

(51) International Patent Classification:
H04W 56/00 (2009.01)(21) International Application Number:
PCT/CN2014/083747(22) International Filing Date:
5 August 2014 (05.08.2014)

(25) Filing Language: English

(26) Publication Language: English

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

(72) Inventors; and

(71) Applicants (for SC only): XU, Xiang [CN/CN]; Room A-1505, No. 218 Hanzhong Road, Gulou District, Nanjing, Jiangsu 210029 (CN). YAO, Chunhai [CN/CN]; Room 602, Building 125, Nanhuzhongyuan, Chaoyang District, Beijing, 100102 (CN).

(74) Agent: KING & WOOD MALLESONS; 20th Floor, East Tower, World Financial, Centre, No.1 Dongsanhuan Zhonglu, Chaoyang District, Beijing, 100020 (CN).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,

BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— of inventorship (Rule 4.17(iv))

Published:

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

(54) Title: CONTROLLING SYNCHRONIZATION PROCEDURE OF COMMUNICATION NETWORK CONTROL ELEMENTS

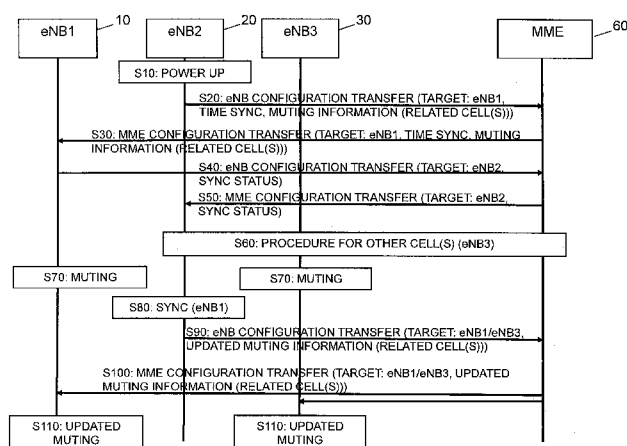


Fig. 2

(57) Abstract: A method including instructing neighboring cells of a synchronization target cell in a communication network to mute, for all stratum levels, specific subframes being transmitted by the neighboring cells and carrying listening reference signals, conducting, when it is assumed that the neighboring cells have muted the specific subframes, a synchronization procedure with a synchronization source cell selected from the neighboring cells, updating, after completing the synchronization procedure, muting information on the basis of a result of the synchronization procedure, and causing transmission of the updated muting information to the neighboring cells.

CONTROLLING SYNCHRONIZATION PROCEDURE OF COMMUNICATION NETWORK CONTROL ELEMENTS

BACKGROUND

5

Field

10

The present invention relates to apparatuses, methods, systems, computer programs, computer program products and computer-readable media usable for controlling a synchronization procedure conducted for synchronizing communication network control elements, such as eNBs.

Background Art

15

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

20

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

25

3GPP	3 rd Generation Partner Project
BS:	base station
CGI:	cell global identity
CoMP:	coordinated multi point transmission
CPU:	central processing unit
CRS:	common reference signal
CSI-RS:	channel state information reference signal
eICIC:	enhanced inter-cell interference coordination
eNB:	evolved node B

30

	EPC:	evolved packet core
	EPS:	evolved packet system
	EUTRAN:	evolved UTRAN
	FDD:	frequency division duplex
5	GNSS:	global navigation satellite system
	ID:	identification, identifier
	IE:	information element
	LTE:	Long Term Evolution
	LTE-A:	LTE Advanced
10	MME:	mobility management element
	OAM:	operation and maintenance
	PRS:	positional reference signal
	PSS:	primary synchronization signal
	RIBS:	radio interface based synchronization
15	RS:	reference signal
	SIB:	system information block
	SINR:	signal to interference plus noise ratio
	SON:	self-organizing network
	SSS:	secondary synchronization signal
20	TDD:	time division duplex
	UE:	user equipment
	UMTS:	universal mobile telecommunication system
	UTRAN:	UMTS terrestrial radio access network
25	Embodiments of the present invention are related to a communication network in which a synchronization among communication network control elements each controlling at least one cell of the communication network is conducted.	
30	SUMMARY	

According to an example of an embodiment, there is provided, for example, a method including instructing neighboring cells of a synchronization target cell in a communication network to mute, for all stratum levels, specific

subframes being transmitted by the neighboring cells and carrying listening reference signals, conducting, when it is assumed that the neighboring cells have muted the specific subframes, a synchronization procedure with a synchronization source cell selectable from the neighboring cells, updating,
5 after completing the synchronization procedure, muting information on the basis of a result of the synchronization procedure, and causing transmission of the updated muting information to the neighboring cells.

Furthermore, according to an example of an embodiment, there is provided,
10 for example, an apparatus including at least one processing circuitry, and at least one memory for storing instructions to be executed by the processing circuitry, wherein the at least one memory and the instructions are configured to, with the at least one processing circuitry, cause the apparatus at least: to instruct neighboring cells of a synchronization target
15 cell in a communication network to mute, for all stratum levels, specific subframes being transmitted by the neighboring cells and carrying listening reference signals, to conduct, when it is assumed that the neighboring cells have muted the specific subframes, a synchronization procedure with a synchronization source cell selectable from the neighboring cells, to update,
20 after completing the synchronization procedure, muting information on the basis of a result of the synchronization procedure, and to cause transmission of the updated muting information to the neighboring cells.

According to further refinements, these examples may include one or more
25 of the following features:

information related to the listening reference signals and identification information of the neighboring cells required for instructing the neighboring cells to mute the specific subframes may be obtained;

the information related to the listening reference signals may include
30 at least one of reference signal pattern information, antenna port information and carrier frequency information;

muting of the specific subframes may include maintaining a transmission of listening reference signals or transmission of listening reference signals and specified information carried in the specific subframes,

and stopping a transmission of other information carried in the specific subframes during a muting phase;

the specified information may comprise at least one of a primary synchronization signal, a secondary synchronization signal, a physical broadcast channel signaling, a system information block, a paging signal, a positional reference signal, and a channel state information reference signal, and the listening reference signal may include a common reference signal or a combination of a common reference signal and a positional reference signal;

instructing the neighboring cells to mute, for all stratum levels, specific subframes being transmitted by the neighboring cells and carrying listening reference signals may include triggering a configuration transfer procedure for retrieving synchronization status information from the neighboring cells, wherein muting information for providing information related to the muting of the specific subframes may be included in a configuration transfer message requesting the synchronization status information; in addition, the synchronization status information may be received from the neighboring cells;

instructing the neighboring cells to mute, for all stratum levels, specific subframes being transmitted by the neighboring cells and carrying listening reference signals may include triggering a configuration transfer procedure for retrieving synchronization status information from the neighboring cells, receiving the synchronization status information from the neighboring cells, and causing transmission of muting information for providing information related to the muting of the specific subframes in a further configuration transfer message;

the updated muting information may indicate to mute only for specific subframes related to a stratum level of the selected synchronization source cell;

transmission of the updated muting information by a configuration transfer signaling message may be caused;

it may be assumed that the neighboring cells have muted the specific subframes, for conducting the a synchronization procedure with the synchronization source cell selected from the neighboring cells, when one of

the following conditions is met: a predetermined time is elapsed since the instruction to mute the specific subframes is issued, and a confirmation indication is received from the neighboring cells that muting is executed;

the processing may be implemented in a communication network control element configured to control at least one cell of the communication network, wherein the neighboring cells may be controlled by a respective other communication network control element of which one may be selectable as a synchronization source;

signaling and messages may be exchanged between the communication network control elements via a core network control element, wherein the communication network may be based on Long Term Evolution or Long Term Evolution Advanced specifications.

In addition, according to an example of an embodiment, there is provided, for example, a method including receiving and processing an instruction from a neighboring cell representing a synchronization target cell in a communication network to mute, for all stratum levels, specific subframes being transmitted and carrying listening reference signals, conducting muting of the specific subframes for all stratum levels according to the instruction, receiving and processing updated muting information from the neighboring cell representing the synchronization target cell, and conducting muting of the specific subframes for stratum levels according to the updated muting information.

Furthermore, according to an example of an embodiment, there is provided, for example, an apparatus including at least one processing circuitry, and at least one memory for storing instructions to be executed by the processing circuitry, wherein the at least one memory and the instructions are configured to, with the at least one processing circuitry, cause the apparatus at least: to receive and process an instruction from a neighboring cell representing a synchronization target cell in a communication network to mute, for all stratum levels, specific subframes being transmitted and carrying listening reference signals, to conduct muting of the specific subframes for all stratum levels according to the instruction, to receive and

process updated muting information from the neighboring cell representing the synchronization target cell, and to conduct muting of the specific subframes for stratum levels according to the updated muting information.

5 According to further refinements, these examples may include one or more of the following features:

muting of the specific subframes may include maintaining a transmission of listening reference signals or transmission of listening reference signals and specified information carried in the specific subframes,
10 and stopping a transmission of other information carried in the specific subframes during a muting phase;

the specified information may comprise at least one of a primary synchronization signal, a secondary synchronization signal, a physical broadcast channel signaling, a system information block, a paging signal, a
15 positional reference signal, and a channel state information reference signal, and the listening reference signal may include a common reference signal or a combination of a common reference signal and a positional reference signal;

for receiving the instruction to mute, for all stratum levels, specific subframes being transmitted and carrying listening reference signals, a
20 configuration transfer procedure may be conducted for providing synchronization status information to a neighboring cell, wherein muting information for providing information related to the muting of the specific subframes may be included in a received configuration transfer message
25 requesting the synchronization status information;

transmission of the synchronization status information to the requesting neighboring cell may be caused;

for receiving the instruction to mute, for all stratum levels, specific subframes being transmitted and carrying listening reference signals, a
30 configuration transfer procedure for providing synchronization status information to a neighboring cell may be conducted, transmission of the synchronization status information to the neighboring cell may be caused, and a further configuration transfer message including muting information

for providing information related to the muting of the specific subframes may be received;

the updated muting information may indicate to mute only for specific subframes related to a stratum level of the selected synchronization source cell;

the updated muting information may be received in a configuration transfer signaling message;

the muting of the specific subframes may be conducted in a predetermined time after receiving the instruction to mute the specific subframes;

transmission of a confirmation indication to neighboring cell may be caused when the muting of the specific subframes is completed;

the processing may be implemented in a communication network control element configured to control at least one cell of the communication network, wherein the neighboring cell from which the instruction may be received may be controlled by another communication network control element which may be a synchronization target;

signaling and messages may be exchanged between the communication network control elements via a core network control element, wherein the communication network may be based on Long Term Evolution or Long Term Evolution Advanced specifications.

In addition, according to embodiments, there is provided, for example, a computer program product for a computer, including 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 include a computer-readable medium on which said software code portions are stored. Furthermore, the computer program product may be directly loadable into the internal memory of the computer and/or transmittable via a network by means of at least one of upload, download and push procedures.

BRIEF DESCRIPTION OF THE DRAWINGS

Some embodiments of the present invention are described below, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 shows a diagram illustrating a general configuration of a communication network where some examples of embodiments are implementable;

Fig. 2 shows a signaling diagram illustrating a synchronization control processing according to some examples of embodiments;

Fig. 3 shows a signaling diagram illustrating a synchronization control processing according to some examples of embodiments;

Fig. 4 shows a flow chart of a processing conducted in a communication network control element of a synchronization target cell according to some examples of embodiments;

Fig. 5 shows a flow chart of a processing conducted in a communication network control element of a (potential) synchronization source cell according to some examples of embodiments;

Fig. 6 shows a diagram of a communication network control element of a synchronization target cell according to some examples of embodiments; and

Fig. 7 shows a diagram of a communication network control element of a (potential) synchronization source cell according to some examples of embodiments.

DESCRIPTION OF EMBODIMENTS

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) like the Universal Mobile Telecommunications System (UMTS), and fourth generation (4G) communication networks or enhanced communication networks based e.g. on LTE or LTE-A, cellular 2nd generation (2G) communication networks like the Global System for Mobile communications (GSM), the General Packet Radio System (GPRS), the Enhanced Data Rates for Global Evolution (EDGE), or other wireless communication system, such as the Wireless Local Area Network (WLAN), Bluetooth or Worldwide Interoperability for Microwave Access (WiMAX), took place all over the world. Various organizations, such as the 3rd Generation Partnership Project (3GPP), Telecoms & Internet converged Services & Protocols for Advanced Networks (TISPAN), the International Telecommunication Union (ITU), 3rd Generation Partnership 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.

In the following, examples of embodiments are described with reference to the drawings, wherein, as an example of a communication network, a cellular wireless communication network, such as an LTE-Advanced based system, is used, in which communication cells are controlled by a corresponding communication network control element, such as an eNB, wherein the cells may be of different sizes, such as so-called macro cells, small cells (e.g. so-called pico cells, femto cells etc.) etc.. 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, be it wireless systems, wired systems or systems using a combination thereof.

The following examples and embodiments are to be understood only as illustrative examples. Although the specification may refer to "an", "one", or "some" example(s) or embodiment(s) in several locations, this does not necessarily mean that each such reference is related to the same

example(s) or embodiment(s), or that the feature only applies to a single example or embodiment. Single features of different embodiments may also be combined to provide other embodiments. Furthermore, terms like "comprising" and "including" should be understood as not limiting the described embodiments to consist of only those features that have been mentioned; such examples and embodiments may also contain features, structures, units, modules etc. that have not been specifically mentioned.

A basic system architecture of a communication system where examples of embodiments are applicable may include an architecture of one or more communication networks including a wired or wireless access network subsystem and a core network. Such an architecture may include one or more communication network control elements, access network elements, radio access network elements, access service network gateways or base transceiver stations, such as a base station (BS), an access point or an eNB, which control a respective coverage area or cell(s) and with which one or more communication elements or terminal devices such as a UE or another device having a similar function, such as a modem chipset, a chip, a module etc., which can also be part of an element, function or application capable of conducting a communication, such as a UE, an element or function usable in a machine to machine communication architecture, or attached as a separate element to such an element, function or application capable of conducting a communication, or the like, are capable to communicate via one or more channels for transmitting several types of data. Furthermore, core network elements such as gateway network elements, policy and charging control network elements, mobility management entities, operation and maintenance elements, and the like may be included.

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

communication network control element such as an eNB, and a communication network besides those described in detail herein below.

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

Furthermore, the described network elements, such as communication network control elements of a cell, like an eNB, access network elements and the like, core network elements such as an MME or OAM etc. as well as
15 corresponding functions as described herein, and other elements, functions or applications may be implemented by software, e.g. by a computer program product for a computer, and/or by hardware. For executing their respective functions, correspondingly used devices, nodes or network elements may include several means, modules, units, components, etc. (not
20 shown) which are required for control, processing and/or communication/signaling functionality. Such means, modules, units and components may include, for example, one or more processors or processor units including one or more processing portions for executing instructions and/or programs and/or for processing data, storage or memory units or
25 means for storing instructions, programs and/or data, for serving as a work area of the processor or processing portion and the like (e.g. ROM, RAM, EEPROM, and the like), input or interface means for inputting data and instructions by software (e.g. floppy disc, CD-ROM, EEPROM, and the like), a user interface for providing monitor and manipulation possibilities to a
30 user (e.g. a screen, a keyboard and the like), other interface or means for establishing links and/or connections under the control of the processor unit or portion (e.g. wired and wireless interface means, radio interface means including e.g. an antenna unit or the like, means for forming a radio communication part etc.) and the like, wherein respective means forming

an interface, such as a radio communication part, can be also located on a remote site (e.g. a radio head or a radio station etc.). It is to be noted that in the present specification processing portions should not be only considered to represent physical portions of one or more processors, but may also be considered as a logical division of the referred processing tasks performed by one or more processors.

It should be appreciated that according to some examples, a so-called "liquid" or flexible network concept may be employed where the operations and functionalities of a communication network element, network function, or of another entity of the communication network, such as of one or more of radio access network elements like an eNB, may be performed in different entities or functions, such as in a node, host or server, in a flexible manner. In other words, a "division of labour" between involved network elements, functions or entities may vary case by case.

For properly conducting communications in a communication system using an access subsystem comprising e.g. BS or eNBs, it is required to synchronize the BS or eNBs with each other. In the following, this will be referred to as "eNB synchronization", wherein the same principles are also applicable for other access network elements, such as access points, BS etc..

eNB synchronization is related to uniform starting time of data transmission from eNBs so that the transmitted signal from multiple eNBs is received by mobile devices such as UEs at approximately the same time. Without time synchronization, a listener may hear time gaps in received signals as the device moves between cell radio coverage areas. Hence, synchronization among eNBs is important, not only for TDD system but also for at least some features of FDD systems, such as CoMP and eICIC.

A plurality of synchronization solutions is conceivable. For example, one solution is that the eNB synchronizes to a GNSS. Another solution is that

eNB synchronization is conducted by using a time protocol, such as IEEE 1588v2.

On the other hand, e.g. in cases where a GNSS signal is not available or backhaul link limitations are to be considered, also a so-called over-the-air synchronization solution is applicable, as defined e.g. by 3GPP. Here, a listening eNB measures the PSS/SSS/CRS of a source eNB to get the synchronization. A further development of such an over-the-air synchronization solution is RIBS, which is extended, for example, to FDD (small) cell and adapted to a dense small cell deployment scenario for achieving an improved synchronization accuracy.

RIBS is an approach to provide an efficient radio interface based inter-cell synchronization, i.e. network listening, in a single-carrier or multi-carrier operation. In particular, it is intended to support multiple stratum levels (beyond 3 hops, e.g. 4 to 6 hops), wherein the number of hops configured in the network may be dependent on scenarios. Furthermore, the achievable synchronization accuracy is to be improved based on existing RSs, e.g. by improving the hearability of received RS for network listening at the target cells. RIBS is also intended to be applicable to small cell on/off and enhanced interference mitigation and traffic adaptation, and inter-operator TDD deployment in the same band.

With regard to Fig. 1, a diagram illustrating examples of a communication network configuration is shown where examples of embodiments of the invention are applicable. It is to be noted that the structure indicated in Fig. 1 shows only those devices, network elements and links which are useful for understanding principles underlying the 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 communication in the network which are omitted here for the sake of simplicity.

It is to be noted that the example shown in Fig. 1 is related to a densely deployed small cells scenario, but examples of embodiments are also

applicable in other deployment scenarios being not related (solely) to densely deployed small cells.

In Fig. 1, reference sign 10 denotes, as a communication network control element, an eNB controlling at least one communication area or cell (small cell) 100 (the communication network control element is referred to herein as eNB1). Reference sign 20 denotes, as a further communication network control element, an eNB controlling at least one communication area or cell (small cell) 200 (the communication network control element is referred to herein as eNB2). Reference sign 30 denotes, as a further communication network control element, an eNB controlling at least one communication area or cell (small cell) 300 (the communication network control element is referred to herein as eNB3). Reference sign 40 denotes, as a further communication network control element, an eNB controlling at least one communication area or cell (small cell) 400 (the communication network control element is referred to herein as eNB4). It is assumed that the cells 100 to 400 overlap at least partially with each other so that interferences may be caused by communications in the respective cells.

Reference sign 50 denotes an OAM entity or function which is connected to the eNBs via a suitable interface 55 (e.g. wired or wireless) for control purposes. In Fig. 1, only the connection to the eNB2 20 is depicted, but it is obvious that the OAM is also connected to the other communication network control elements, such as eNBs 10, 30 and 40.

Reference sign 60 denotes a communication network control element of a core network, such as a MME. The MME 60 is connected to the access network (i.e. the eNBs) via a suitable link or interface, such as an S1 interface.

In the example illustrated in Fig. 1, it is assumed that eNB2 20 has to conduct a synchronization with the network by means of an over-the-air synchronization mechanism, such as RIBS (for example, eNB2 20 is just powered on). Due to this, eNB2 20 has to listen to other cells for receiving

RS used for synchronization. That is, in the scenario of Fig. 1, since eNB2 20 listens to other cells for synchronization purposes, cell 200 is referred to also as a synchronization target cell. On the other hand, eNB1 10, eNB3 30 and eNB4 40 are potential candidates for eNB2 20 for synchronization, i.e. cells 100, 300 and 400 are potential synchronization source cells. It is assumed in the following that eNB1 10 is used by eNB2 20 for synchronization, i.e. cell 200 is the synchronization source cell (indicated in Fig. 1 by a dashed arrow). On the other hand, the other neighboring cells or eNBs (eNB3 30 and eNB4 40) are to be seen by eNB2 20 as interference cells in the synchronization procedure (indicated in Fig. 1 by chain-dotted arrows).

Specifically, when, as indicated above, eNB2 20 is the synchronization target and eNB1 10 is the synchronization source, i.e. when eNB2 20 tries to synchronize to eNB1 10, eNB2 20 monitors the subframe(s) carrying listening RS (CRS, CRS+PRS or other RS for synchronization purpose) of eNB1 10. In case the synchronization status/stratum level of the eNB being the synchronization source (e.g. eNB1 10) is stratum level 1, then the synchronization target (e.g. eNB2 20) is in stratum level 2. However, at the same time, eNB2 20 may receive also the interference from eNB3 30 (e.g. in stratum level 3) and eNB4 40 (e.g. in stratum level 3). As a result, the synchronization accuracy may be degraded with the received interference.

One possibility to improve the synchronization performance in a scenario as indicated in Fig. 1 is to use subframe-level muting. Assuming that a supported maximum stratum level in Fig. 1 is 4, then specific subframe(s) carrying listening RS for each stratum level are different to each other. In this case, an eNB has several choices to do subframe muting, e.g. to mute only subframe(s) for a specific stratum level or to mute subframe(s) for all stratum levels. Furthermore, it is possible to differentiate the muting scheme according to whether muting is to be executed with regard to a (new) eNB powering on or a (known) eNB doing synchronization tracking. Also overhead caused by subframe muting is to be considered.

When considering a situation where a (new) eNB is started (powered on) and requires synchronization, it is possible that problems arise. Specifically, in case interference from a neighboring cell (e.g. eNB4 40) is strong, eNB2 20 may not be able to synchronize to eNB1 10 (in case of eNB4 does not apply subframe muting, as described later). In short, when an eNB such as eNB2 20 is booting up, the eNB may not be able to select the optimal synchronization source because of the interference from neighboring eNBs, which may degrade the synchronization accuracy. Furthermore other eNBs may not get the synchronization source because of a maximum stratum level is reached (in case the stratum level of the selected synchronization source is higher than required).

Another possibility for synchronization procedure is a stratum indication by blind detection. Here, the eNB just mutes the subframes according to its stratum level. For instance, if the eNB stratum level is 2, then eNB mutes the subframe(s) and tracks the listening RS of stratum level 1, and also mutes the subframe(s) to avoid interference to a listening of a stratum level 1 eNB. However, also in this procedure, in case an eNB powers on, it is possible that not the optimal synchronization source is selected because the subframe carrying listening RS in higher stratum level is not protected.

Consequently, it is required to deal with interference issues before eNB synchronizes to the network in order to ensure that the eNB is able to synchronize to the optimal synchronization source by avoiding a (strong) interference.

According to examples of embodiments of the invention, a synchronization control is implemented in which the synchronization performance is improved, for example in cases where a communication network control element, such as an eNB is started up. According to some examples of embodiments, in particular the hearability of listening RS is improved.

According to examples of embodiments, a synchronization control method is defined which is capable to support the muting of subframes for a

synchronization procedure which is based, for example, on RIBS. Specifically, according to examples of embodiments, before a communication network control element, such as an eNB (in Fig. 1, for example, eNB2 20) executed a synchronization procedure, it informs or instructs the neighboring cells (i.e. all neighboring cells being possible interference sources) to mute specific subframes for all stratum levels. After the synchronization is completed, the (target) communication network control element updates the setting for muting (i.e. updates corresponding muting information which is used for informing/instructing the muting of subframes for all stratum levels in the beginning) and sends the updated muting information to indicate all the neighboring cells to mute subframes only for specific stratum level (which is based on the synchronization result).

It is to be noted that „mute“ or „muting“ subframes is to be understood in such a manner that specific subframes (e.g. the subframes carrying listening RS) are modified so as to further transmit specific information or signals, such as PSS/SSS/PBCH/SIB1/Paging/PRS/CSI-RS, wherein also the listening RS (which can be e.g. CRS or CRS+PRS, according to RIBS, for example) are transmitted in case the subframe in question is configured to carry the listening RS. On the other hand, when a subframe is muted, no other signal or information is transmitted. It is to be noted that it is subject to the network configuration what kind of subframe is used for listening RS transmission.

According to examples of embodiments, for exchanging muting information, but also listening patterns or synchronization information between cells (i.e. corresponding eNBs, for example), core network elements are used, e.g. via S1 signaling using the MME 60 as a relay.

By means of the measures discussed above and provided in some examples of embodiments, an efficient synchronization control method is achieved which enables to support the muting for RIBS, for example, wherein a muting overhead is reasonably sized, a listening RS hearability is enhanced

and the synchronization accuracy is improved. Furthermore, the synchronization control according to some examples of embodiments is applicable in a case when a communication network control element, such as an eNB, powers on and when it is in synchronization tracking stage.

5

In the following, some examples of embodiments of the invention are explained assuming that an eNB, i.e. eNB2 20 shown in Fig. 1, is powered on and needs to do synchronization with RIBS, i.e. a synchronization and muting procedure is conducted between eNBs shown in Fig. 1 using a signaling via the MME 60.

10

According to a first example of embodiments, in an initial phase after start, the powered on communication network control element, such as eNB2 20, obtains listening RS related information on specific frequency, such as the listening RS pattern (CRS, or CSR+PRS and antenna ports info), carrier frequency information, periodicity information and a subframe offset. According to some examples of embodiments, the listening RS related information is obtained e.g. by the OAM 50 via link 55. For example, the listening RS for each stratum could be statically configured in a certain radio-frame and subframe, e.g. stratum-1 cells transmit the listening RS in a first set of subframes while stratum-2 cells transmit the listening RS in another set of subframes. In addition, the eNB2 20 obtains also neighboring cells ID, e.g. by a SON processing or also configured by OAM 50.

15

20

25

30

Next, the eNB2 20 triggers a signaling between the communication network control elements (i.e. eNBs), for example, by means of a communication conducted via the core network. For example, according to some examples of embodiments, for communicating between the eNBs of the EUTRAN, a control element of the EPC is used for forwarding the signaling, such as the MME 60 via S1 link. In such a S1 signalling process, all neighboring cells are requested to mute the subframes for all stratum levels, except that at least the listening RS is still transmitted from the neighboring cells.

In response to the S1 signaling, according to some examples of embodiments, the neighboring cells may send back synchronization status information, i.e., synchronization status and stratum level. It is to be noted that this step may be omitted, depending on eNB implementation by detecting listening RS on specific place with network configuration of the listening RS for synchronized node and asynchronized node (that is, an eNB may be configured to detect the stratum of neighboring cells, considering the network configuration on listening RS; for example, the network may configure that listening RS for stratum 1 is transmitted in subframe #1 of a radio frame #1, wherein other eNBs may detect the listening RS in subframe#1 of radio frame #1, so that the eNB knows that the detected eNB is stratum 1).

Next, the eNB2 20 conducts the synchronization procedure with a selected source cell. As indicated above, the selected source cell is assumed to be that of eNB1 10. With regard to the selection process of the source cell, eNB2 20 may detect more than one synchronization signal from multiple cells (e.g. also from eNB3 30 or eNB4 40). After acquiring a respective measurement of listening RS SINR, stratum levels, synchronization status and listening pattern, eNB2 20 may conduct a selection for the source cell on the basis of a comparison of the stratum level (i.e. the cell with the lowest stratum level and best SINR is selected) wherein also an appropriate listening RS pattern may be considered in the selection for being the source cell.

After the synchronization with eNB1 10 is completed, the eNB2 20 refines or updates the muting information and informs all neighboring cells to mute only for specific stratum level.

Fig. 2 shows a signaling diagram illustrating a synchronization control processing according to some examples of embodiments which correspond to the above described alternative. It is to be noted that the signaling partners indicated in Fig. 2 are related to the elements shown in Fig. 1.

In S10, the eNB2 20 powers up. In this connection, according to some examples of embodiments, also the listening RS related information and the neighboring cell IDs can be obtained from OAM (not shown). Alternatively, the neighboring cell IDs may be detected by eNB 20.

5

In S20, the eNB2 initiates, for example, a SON procedure for retrieving eNB1 10 synchronization status (time sync) by transmitting an eNB Configuration Transfer procedure related message to the MME 60. The eNB Configuration Transfer message further includes an information or instruction for muting specific subframes for all stratum levels, e.g. in the form of corresponding muting information. In this context, it may also be indicated which cells controlled by eNB1 10 are to be considered (in case eNB1 10 controls more than one cell, for example).

10

15

In S30, the MME 60 sends an MME Configuration Transfer message to eNB1 10. The MME Configuration Transfer message in S30 reflects the information included in the eNB Configuration Transfer message of S20, i.e. it includes also the muting information, for example.

20

In S40, the eNB1 10 replies with synchronization status by sending a corresponding eNB Configuration Transfer message to the MME 60, wherein the eNB2 20 is indicated as a target. Correspondingly, in S50, the MME 60 sends a corresponding MME Configuration Transfer message to the eNB2 20, in which the synchronization status of eNB1 10 is included.

25

S60 is related to a procedure for retrieving synchronization information and providing muting information from/to other cells/eNBs. In Fig. 2, only eNB3 30 is depicted, but corresponding procedures are to be executed also with regard to (all) other neighboring cells, such as cell 400 (eNB4 40). The processing to be conducted in S60 corresponds to the processing described in connection with S20 to S50.

30

In S70, eNB1 10 and eNB3 30 perform muting for subframes related to all stratum levels, in accordance with the muting information which is received

from the eNB2 20 (in S20 to S50). It is to be noted that the muting is executed, for example, after a certain period of time after having received the muting information. Furthermore, even though not shown in Fig. 2, according to some examples of embodiments, the eNBs conducting the muting may also send a confirmation indication to eNB2 20 in order to inform it that the muting is done.

Thus, in S80, when it is assumed that the muting for the subframes related to all stratum levels is done by the neighboring cells, the eNB2 20 selects a synchronization source and conducts a synchronization procedure to e.g. eNB1 10 (in the following, it is assumed that eNB1 10 has a stratum level of 1).

In S90, after the synchronization is completed, the eNB2 20 initiates eNB Configuration Transfer procedure to inform eNB1 and eNB3 for a refined or updated muting. That is, updated muting information is generated for being forwarded to the neighboring cells. For example, a Muting Stratum info IE (described later) is set to such a value that the other eNBs recognizes to mute only subframes for stratum level 1.

In S100, similar to the preceding processing, the MME 60 sends a MME Configuration Transfer message to eNB1 10 and eNB3 30 for providing the updated muting information.

Correspondingly, in S110, eNB1 10 and eNB3 30 update a muting of subframes. Specifically, eNB3 30 performs a processing for muting only for subframes related to stratum level 1, and eNB1 10 stops the muting for subframes related to other stratum levels. Then, the synchronization control procedure is completed.

Next, a second first example of embodiments is described. Also in the second example of embodiments, in an initial phase after start, the powered on communication network control element, such as eNB2 20, obtains listening RS related information, such as the listening RS pattern (CRS, or

CSR+PRS and antenna ports info), carrier frequency information, periodicity information and a subframe offset. According to some examples of embodiments, the listening RS related information is obtained e.g. by the OAM 50 via link 55, as in the first example of embodiments. In addition, the eNB2 20 obtains also neighboring cells ID, e.g. by a SON processing or also configured by OAM 50.

Next, the eNB2 20 triggers a signaling between the communication network control elements (i.e. eNBs), for example, by means of a communication conducted via the core network. For example, according to some examples of embodiments, for communicating between the eNBs of the EUTRAN, a control element of the EPC is used for forwarding the signaling, such as the MME 60 via S1 link.

In response to the S1 signaling, the neighboring cells may send back synchronization status information, i.e., synchronization status and stratum level.

Then, the eNB2 20 requests in a further S1 signaling process all neighboring cells to mute the subframes for all stratum levels, except that at least the listening RS is still transmitted from the neighboring cells.

Next, the eNB2 20 conducts the synchronization procedure with a selected source cell. As indicated above, the selected source cell is assumed to be that of eNB1 10. With regard to the selection process of the source cell, eNB2 20 may detect more than one synchronization signal from multiple cells (e.g. also from eNB3 30 or eNB4 40). After acquiring the respective stratum levels, synchronization status and listening pattern, eNB2 20 may conduct a selection for the source cell on the basis of a comparison of the stratum level (i.e. the cell with the lowest stratum level and best listening RS SINR is selected) wherein also an appropriate listening pattern may be considered in the selection for being the source cell.

After the synchronization with eNB1 10 is completed, the eNB2 20 refines or updates the muting information and informs all neighboring cells to mute only for specific stratum level.

Fig. 3 shows a signaling diagram illustrating a synchronization control processing according to some examples of embodiments which correspond to the above described second alternative. It is to be noted that the signaling partners indicated in Fig. 3 are also related to the elements shown in Fig. 1.

In S210, the eNB2 20 powers up. In this connection, according to some examples of embodiments, also the listening RS related information and the neighboring cell IDs can be obtained from OAM (not shown).

In S220, a procedure of retrieving the synchronization status of the neighboring cells (e.g. of eNB1 10 and eNB3 30) is triggered by the eNB2 20, for example, a corresponding SON procedure for retrieving eNB1 10 and eNB3 30 synchronization status (time sync). This may be done, for example, via the MME 60 and by exchanging Configuration Transfer procedure related messages.

In S230, after the eNB2 20 has learned the synchronization status of the neighboring eNBs, the eNB2 20 requests the eNB3 to mute for all stratum levels. For example, a corresponding eNB Configuration Transfer message is transmitted to the MME 60 which includes an information or instruction for muting specific subframes for all stratum levels, e.g. in the form of corresponding muting information. In this context, according to some examples of embodiments, a list of eNB3's cells which need to do subframe level muting is indicated. For example a value of *Muting Stratum info* IE (described later) is set to "1111" to mute for all stratum levels.

In S240, the MME 60 sends an MME Configuration Transfer message to eNB3 30. The MME Configuration Transfer message in S240 reflects the

information included in the eNB Configuration Transfer message of S230, i.e. it includes also the muting information, for example.

5 In S250, similar to S230, the eNB2 20 requests the eNB1 10 to mute for all stratum levels. For example, a corresponding eNB Configuration Transfer message is transmitted to the MME 60 which includes an information or instruction for muting specific subframes for all stratum levels, e.g. in the form of corresponding muting information. In this context, according to some examples of embodiments, a list of eNB1's cells which need to do subframe level muting is indicated. For example a value of *Muting Stratum*
10 *info* IE (described later) is set to "1111" to mute for all stratum levels.

15 In S260, the MME 60 sends an MME Configuration Transfer message to eNB1 10. The MME Configuration Transfer message in S260 reflects the information included in the eNB Configuration Transfer message of S250, i.e. it includes also the muting information, for example.

20 In S270, eNB1 10 and eNB3 30 perform muting for subframes related to all stratum levels, in accordance with the muting information which is received from the eNB2 20 (in S230 to S250). It is to be noted that the muting is executed, for example, after a certain period of time after having received the muting information. Furthermore, even though not shown in Fig. 3, according to some examples of embodiments, the eNBs conducting the muting may also send a confirmation indication to eNB2 20 in order to
25 inform it that the muting is done.

30 Thus, in S280, when it is assumed that the muting for the subframes related to all stratum levels is done by the neighboring cells, the eNB2 20 selects a synchronization source and conducts a synchronization procedure to e.g. eNB1 10 (in the following, it is assumed that eNB1 10 has a stratum level of 1).

In S290, after the synchronization is completed, the eNB2 20 initiates eNB Configuration Transfer procedure to inform eNB1 and eNB3 for a refined or

updated muting. That is, updated muting information is generated for being forwarded to the neighboring cells. For example, a Muting Stratum info IE (described later) is set to such a value that the other eNBs recognizes to mute only subframes for stratum level 1.

5

In S300, similar to the preceding processing, the MME 60 sends a MME Configuration Transfer message to eNB1 10 and eNB3 20 for providing the updated muting information.

10 Correspondingly, in S310, eNB1 10 and eNB3 30 update a muting of subframes. Specifically, eNB3 30 performs a processing for muting only for subframes related to stratum level 1, and eNB1 10 stops the muting for subframes related to other stratum levels. Then, the synchronization control procedure is completed.

15

When comparing the alternatives shown in Fig. 2 and Fig. 3, it is to be noted that the alternative according to Fig. 2 can save some signaling exchanges among the eNBs compared to Fig. 3.

20 Depending on an actual implementation of the above described examples of embodiments in a communication network, it may be required to define corresponding information elements or instructions, e.g. for providing the muting information or the updated muting information. In the following, for illustrative purposes, as one example which is based e.g. on 3GPP (LTE-A)
25 based communication standards, in particular an E-UTRAN radio network layer signaling protocol for the S1 interface, corresponding IE may be defined as indicated below. In this connection, it is to be noted that the illustrated example is based on 3GPP specification TS36.413 (e.g. version 12.2.0). However, it is to be noted that an actual or future definition used in
30 connection with examples of embodiments may vary therefrom, so that examples of embodiments are not limited to the following definitions and terms.

As one example, which is related to a SON configuration transfer (such as e.g. in S20 to S50 etc.), besides SON Information and additionally the eNB ID of the destination of the SON information and the eNB ID of the source of the information, the IE includes also information related to the muting request (e.g. Muting Request Info). Presence of the Muting Request Info is, for example, conditional, i.e. it has to be included in a message only if a corresponding condition is satisfied, i.e. it shall be present if a SON information IE contains a SON information request IE set to „Muting Request Info“. Otherwise, the IE shall not be included.

Furthermore, the IE „Muting Request info“ is deemed to be critical (wherein in case a receiving element does not understand this IE, it may be ignored).

The IE „Muting Request info“ is used to identify a muting request. The range of the request may be 1 to the maximum number of cells which can be served by an eNB (e.g. a value of 256 is set). Furthermore, the IE comprises an ID of the cell, such as an EUTRAN CGI, and muting stratum information (which is critical wherein in case a receiving element does not understand it, it may be ignored).

The muting stratum information is, for example, a bitstring of a predetermined size (e.g. 4), corresponding to the number of strata being configured (e.g. stratum level 1 to stratum level 4). That is, for example, the muting stratum information indicates in each position in the bitmap whether the muting is required for a corresponding stratum level (e.g. first bit = stratum level 0, second bit= stratum level 1, third bit = stratum level 2, forth bit = stratum level 3). A value of „1“ indicates e.g. „muting is required“ and a value of „0“ indicates „muting is not required“. That is, for example, a request to mute all stratum levels may have a form of „1111“.

Fig. 4 shows a flow chart of a processing conducted in a communication network control element, such as eNB2 20 according to some examples of embodiments. Specifically, the example according to Fig. 4 is related to the case where a synchronization control procedure is executed in a

synchronization target cell (i.e. a corresponding communication network control element, such as eNB2 20).

5 In S420, neighboring cells (according to some examples of embodiment, all neighboring cells) of a synchronization target cell in a communication network are informed or instructed to mute, for all stratum levels, specific subframes being transmitted by the neighboring cells and carrying listening RS.

10 It is to be noted that according to some examples of embodiments, before conducting S420, S410 is executed. Here, e.g. when a cell (i.e. its communication network control element) starts up, information required for instructing the neighboring cells to mute the specific subframes, such as information related to the listening RS and ID information of the
15 neighboring cells are obtained, e.g. from OAM or by own detection. According to some examples of embodiments, the information related to the listening RS includes at least one of RS pattern information, antenna port information and carrier frequency information.

20 With regard to S420, according to some examples of embodiments, muting of the specific subframes includes maintaining a transmission of listening RS or transmission of listening RS and specified information carried in the specific subframes. On the other hand, a transmission of other information carried in the specific subframes is stopped during a muting phase.

25 According to some examples of embodiments, the specified information comprises at least one of PSS, SSS, PHBC, a SIB (e.g. SIB1), paging, PRS, and CSI-RS. In this context, it is to be noted that according to some examples of embodiments, the listening RS includes CRS or a combination
30 of CRS and PRS.

For instructing the neighboring cells to mute, for all stratum levels, the specific subframes being transmitted by the neighboring cells and carrying listening RS, according to some examples of embodiments, a configuration

transfer procedure for retrieving synchronization status information from the neighboring cells is triggered, wherein muting information for providing information related to the muting of the specific subframes is included in a configuration transfer message requesting the synchronization status information. In this connection, according to some examples of embodiments, the synchronization status information can be received from the neighboring cells.

Alternatively, for instructing the neighboring cells to mute, for all stratum levels, specific subframes being transmitted by the neighboring cells and carrying listening RS, according to some examples of embodiments, a configuration transfer procedure for retrieving synchronization status information from the neighboring cells is triggered and conducted, in which the synchronization status information are received from the neighboring cells. Then, muting information for providing information related to the muting of the specific subframes is transmitted in a further configuration transfer message.

In S430, when it is assumed that the neighboring cells have muted the specific subframes, a synchronization procedure with a synchronization source cell selectable from the neighboring cells is conducted. According to some examples of embodiments, when conducting the synchronization procedure with the synchronization source cell selected from the neighboring cells, it is assumed that the neighboring cells have muted the specific subframes when either a predetermined time is elapsed since the instruction to mute the specific subframes is issued, or a confirmation indication is received from the neighboring cells that muting is executed.

In S440, after completing the synchronization procedure, muting information is updated on the basis of a result of the synchronization procedure (i.e. the stratum level of the synchronization source cell is considered). For example, according to examples of embodiments, the updated muting information indicates to mute only for specific subframes related to a stratum level of the selected synchronization source cell.

In S450, the updated muting information is transmitted to the neighboring cells (i.e. the source cell and the interfering cells). For example, the updated muting information is transmitted by a configuration transfer signaling message.

Fig. 5 shows a flow chart of a processing conducted in a communication network control element, such as eNB1 10 according to some examples of embodiments. Specifically, the example according to Fig. 5 is related to the case where a synchronization control procedure is executed in a (potential) synchronization source or interfering cell (i.e. a corresponding communication network control element, such as eNB1 10 or eNB3 30, for example).

In S510, information or instruction from a neighboring cell representing a synchronization target cell in a communication network is received and processed, the information or instruction is related to mute, for all stratum levels, specific subframes being transmitted and carrying listening RS.

With regard to S510, according to some examples of embodiments, muting of the specific subframes includes maintaining a transmission of listening RS or transmission of listening RS and specified information carried in the specific subframes. On the other hand, a transmission of other information carried in the specific subframes is stopped during a muting phase.

According to some examples of embodiments, the specified information comprises at least one of PSS, SSS, PHBC, a SIB (e.g. SIB1), paging, PRS, and CSI-RS. In this context, it is to be noted that according to some examples of embodiments, the listening RS includes CRS or a combination of CRS and PRS.

Regarding the receiving of the instruction to mute, for all stratum levels, specific subframes being transmitted and carrying listening reference signals, according to some examples of embodiments, a configuration

transfer procedure for providing synchronization status information to a neighboring cell is conducted, wherein muting information for providing information related to the muting of the specific subframes is included in a received configuration transfer message requesting the synchronization status information. According to some examples of embodiments, the synchronization status information are transmitted to the requesting neighboring cell.

Alternatively, for receiving the instruction to mute, for all stratum levels, specific subframes being transmitted and carrying listening reference signals, according to some examples of embodiments, a configuration transfer procedure for providing synchronization status information to a neighboring cell is conducted wherein the synchronization status information is transmitted to the neighboring cell. Then, a further configuration transfer message is received and processed which includes muting information for providing information related to the muting of the specific subframes.

In S520, muting of the specific subframes for all stratum levels according to the instruction or information is conducted. In this context, according to some examples of embodiments, the muting of the specific subframes is conducted in a predetermined time after receiving the instruction to mute the specific subframes. According to some further examples of embodiments, a confirmation indication is transmitted to the neighboring cell when the muting of the specific subframes is completed.

In S530, updated muting information from the neighboring cell representing the synchronization target cell is received and processed. According to some examples of embodiments, the updated muting information indicates to mute only for specific subframes related to a stratum level of the selected synchronization source cell (i.e. not all stratum levels anymore). According to some examples of embodiments, the updated muting information is received in a configuration transfer signaling message.

In S540, muting of the specific subframes for stratum levels according to the updated muting information is conducted.

Fig. 6 shows a diagram of a communication network control element according to some examples of embodiments, which is configured to implement the synchronization control procedure as a synchronization target, as described in connection with some of the examples of embodiments. It is to be noted that the communication network control element, like eNB 20, which is shown in Fig. 6, may include further elements or functions besides those described herein below. Furthermore, even though reference is made to a communication network control element, the element may be also another device or function having a similar task, such as a chipset, a chip, a module, an application etc., which can also be part of a communication network control element or attached as a separate element to a communication network control element, or the like. It should be understood that each block and any combination thereof may be implemented by various means or their combinations, such as hardware, software, firmware, one or more processors and/or circuitry.

The communication network control element shown in Fig. 6 may include a processing circuitry, a processing function, a control unit or a processor 21, such as a CPU or the like, which is suitable for executing instructions given by programs or the like related to the synchronization control procedure. The processor 21 may include one or more processing portions or functions dedicated to specific processing as described below, or the processing may be run in a single processor or processing function. Portions for executing such specific processing may be also provided as discrete elements or within one or more further processors, processing functions or processing portions, such as in one physical processor like a CPU or in one or more physical or virtual entities, for example. Reference signs 22 and 23 denote transceiver or input/output (I/O) units or functions (interfaces) connected to the processor or processing function 21. The I/O units 22 may be used for communicating with the communication network, such as other communication network control elements (e.g. core and/or access network

elements), such as other eNBs or the MME 60, and the like. The I/O units 23 may be used for communicating with OAM 50. The I/O units 22 and 23 may be a combined unit including communication equipment towards several network elements, or may include 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 or processing function 21 and/or as a working storage of the processor or processing function 21. It is to be noted that the memory 24 may be implemented by using one or more memory portions of the same or different type of memory.

The processor or processing function 21 is configured to execute processing related to the above described synchronization control procedure. In particular, the processor or processing circuitry or function 21 includes one or more of the following sub-portions. Sub-portion 211 is a processing portion which is usable for instructing a muting of subframes. The portion 211 may be configured to perform processing according to S420 of Fig. 4. Furthermore, the processor or processing circuitry or function 21 may include a sub-portion 212 usable as a portion for conducting a synchronization with a source cell. The portion 212 may be configured to perform processing according to S430 of Fig. 4. Furthermore, the processor or processing circuitry or function 21 may include a sub-portion 213 usable as a portion for updating muting information. The portion 213 may be configured to perform processing according to S440 of Fig. 4. Moreover, the processor or processing circuitry or function 21 may include a sub-portion 214 usable as a portion for transmitting information, such as muting information or updated muting information. The portion 214 may be configured to perform processing according to S420 or S450 of Fig. 4.

Fig. 7 shows a diagram of a communication network control element according to some examples of embodiments, which is configured to implement the synchronization control procedure as a (potential) synchronization source (or interference source), as described in connection with some of the examples of embodiments. It is to be noted that the

communication network control element, like the eNB 10, which is shown in Fig. 7, may include further elements or functions besides those described herein below. Furthermore, even though reference is made to a communication network control element like an eNB, the communication network control element may be also another device or function having a similar task, such as a chipset, a chip, a module, an application etc., which can also be part of a communication network control element or attached as a separate element to a communication network control element, or the like. It should be understood that each block and any combination thereof may be implemented by various means or their combinations, such as hardware, software, firmware, one or more processors and/or circuitry.

The communication network control element shown in Fig. 7 may include a processing circuitry, a processing function, a control unit or a processor 11, such as a CPU or the like, which is suitable for executing instructions given by programs or the like related to the synchronization control procedure. The processor 11 may include one or more processing portions or functions dedicated to specific processing as described below, or the processing may be run in a single processor or processing function. Portions for executing such specific processing may be also provided as discrete elements or within one or more further processors, processing functions or processing portions, such as in one physical processor like a CPU or in one or more physical or virtual entities, for example. Reference signs 12 and 13 denote transceiver or input/output (I/O) units or functions (interfaces) connected to the processor or processing function 11. The I/O units 12 may be used for communicating with the communication network, such as other communication network control elements (e.g. core and/or access network elements), such as other eNBs or the MME 60, and the like. The I/O units 13 may be used for communicating with OAM 50. The I/O units 12 and 13 may be a combined unit including communication equipment towards several network elements, or may include 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 or processing function 11 and/or

as a working storage of the processor or processing function 11. It is to be noted that the memory 14 may be implemented by using one or more memory portions of the same or different type of memory.

5 The processor or processing function 11 is configured to execute processing related to the above described synchronization control procedure. In particular, the processor or processing circuitry or function 11 includes one or more of the following sub-portions. Sub-portion 111 is a processing
10 of subframes. The portion 111 may be configured to perform processing according to S510 of Fig. 5. Furthermore, the processor or processing circuitry or function 11 may include a sub-portion 112 usable as a portion for executing the muting instruction. The portion 112 may be configured to perform processing according to S520 and also S540 of Fig. 5. Furthermore,
15 the processor or processing circuitry or function 11 may include a sub-portion 113 usable as a portion for receiving and processing updated muting information. The portion 113 may be configured to perform processing according to S530 of Fig. 5.

20 It is to be noted that according to some examples of embodiments, a communication network control element used in a communication network as depicted e.g. in Fig. 1 is configured to act as both a synchronization source and a synchronization target. Consequently, a correspondingly configured communication network control element, such as an eNB, small-
25 cell eNB etc., includes elements and/or functions of both communication network control elements illustrated in Figs. 6 and 7.

Even though in the above described examples of embodiments a scenario is assumed where a plurality of so-called small cells is used for explaining the principles of the synchronization control procedures, the invention is not
30 limited to such small cells. According to further examples of embodiments, the synchronization target cell, the (potential) synchronization source cell and the interfering neighboring cells may be of different sizes, such as so-called macro cells etc., or may belong to different communication networks.

According to another example of embodiments, there is provided an apparatus including means for instructing neighboring cells of a synchronization target cell in a communication network to mute, for all stratum levels, specific subframes being transmitted by the neighboring cells and carrying listening reference signals, means for conducting, when it is assumed that the neighboring cells have muted the specific subframes, a synchronization procedure with a synchronization source cell selectable from the neighboring cells, means for updating, after completing the synchronization procedure, muting information on the basis of a result of the synchronization procedure, and means for causing transmission of the updated muting information to the neighboring cells.

Furthermore, according to another example of embodiments, there is provided an apparatus including means for receiving and processing an instruction from a neighboring cell representing a synchronization target cell in a communication network to mute, for all stratum levels, specific subframes being transmitted and carrying listening reference signals, means for conducting muting of the specific subframes for all stratum levels according to the instruction, means for receiving and processing updated muting information from the neighboring cell representing the synchronization target cell, and means for conducting muting of the specific subframes for stratum levels according to the updated muting information.

It should be appreciated that

- an access technology via which signaling is transferred to and from a network element may be any suitable present or future technology, such as WLAN (Wireless Local Access Network), WiMAX (Worldwide Interoperability for Microwave Access), LTE, LTE-A, Bluetooth, Infrared, and the like may be used; additionally, embodiments may also apply wired technologies, e.g. IP based access technologies like cable networks or fixed lines.

- a user device (also called UE, user equipment, user terminal, terminal device, etc.) illustrates one type of an apparatus to which resources on the air interface may be allocated and assigned, and thus any feature described herein with a user equipment may be implemented with a corresponding

apparatus, such as a relay node. An example of such a relay node is a layer 3 relay (self-backhauling relay) towards a base station or eNB. The user device typically refers to a portable computing device that includes wireless mobile communication devices operating with or without a subscriber identification module (SIM), including, but not limited to, the following types of devices: a mobile station (mobile phone), smartphone, personal digital assistant (PDA), handset, device using a wireless modem (alarm or measurement device, etc.), laptop and/or touch screen computer, tablet, game console, notebook, and multimedia device. It should be appreciated that a user device may also be a nearly exclusive uplink only device, of which an example is a camera or video camera loading images or video clips to a network, or a nearly exclusive downlink only device, such as a portable video player. Also equipment used for measuring certain values, such as sensors which can measure a temperature, a pressure etc., can be used as a corresponding user device. It should be appreciated that a device may be regarded as an apparatus or as an assembly of more than one apparatus, whether functionally in cooperation with each other or functionally independently of each other but in a same device housing.

- embodiments suitable to be implemented as software code or portions of it and being run using a processor or processing function are software code independent and can be specified using any known or future developed programming language, such as a high-level programming language, such as objective-C, C, C++, C#, Java, etc., or a low-level programming language, such as a machine language, or an assembler.

- implementation of embodiments is hardware independent and may be implemented using any known or future developed hardware technology or any hybrids of these, such as a microprocessor or CPU (Central Processing Unit), MOS (Metal Oxide Semiconductor), CMOS (Complementary MOS), BiMOS (Bipolar MOS), BiCMOS (Bipolar CMOS), ECL (Emitter Coupled Logic), and/or TTL (Transistor-Transistor Logic).

- embodiments may be implemented as individual devices, apparatuses, units, means or functions, or in a distributed fashion, for example, one or more processors or processing functions may be used or shared in the processing, or one or more processing sections or processing portions may

be used and shared in the processing, wherein one physical processor or more than one physical processor may be used for implementing one or more processing portions dedicated to specific processing as described,

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

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

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

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. A method including

instructing neighboring cells of a synchronization target cell in a communication network to mute, for all stratum levels, specific subframes being transmitted by the neighboring cells and carrying listening reference signals,

conducting, when it is assumed that the neighboring cells have muted the specific subframes, a synchronization procedure with a synchronization source cell selectable from the neighboring cells,

updating, after completing the synchronization procedure, muting information on the basis of a result of the synchronization procedure, and

causing transmission of the updated muting information to the neighboring cells.

2. The method according to claim 1, further including

obtaining information related to the listening reference signals and identification information of the neighboring cells required for instructing the neighboring cells to mute the specific subframes.

3. The method according to claim 2, wherein

the information related to the listening reference signals includes at least one of reference signal pattern information, antenna port information and carrier frequency information.

4. The method according to any of claims 1 to 3, wherein

muting of the specific subframes includes maintaining a transmission of listening reference signals or transmission of listening reference signals and specified information carried in the specific subframes, and stopping a transmission of other information carried in the specific subframes during a muting phase.

5. The method according to claim 4, wherein

the specified information comprises at least one of a primary synchronization signal, a secondary synchronization signal, a physical broadcast channel signaling, a system information block, a paging signal, a positional reference signal, and a channel state information reference signal, and

the listening reference signal includes a common reference signal or a combination of a common reference signal and a positional reference signal.

6. The method according to any of claims 1 to 5, wherein instructing the neighboring cells to mute, for all stratum levels, specific subframes being transmitted by the neighboring cells and carrying listening reference signals includes

triggering a configuration transfer procedure for retrieving synchronization status information from the neighboring cells, wherein muting information for providing information related to the muting of the specific subframes is included in a configuration transfer message requesting the synchronization status information.

7. The method according to claim 6, further comprising

receiving the synchronization status information from the neighboring cells.

8. The method according to any of claims 1 to 5, wherein instructing the neighboring cells to mute, for all stratum levels, specific subframes being transmitted by the neighboring cells and carrying listening reference signals includes

triggering a configuration transfer procedure for retrieving synchronization status information from the neighboring cells,

receiving the synchronization status information from the neighboring cells, and

causing transmission of muting information for providing information related to the muting of the specific subframes in a further configuration transfer message.

9. The method according to any of claims 1 to 8, wherein the updated muting information indicates to mute only for specific subframes related to a stratum level of the selected synchronization source cell.

5 10. The method according to claim 9, further including
causing transmission of the updated muting information by a configuration transfer signaling message.

10 11. The method according to any of claims 1 to 10, wherein it is assumed that the neighboring cells have muted the specific subframes, for conducting the a synchronization procedure with the synchronization source cell selected from the neighboring cells, when one of the following conditions is met:

15 a predetermined time is elapsed since the instruction to mute the specific subframes is issued; and

a confirmation indication is received from the neighboring cells that muting is executed.

20 12. The method according to any of claims 1 to 11, wherein the method is implemented in a communication network control element configured to control at least one cell of the communication network, wherein the neighboring cells are controlled by a respective other communication network control element of which one is selectable as a synchronization source.

25 13. The method according to claim 12, wherein signaling and messages are exchanged between the communication network control elements via a core network control element, wherein the communication network is based on Long Term Evolution or Long Term Evolution Advanced specifications.

30 14. An apparatus including
at least one processing circuitry,
and

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

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

5 to instruct neighboring cells of a synchronization target cell in a communication network to mute, for all stratum levels, specific subframes being transmitted by the neighboring cells and carrying listening reference signals,

10 to conduct, when it is assumed that the neighboring cells have muted the specific subframes, a synchronization procedure with a synchronization source cell selectable from the neighboring cells,

 to update, after completing the synchronization procedure, muting information on the basis of a result of the synchronization procedure, and

15 to cause transmission of the updated muting information to the neighboring cells.

15. The apparatus according to claim 14, wherein the at least one memory and the instructions are further configured to, with the at least one processing circuitry, cause the apparatus at least:

20 to obtain information related to the listening reference signals and identification information of the neighboring cells required for instructing the neighboring cells to mute the specific subframes.

16. The apparatus according to claim 15, wherein

25 the information related to the listening reference signals includes at least one of reference signal pattern information, antenna port information and carrier frequency information.

17. The apparatus according to any of claims 14 to 16, wherein

30 muting of the specific subframes includes maintaining a transmission of listening reference signals or transmission of listening reference signals and specified information carried in the specific subframes, and stopping a transmission of other information carried in the specific subframes during a muting phase.

18. The apparatus according to claim 17, wherein

the specified information comprises at least one of a primary synchronization signal, a secondary synchronization signal, a physical broadcast channel signaling, a system information block, a paging signal, a positional reference signal, and a channel state information reference signal, and

the listening reference signal includes a common reference signal or a combination of a common reference signal and a positional reference signal.

19. The apparatus according to any of claims 14 to 18, wherein the at least one memory and the instructions are further configured to, with the at least one processing circuitry, cause the apparatus at least:

when instructing the neighboring cells to mute, for all stratum levels, specific subframes being transmitted by the neighboring cells and carrying listening reference signals, to trigger a configuration transfer procedure for retrieving synchronization status information from the neighboring cells, wherein muting information for providing information related to the muting of the specific subframes is included in a configuration transfer message requesting the synchronization status information.

20. The apparatus according to claim 19, wherein the at least one memory and the instructions are further configured to, with the at least one processing circuitry, cause the apparatus at least:

to receive the synchronization status information from the neighboring cells.

21. The apparatus according to any of claims 14 to 18, wherein the at least one memory and the instructions are further configured to, with the at least one processing circuitry, cause the apparatus at least:

when instructing the neighboring cells to mute, for all stratum levels, specific subframes being transmitted by the neighboring cells and carrying listening reference signals,

to trigger a configuration transfer procedure for retrieving synchronization status information from the neighboring cells,

to receive the synchronization status information from the neighboring cells, and

5 to cause transmission of muting information for providing information related to the muting of the specific subframes in a further configuration transfer message.

10 22. The apparatus according to any of claims 14 to 21 wherein the updated muting information indicates to mute only for specific subframes related to a stratum level of the selected synchronization source cell.

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

to cause transmission of the updated muting information by a configuration transfer signaling message.

20 24. The apparatus according to any of claims 14 to 23, wherein it is assumed that the neighboring cells have muted the specific subframes, for conducting the a synchronization procedure with the synchronization source cell selected from the neighboring cells, when one of the following conditions is met:

25 a predetermined time is elapsed since the instruction to mute the specific subframes is issued; and

a confirmation indication is received from the neighboring cells that muting is executed.

30 25. The apparatus according to any of claims 14 to 24, wherein the apparatus is included in a communication network control element configured to control at least one cell of the communication network, wherein the neighboring cells are controlled by a respective other communication network control element of which one is selectable as a synchronization source.

26. The apparatus according to claim 25, wherein signaling and messages are exchanged between the communication network control elements via a core network control element, wherein the communication network is based on Long Term Evolution or Long Term Evolution Advanced specifications.

27. A method including

receiving and processing an instruction from a neighboring cell representing a synchronization target cell in a communication network to mute, for all stratum levels, specific subframes being transmitted and carrying listening reference signals,

conducting muting of the specific subframes for all stratum levels according to the instruction,

receiving and processing updated muting information from the neighboring cell representing the synchronization target cell, and

conducting muting of the specific subframes for stratum levels according to the updated muting information.

28. The method according to claim 27, wherein

muting of the specific subframes includes maintaining a transmission of listening reference signals or transmission of listening reference signals and specified information carried in the specific subframes, and stopping a transmission of other information carried in the specific subframes during a muting phase.

29. The method according to claim 28, wherein

the specified information comprises at least one of a primary synchronization signal, a secondary synchronization signal, a physical broadcast channel signaling, a system information block, a paging signal, a positional reference signal, and a channel state information reference signal, and

the listening reference signal includes a common reference signal or a combination of a common reference signal and a positional reference signal.

30. The method according to any of claims 27 to 29, further including, for receiving the instruction to mute, for all stratum levels, specific subframes being transmitted and carrying listening reference signals, conducting a configuration transfer procedure for providing synchronization status information to a neighboring cell, wherein muting information for providing information related to the muting of the specific subframes is included in a received configuration transfer message requesting the synchronization status information.

31. The method according to claim 30, further comprising causing transmission of the synchronization status information to the requesting neighboring cell.

32. The method according to any of claims 27 to 29, further including, for receiving the instruction to mute, for all stratum levels, specific subframes being transmitted and carrying listening reference signals, conducting a configuration transfer procedure for providing synchronization status information to a neighboring cell,

causing transmission of the synchronization status information to the neighboring cell, and

receiving a further configuration transfer message including muting information for providing information related to the muting of the specific subframes.

33. The method according to any of claims 27 to 32, wherein the updated muting information indicates to mute only for specific subframes related to a stratum level of the selected synchronization source cell.

34. The method according to claim 33, further including

receiving the updated muting information in a configuration transfer signaling message.

35. The method according to any of claims 27 to 34, wherein the muting of the specific subframes is conducted in a predetermined time after receiving the instruction to mute the specific subframes.

5 36. The method according to claim 35, further comprising
 causing transmission of a confirmation indication to neighboring cell
 when the muting of the specific subframes is completed.

10 37. The method according to any of claims 27 to 36, wherein the method is
 implemented in a communication network control element configured to
 control at least one cell of the communication network, wherein the
 neighboring cell from which the instruction is received is controlled by
 another communication network control element which is a synchronization
 target.

15 38. The method according to claim 37, wherein signaling and messages are
 exchanged between the communication network control elements via a core
 network control element, wherein the communication network is based on
 Long Term Evolution or Long Term Evolution Advanced specifications.

20 39. An apparatus including
 at least one processing circuitry,
 and
 at least one memory for storing instructions to be executed by the
25 processing circuitry, wherein

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

 to receive and process an instruction from a neighboring cell
 representing a synchronization target cell in a communication network to
30 mute, for all stratum levels, specific subframes being transmitted and
 carrying listening reference signals,

 to conduct muting of the specific subframes for all stratum levels
 according to the instruction,

to receive and process updated muting information from the neighboring cell representing the synchronization target cell, and

to conduct muting of the specific subframes for stratum levels according to the updated muting information.

5

40. The apparatus according to claim 39, wherein

muting of the specific subframes includes maintaining a transmission of listening reference signals or transmission of listening reference signals and specified information carried in the specific subframes, and stopping a transmission of other information carried in the specific subframes during a muting phase.

10

41. The apparatus according to claim 40, wherein

the specified information comprises at least one of a primary synchronization signal, a secondary synchronization signal, a physical broadcast channel signaling, a system information block, a paging signal, a positional reference signal, and a channel state information reference signal, and

15

the listening reference signal includes a common reference signal or a combination of a common reference signal and a positional reference signal.

20

42. The apparatus according to any of claims 39 to 41, wherein the at least one memory and the instructions are further configured to, with the at least one processing circuitry, cause the apparatus at least:

25

for receiving the instruction to mute, for all stratum levels, specific subframes being transmitted and carrying listening reference signals, to conduct a configuration transfer procedure for providing synchronization status information to a neighboring cell, wherein muting information for providing information related to the muting of the specific subframes is included in a received configuration transfer message requesting the synchronization status information.

30

43. The apparatus according to claim 42, wherein the at least one memory and the instructions are further configured to, with the at least one processing circuitry, cause the apparatus at least:

to cause transmission of the synchronization status information to the requesting neighboring cell.

44. The apparatus according to any of claims 39 to 41, wherein the at least one memory and the instructions are further configured to, with the at least one processing circuitry, cause the apparatus at least:

for receiving the instruction to mute, for all stratum levels, specific subframes being transmitted and carrying listening reference signals, to conduct a configuration transfer procedure for providing synchronization status information to a neighboring cell,

to cause transmission of the synchronization status information to the neighboring cell, and

to receive a further configuration transfer message including muting information for providing information related to the muting of the specific subframes.

45. The apparatus according to any of claims 39 to 44, wherein the updated muting information indicates to mute only for specific subframes related to a stratum level of the selected synchronization source cell.

46. The apparatus according to claim 45, wherein the at least one memory and the instructions are further configured to, with the at least one processing circuitry, cause the apparatus at least:

to receive the updated muting information in a configuration transfer signaling message.

47. The apparatus according to any of claims 39 to 46, wherein the at least one memory and the instructions are further configured to, with the at least one processing circuitry, cause the apparatus at least:

to conduct the muting of the specific subframes in a predetermined time after receiving the instruction to mute the specific subframes.

48. The apparatus according to claim 47, wherein the at least one memory and the instructions are further configured to, with the at least one processing circuitry, cause the apparatus at least:

5 to cause transmission of a confirmation indication to neighboring cell when the muting of the specific subframes is completed.

10 49. The apparatus according to any of claims 39 to 48, wherein the apparatus is included in a communication network control element configured to control at least one cell of the communication network, wherein the neighboring cell from which the instruction is received is controlled by another communication network control element which is a synchronization target.

15 50. The apparatus according to claim 49, wherein signaling and messages are exchanged between the communication network control elements via a core network control element, wherein the communication network is based on Long Term Evolution or Long Term Evolution Advanced specifications.

20 51. A computer program product for a computer, including software code portions for performing the steps of any of claims 1 to 13 or any of claims 27 to 38 when said product is run on the computer.

25 52. The computer program product according to claim 51, wherein
 the computer program product includes a computer-readable medium on which said software code portions are stored, and/or
 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.

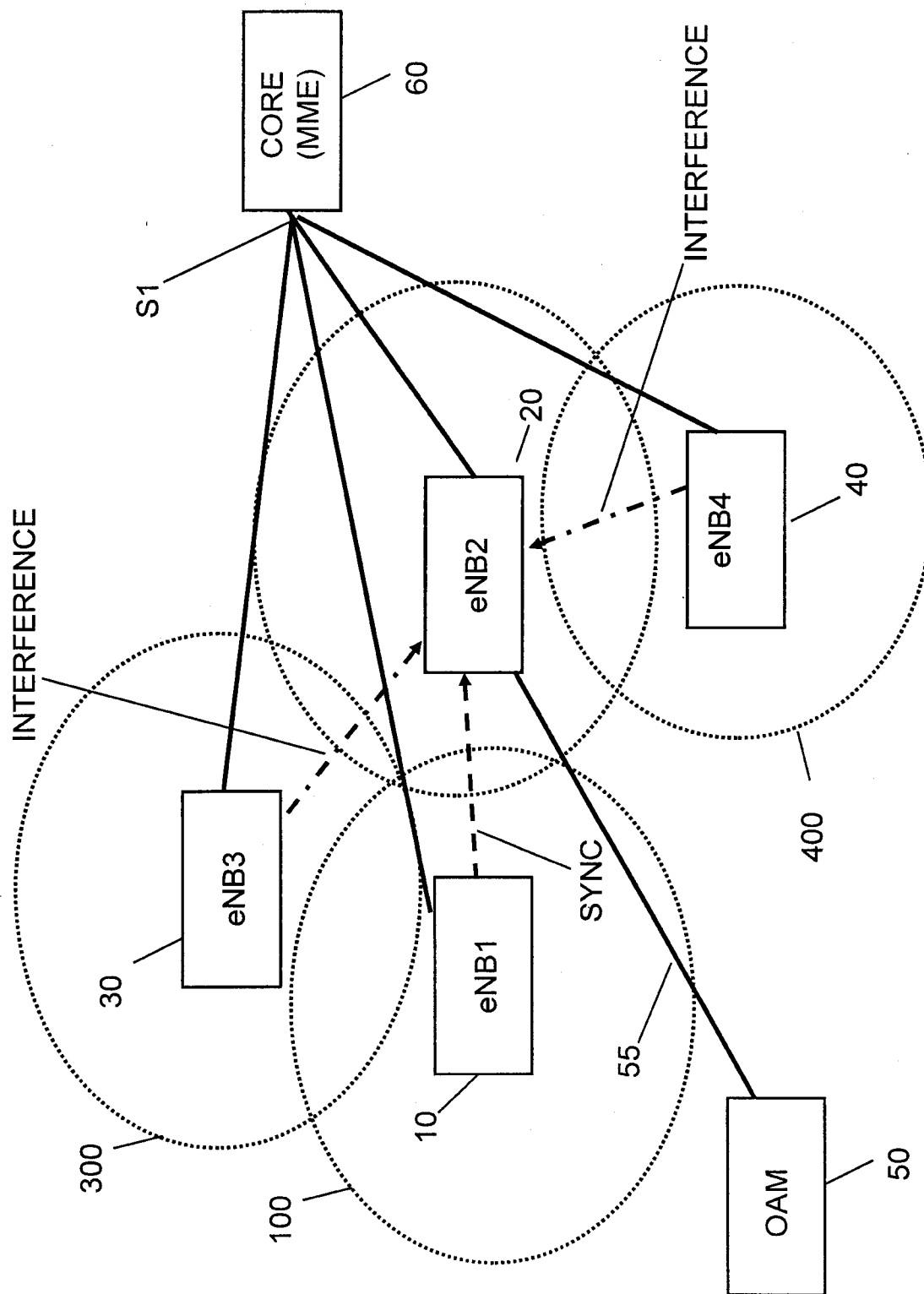


Fig. 1

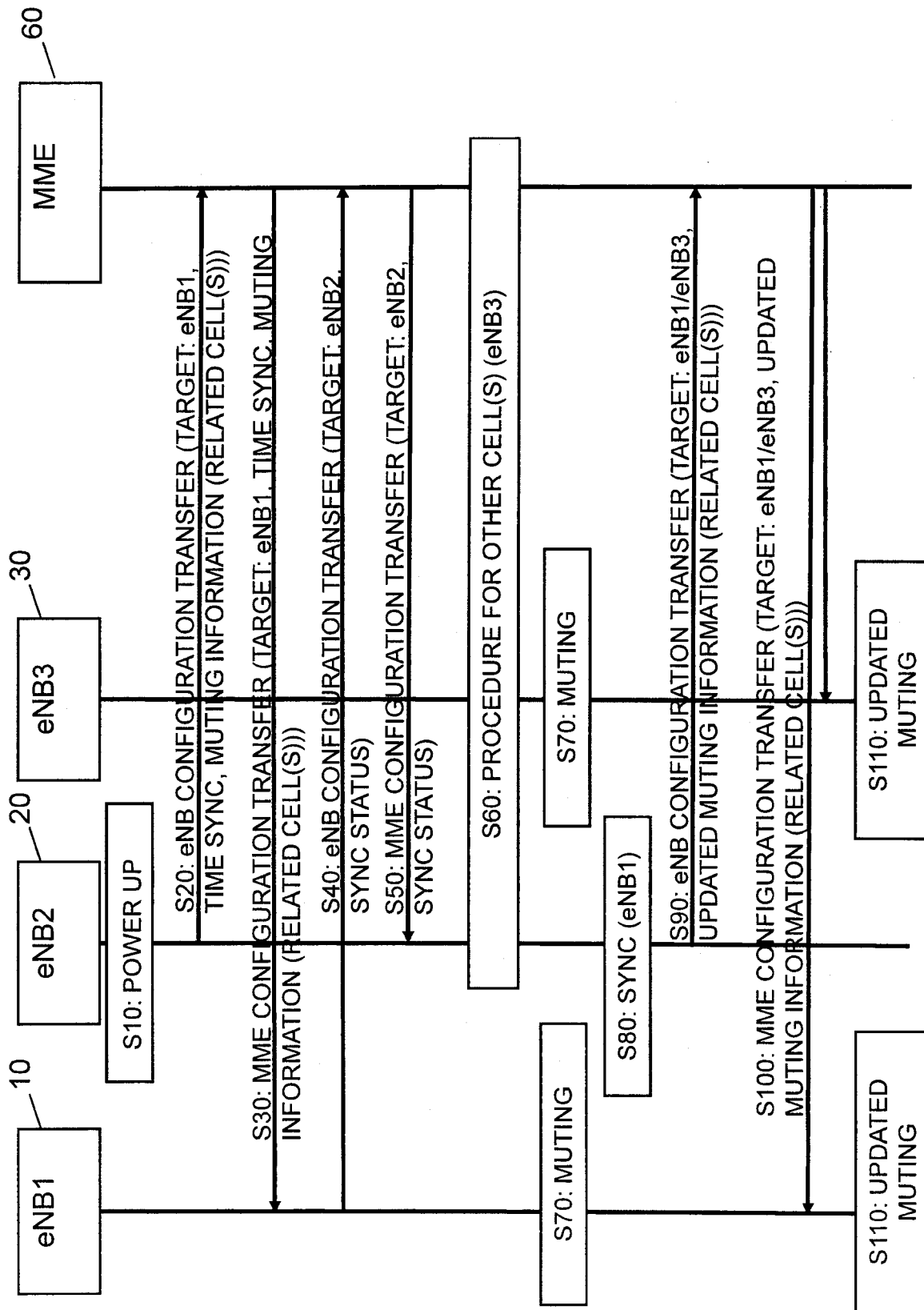


Fig. 2

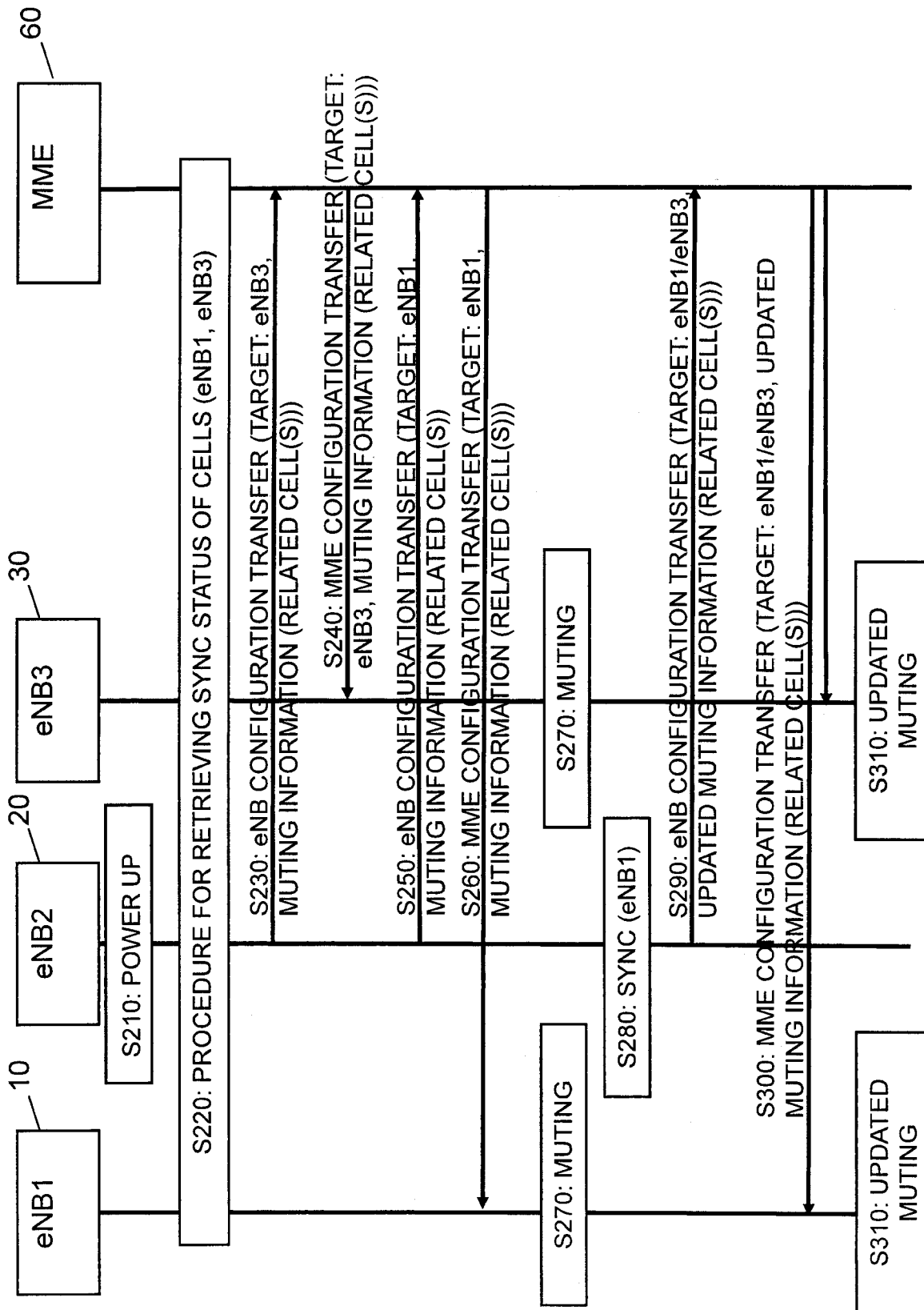


Fig. 3

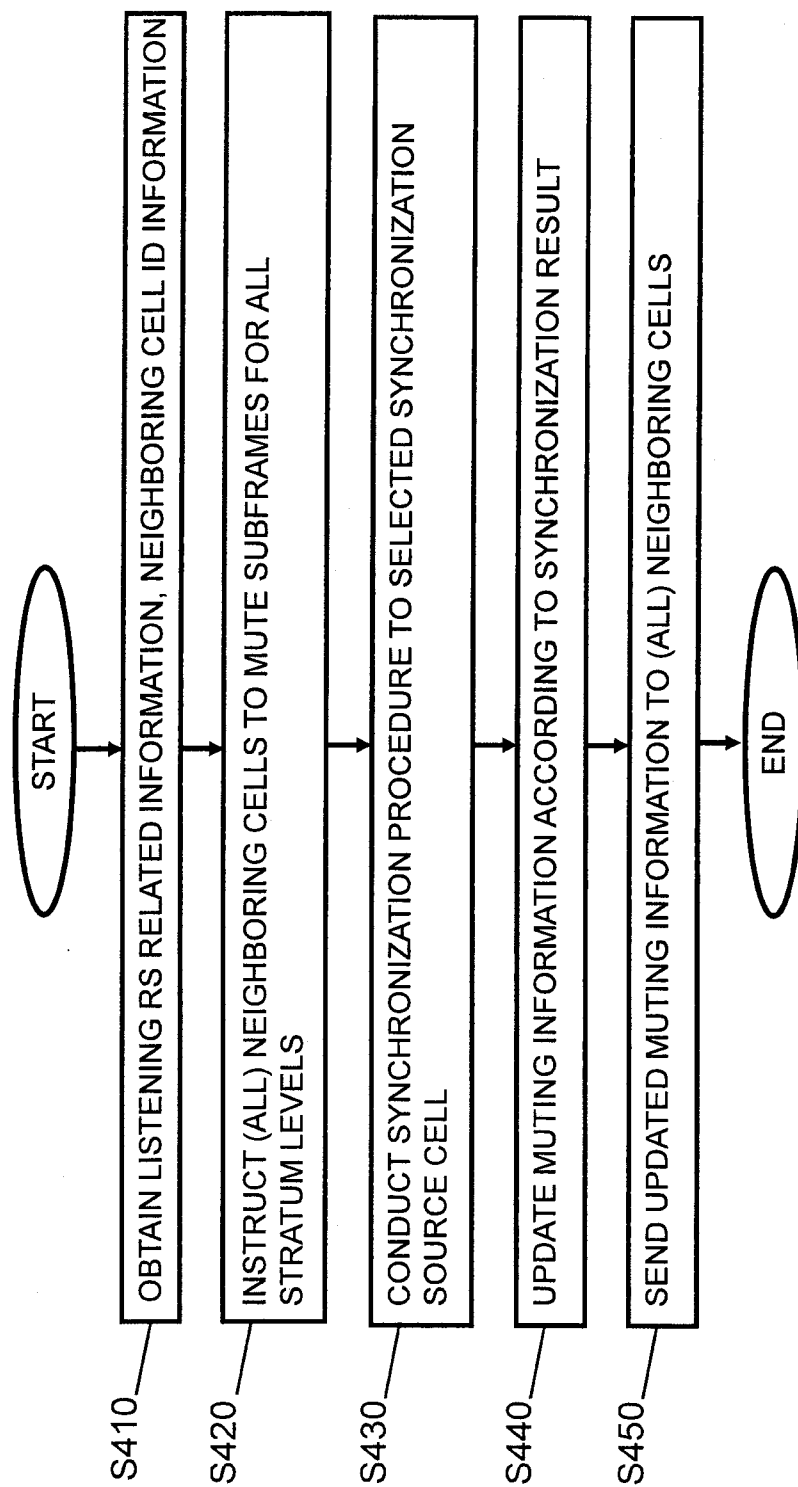


Fig. 4

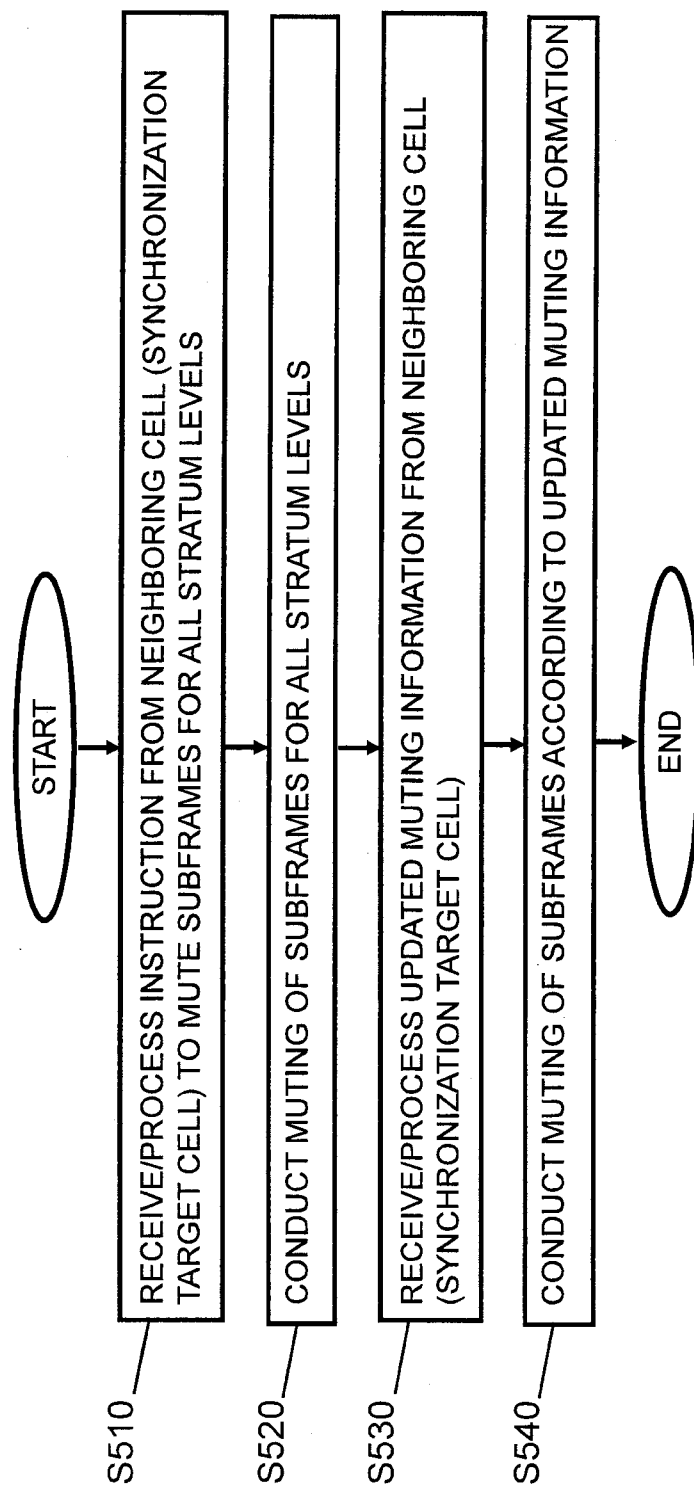


Fig. 5

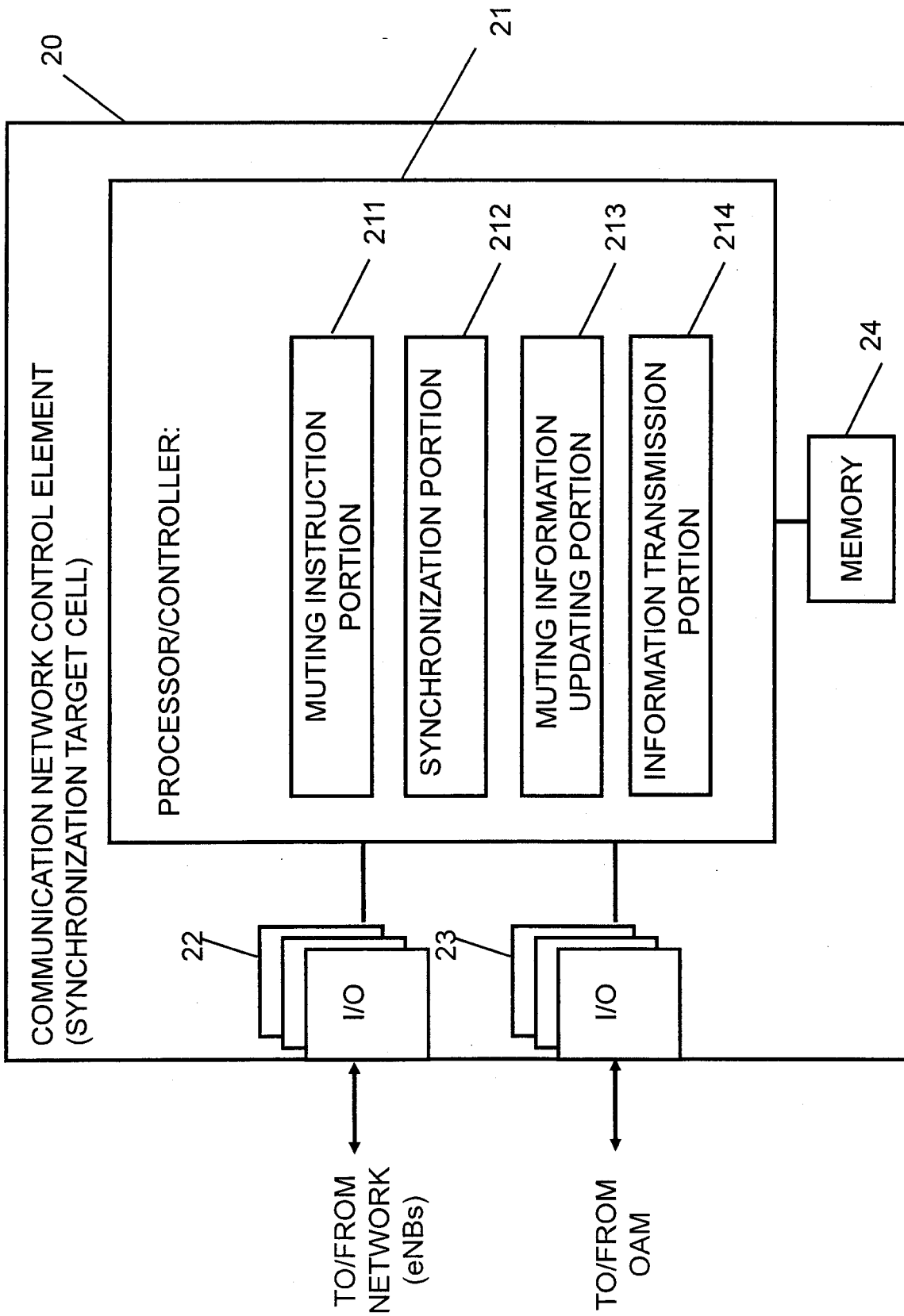


Fig. 6

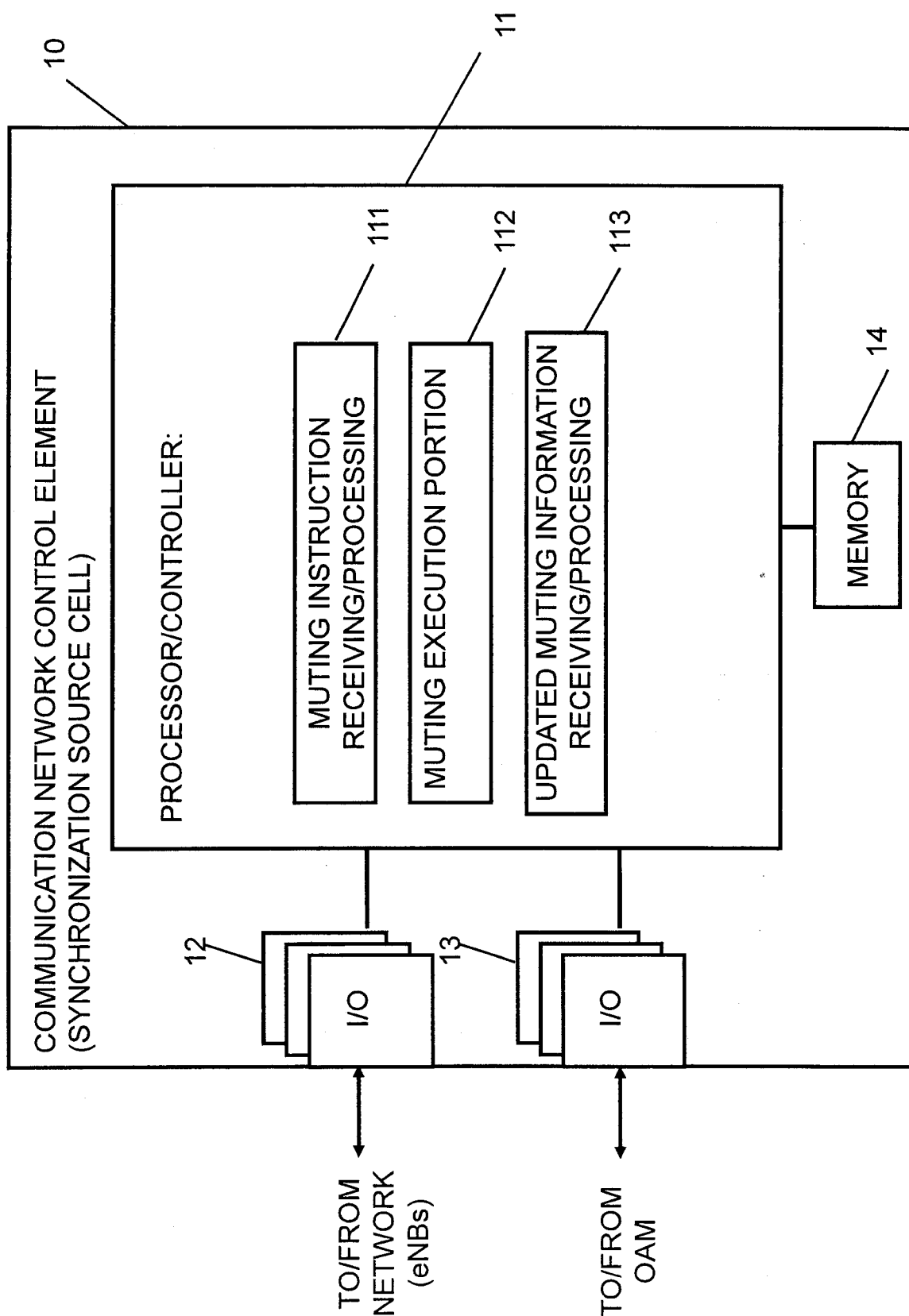


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2014/083747

A. CLASSIFICATION OF SUBJECT MATTER

H04W 56/00(2009.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W; 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)

CNPAT, CNKI, WPI, EPODOC, 3GPP: communication, neighbor+, target, cell, eNB, synchro+, mute, stop, off, subframe, update, information

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 102761956 A (HUAWEI TECHNOLOGIES CO., LTD.) 31 October 2012 (2012-10-31) description page 1 paragraph [0004] - page 5 paragraph [0042]	1-52
A	CN 102045711 A (CHINA MOBILE COMMUNICATIONS CORPORATION) 04 May 2011 (2011-05-04) the whole document	1-52
A	CN 103517397 A (ZTE CORPORATION) 15 January 2014 (2014-01-15) the whole document	1-52
A	CN 103733695 A (NEC EUROPE LTD.) 16 April 2014 (2014-04-16) the whole document	1-52
A	CN 102149185 A (TELECOM SCIENCE AND TECHNOLOGY INSTITUTE) 10 August 2011 (2011-08-10) the whole document	1-52
A	CN 102026363 A (DATANG MOBILE COMMUNICATIONS EQUIPMENT CO., LTD.) 20 April 2011 (2011-04-20) the whole document	1-52

☒ 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	“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
“E”	earlier application or patent but published on or after the international filing date	“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
“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)	“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
“O”	document referring to an oral disclosure, use, exhibition or other means	“&”	document member of the same patent family
“P”	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

21 April 2015

Date of mailing of the international search report

13 May 2015

Name and mailing address of the ISA/CN

STATE INTELLECTUAL PROPERTY OFFICE OF THE
P.R.CHINA(ISA/CN)
6,Xitucheng Rd., Jimen Bridge, Haidian District, Beijing
100088, China

Authorized officer

ZHAO,Qi

Facsimile No. (86-10)62019451

Telephone No. (86-10)62413359

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2014/083747**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 102014405 A (DATANG MOBILE COMMUNICATIONS EQUIPMENT CO., LTD.) 13 April 2011 (2011-04-13) the whole document	1-52
A	CN 102625439 A (TELECOM SCIENCE AND TECHNOLOGY INSTITUTE) 01 August 2012 (2012-08-01) the whole document	1-52
A	WO 2011133084 A1 (TELEFONAKTIEBOLAGET L M ERICSSONPUBL) 27 October 2011 (2011-10-27) the whole document	1-52

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2014/083747

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	102761956	A	31 October 2012	None			
CN	102045711	A	04 May 2011	None			
CN	103517397	A	15 January 2014	None			
CN	103733695	A	16 April 2014	WO	2013014169	A1	31 January 2013
				US	2014153454	A1	05 June 2014
				EP	2737758	A1	04 June 2014
				JP	2014523725	A	11 September 2014
CN	102149185	A	10 August 2011	None			
CN	102026363	A	20 April 2011	WO	2011044836	A1	21 April 2011
CN	102014405	A	13 April 2011	WO	2011076062	A1	30 June 2011
CN	102625439	A	01 August 2012	None			
WO	2011133084	A1	27 October 2011	EP	2561699	A1	27 February 2013
				US	2011256833	A1	20 October 2011