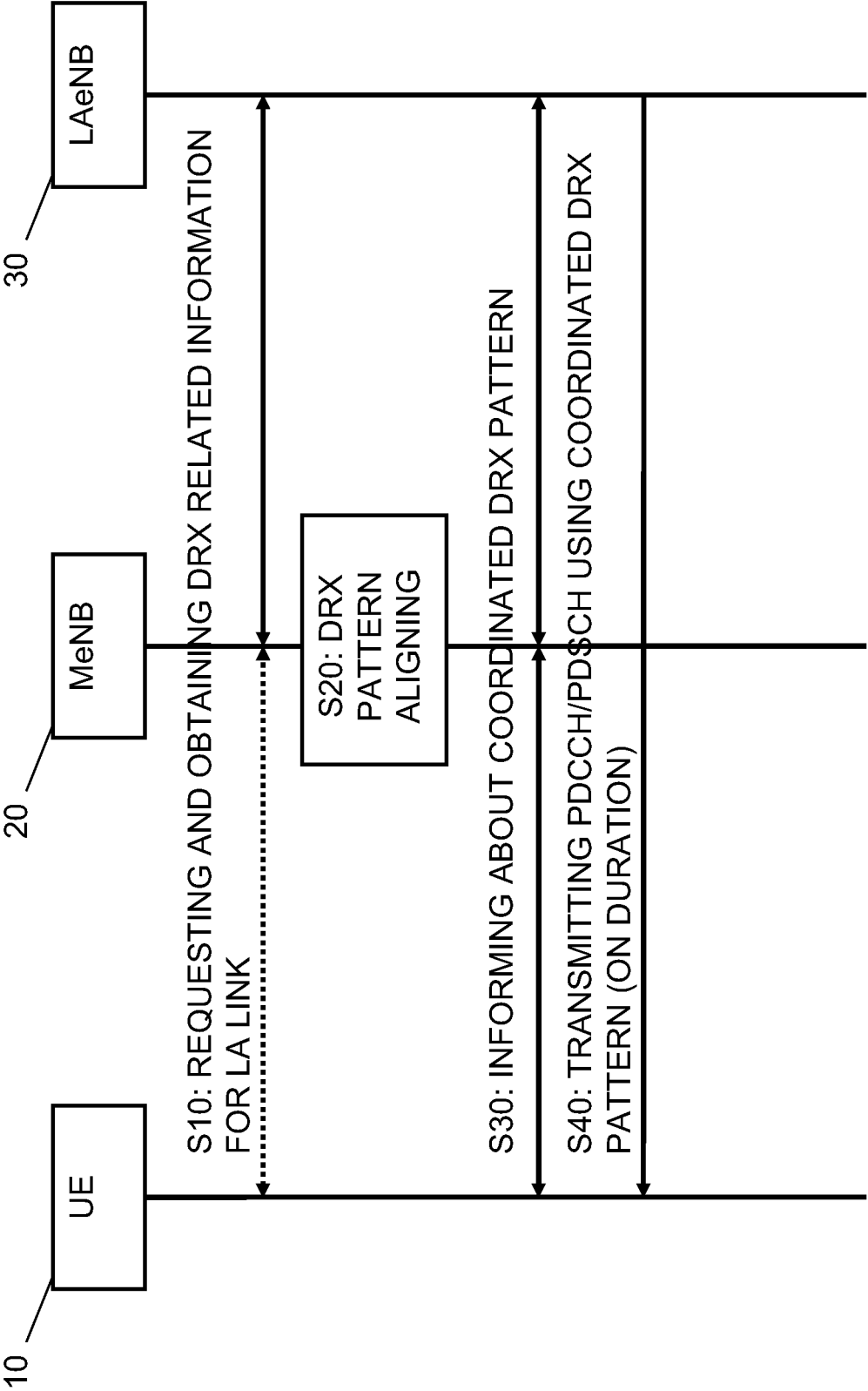


Fig. 2

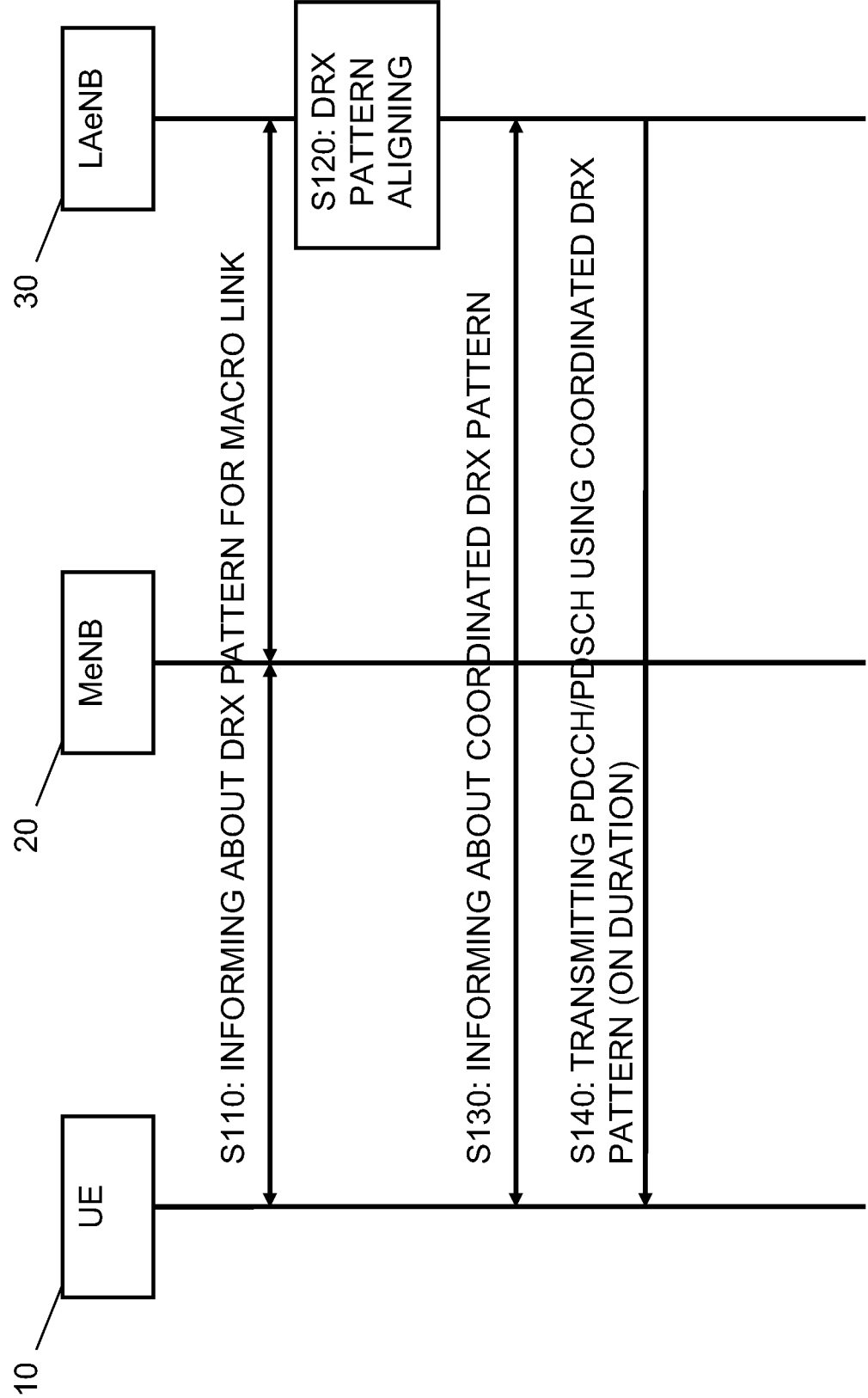


Fig. 3

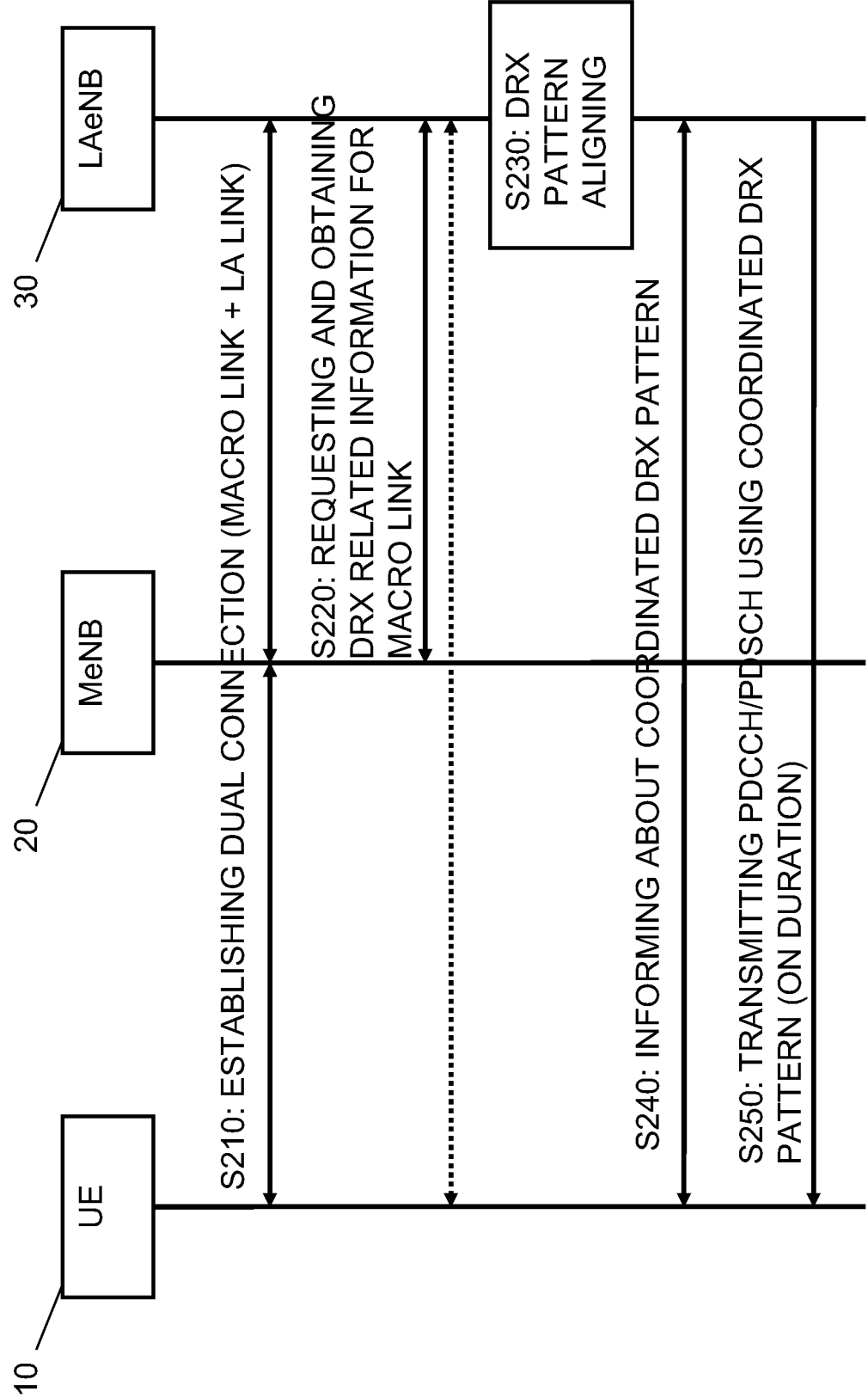


Fig. 4

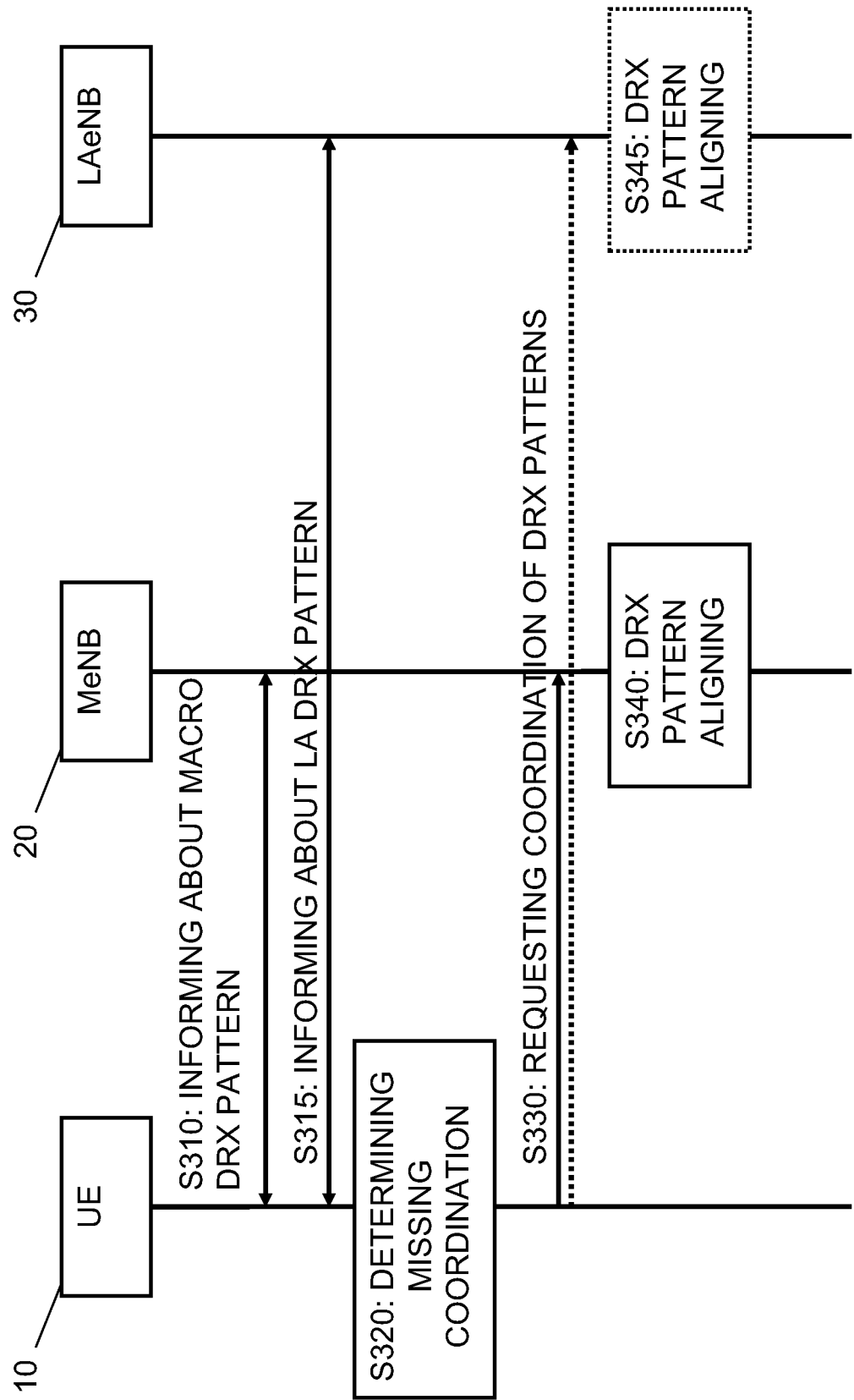
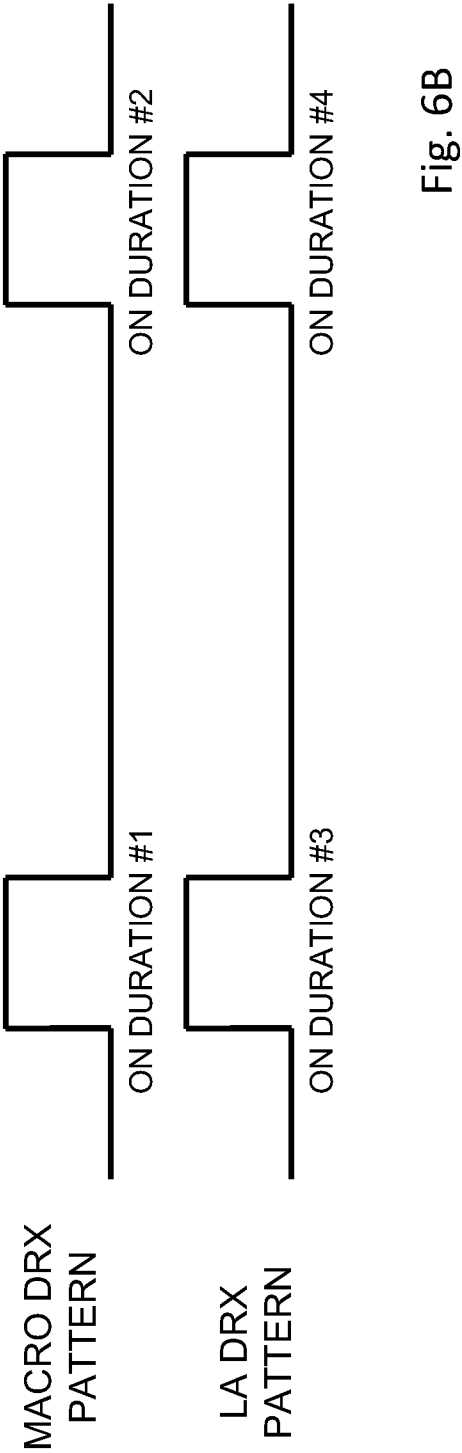
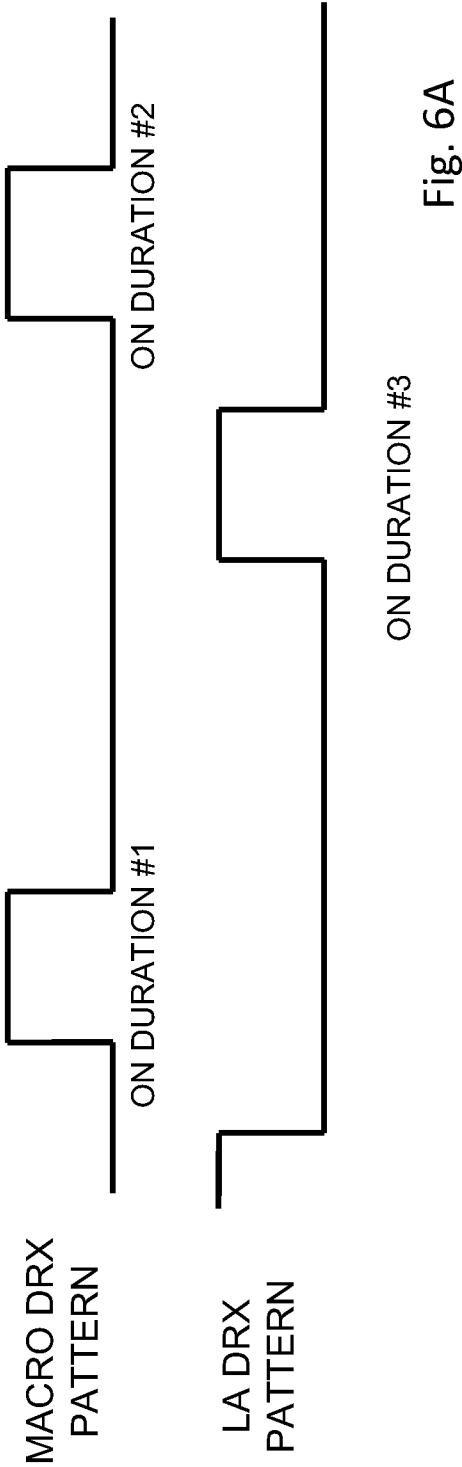


Fig. 5



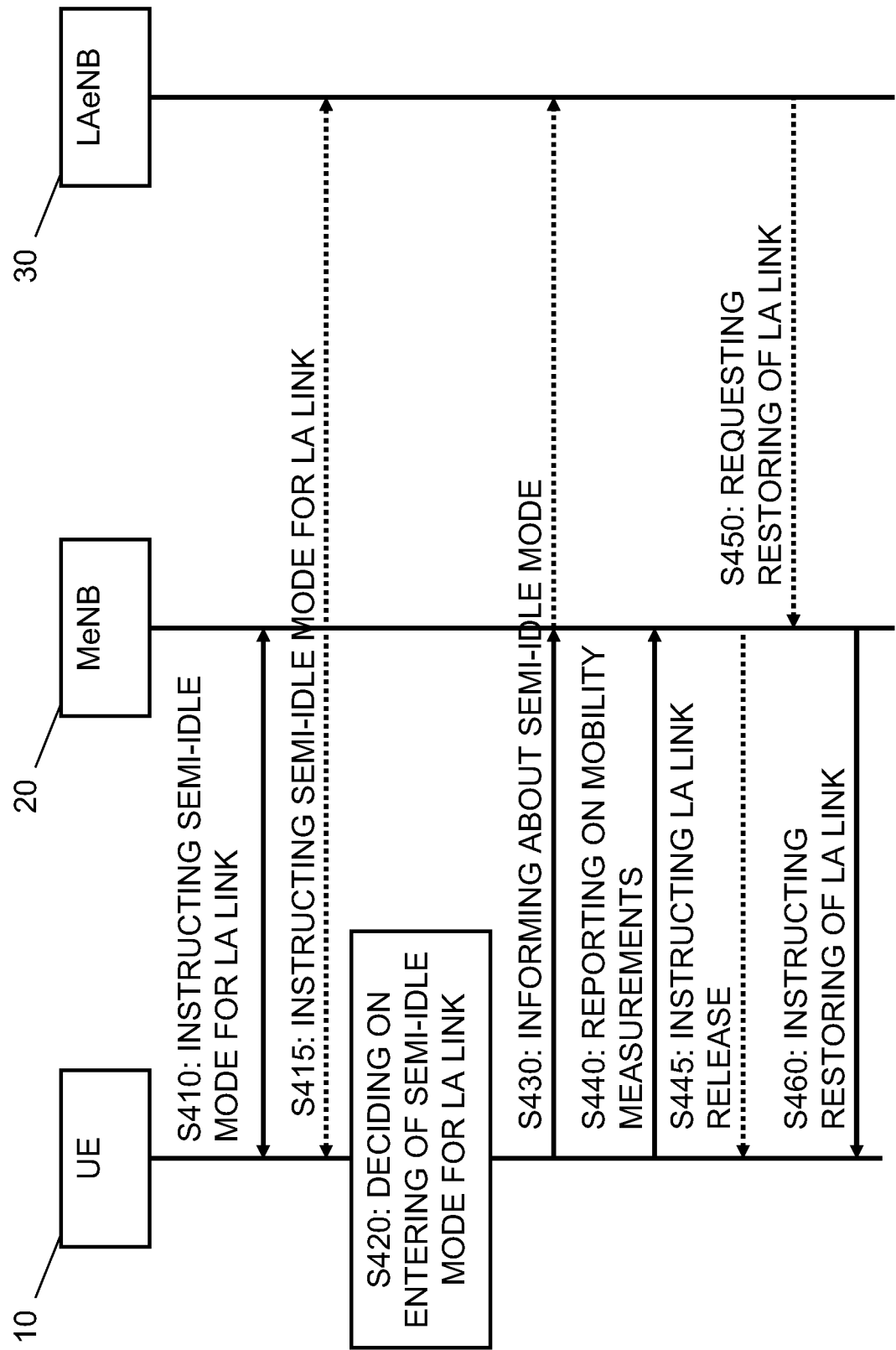


Fig. 7

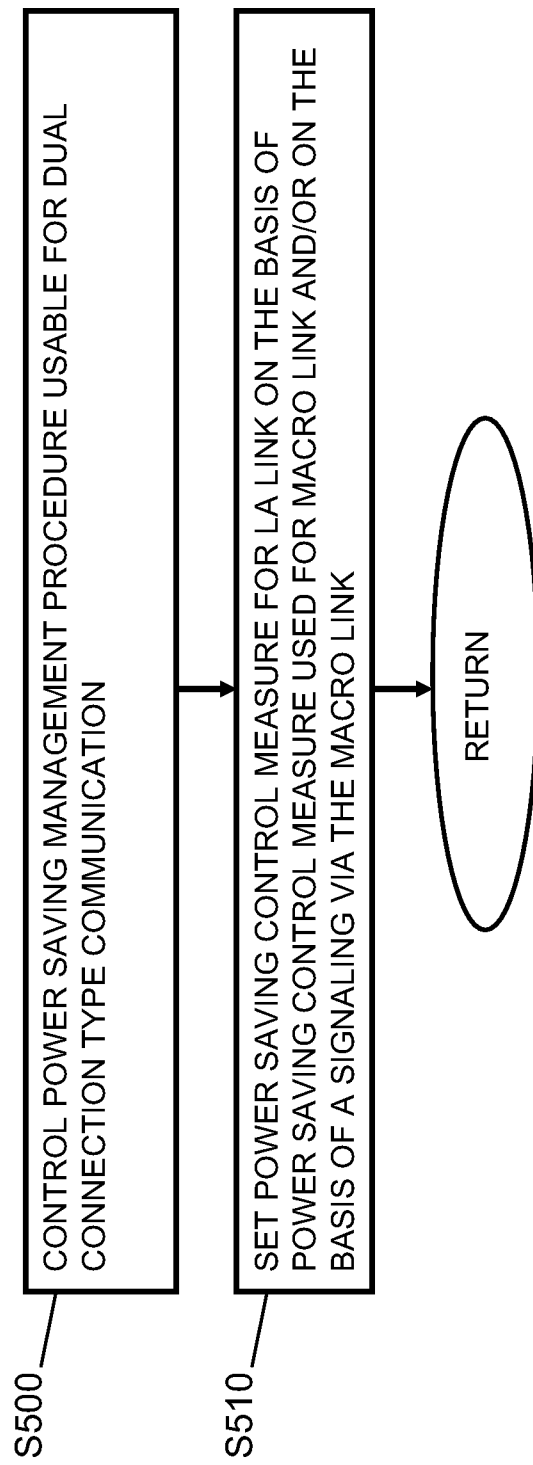


Fig. 8

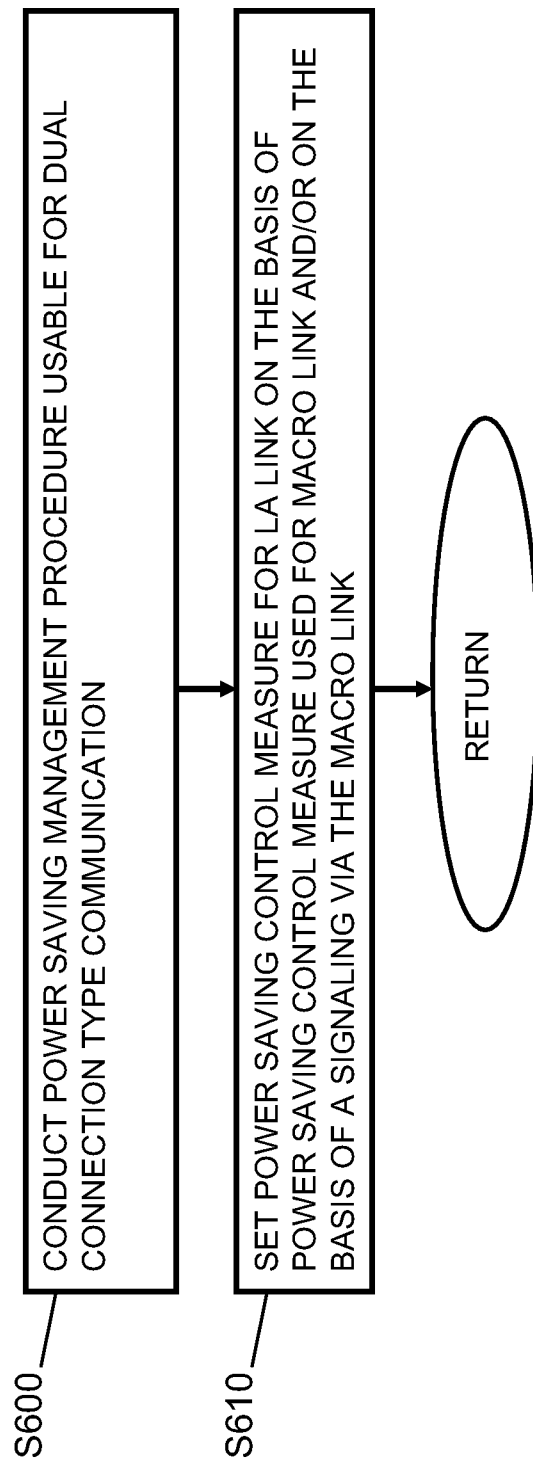


Fig. 9

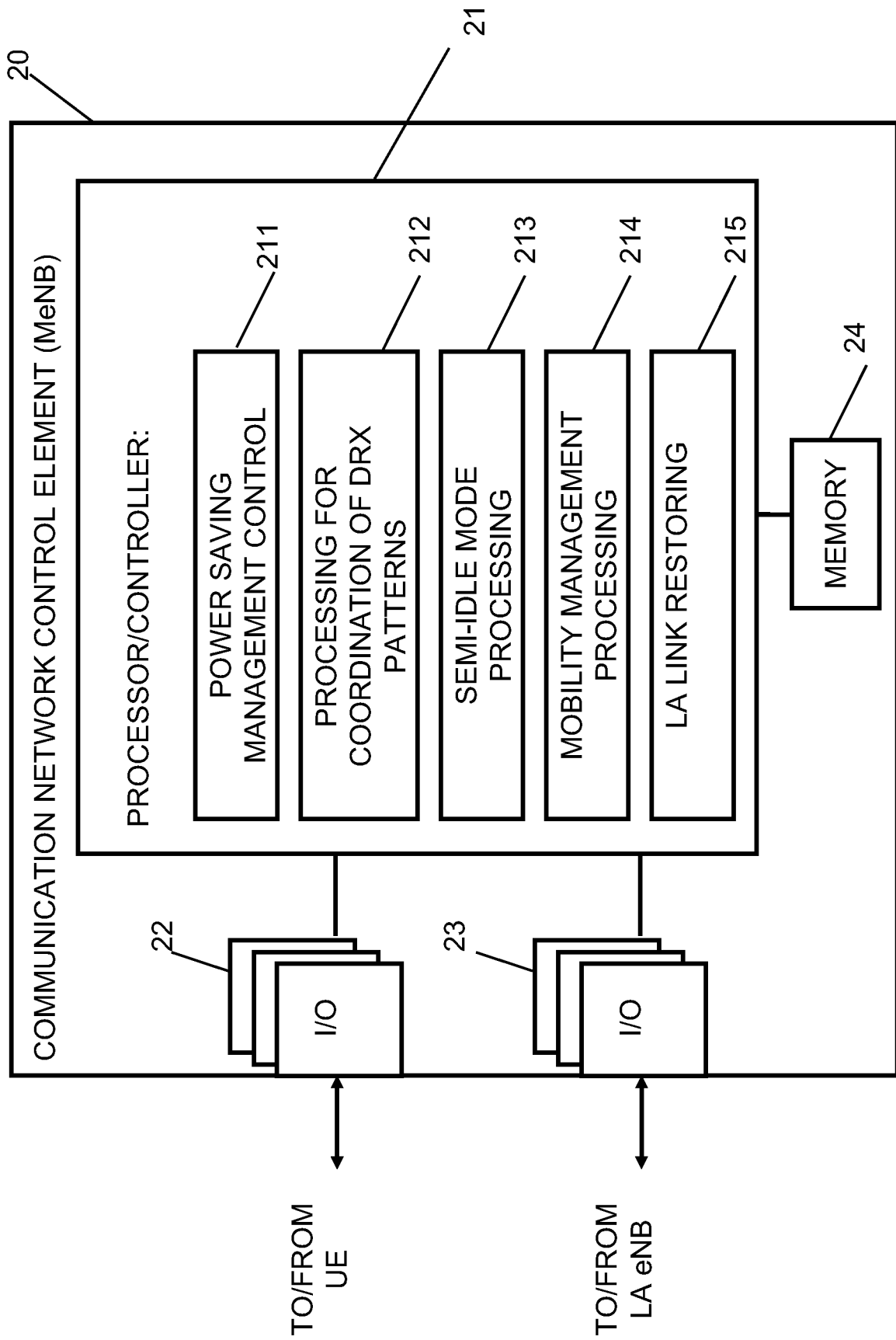


Fig. 10

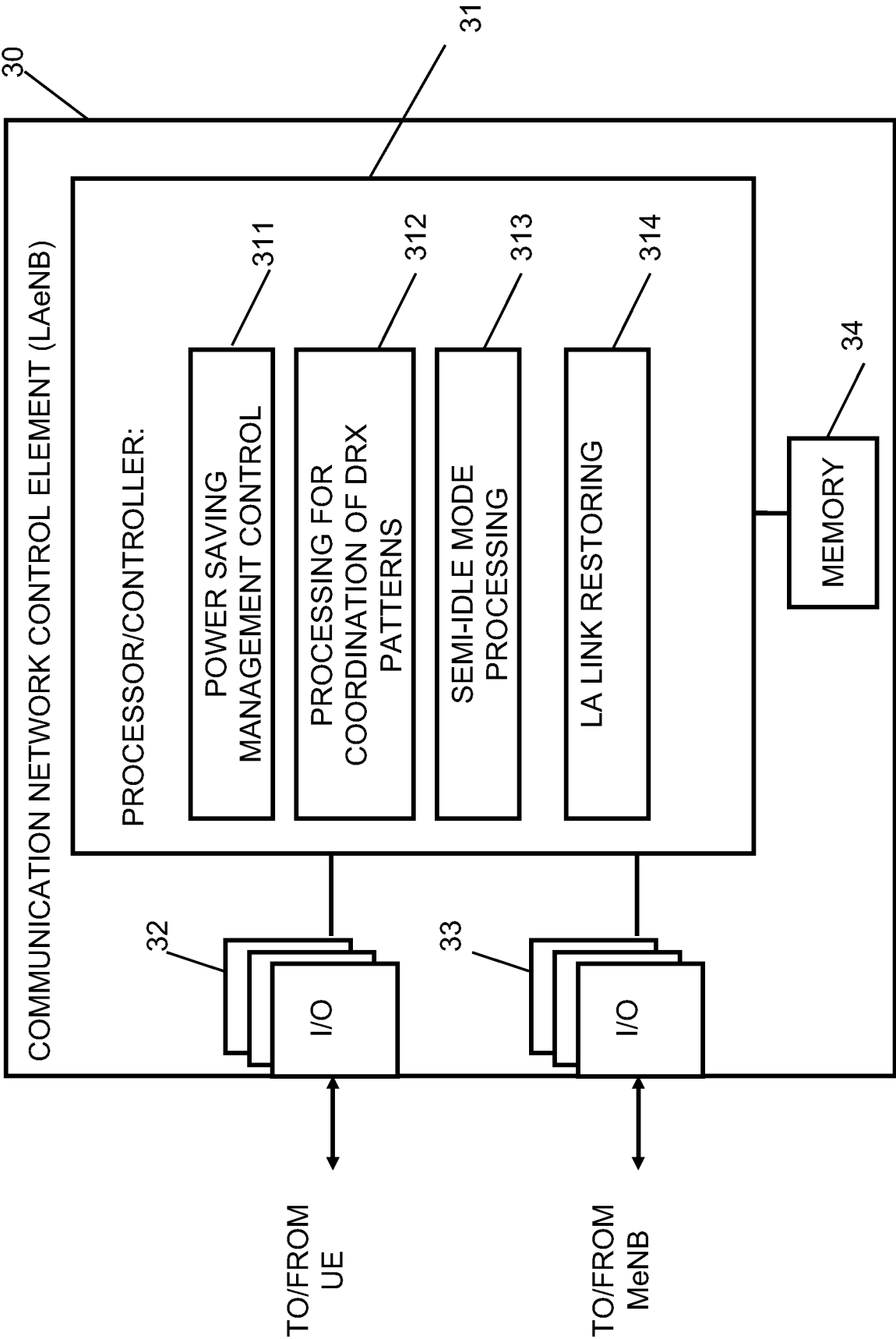


Fig. 11

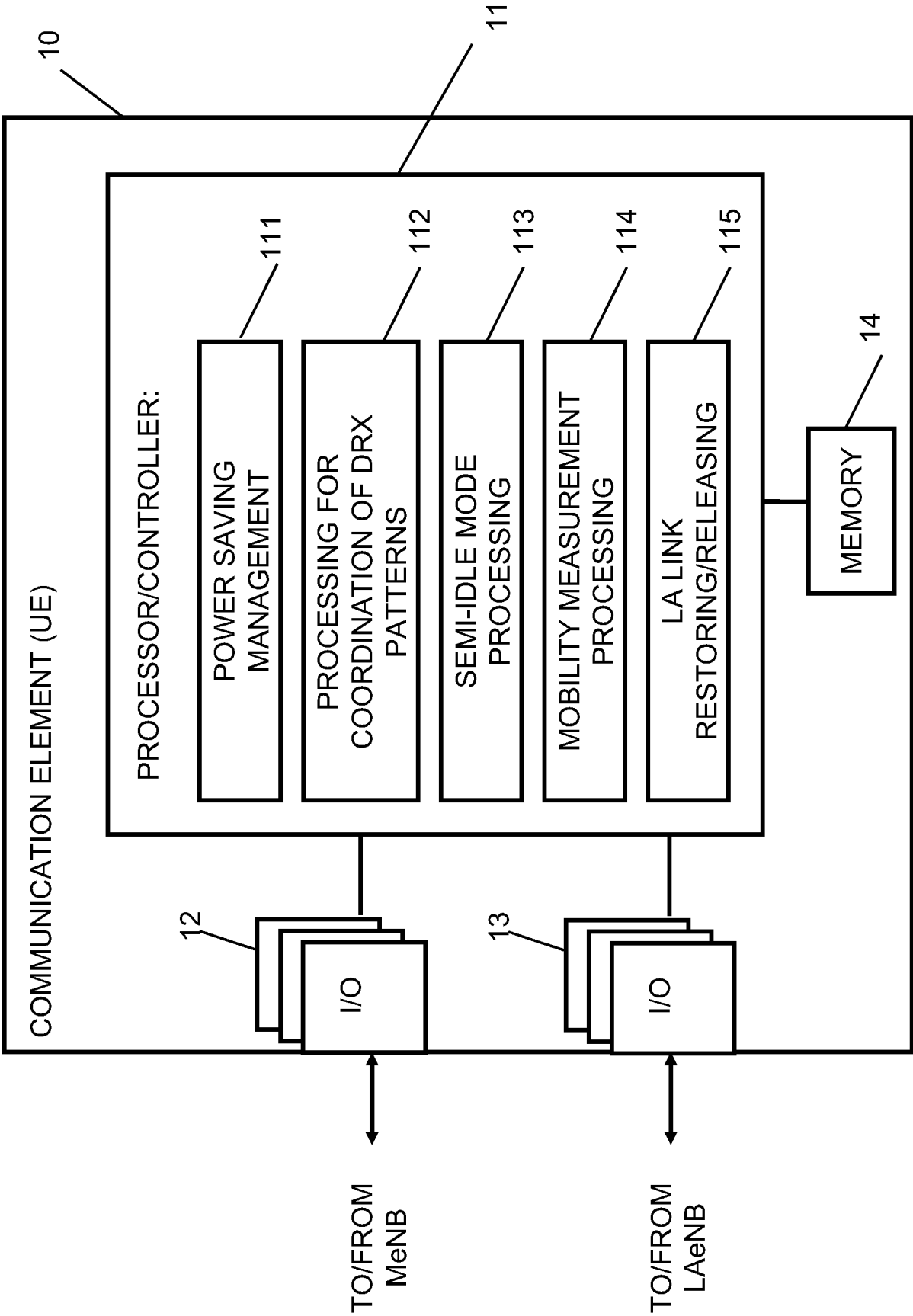


Fig. 12

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2013/071546

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/08 (2009.01) i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H04W, H04L, H04Q

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)

CPRSABS,CNKI,WPI,EPODOC,IEEE,VEN: power, save, control, idle, drx, pattern, macro, cell, femto

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 102573033 A (UNIV XIDIAN) 11 Jul. 2012(11.07.2012) description, paragraphs [0040]-[0082]	1-2,16,32-33,47,63,77, 91-93
A		3-15,17-31,34-46,48-62, 64-76,78-90
A	CN 102905356 A (ALCATEL-LUCENT SHANGHAI BELL CO LTD) 30 Jan. 2013 (30.01.2013) the whole document	1-93
A	CN 101562903 A (NTT DOCOMO INC) 21 Oct. 2009(21.10.2009) the whole document	1-93

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

* Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance

“E” earlier application or patent but published on or after the international filing date

“L” document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)

“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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

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

“&”document member of the same patent family

Date of the actual completion of the international search
21 Oct. 2013(21.10.2013)Date of mailing of the international search report
07 Nov. 2013 (07.11.2013)Name and mailing address of the ISA/CN
The State Intellectual Property Office, the P.R.China
6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China
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International application No.
PCT/CN2013/071546

Form PCT/ISA/210 (patent family annex) (July 2009)