

(51) International Patent Classification:
H04W 48/08 (2009.01)(21) International Application Number:
PCT/CN2012/085075(22) International Filing Date:
22 November 2012 (22.11.2012)

(25) Filing Language: English

(26) Publication Language: English

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

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

Declarations under Rule 4.17:

— of inventorship (Rule 4.17(iv))

[Continued on next page]

(54) Title: ASSISTANT INFO FOR NEW CARRIER TYPE MOBILITY

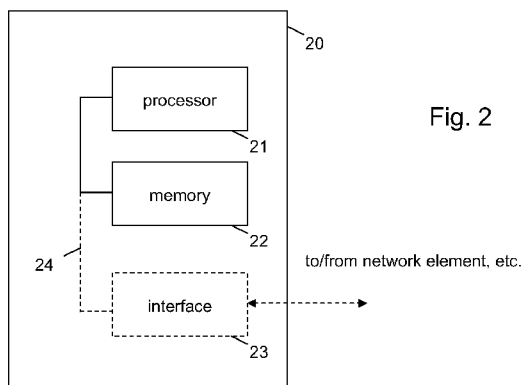


Fig. 2

(57) Abstract: The present invention addresses a method, apparatus and computer program product for enhanced system information transmissions and/or handover command for new carrier type mobility. The invention comprises determining whether the carrier type to be used for communication is a legacy carrier or a new carrier type which supports at least one of a standalone, macro-assisted and non-standalone configuration, in case of a determining the new carrier type, composing assistant information comprising at least one of: reference signal type information indicating support of at least one of reference signal type information indicating support of at least one of a primary/secondary synchronization signal configuration; cell-specific reference signal configuration; channel state information reference signal configuration and physical discovery channel configuration for the new carrier type; sleep/active mode type information; cell deployment type information indicating a macro/pico/small cell deployment; and information indicating enhanced physical download control channel common search space resource; and causing data exchange of the composed assistant information to a network element.



Published:

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

ASSISTANT INFO FOR NEW CARRIER TYPE MOBILITY

Field of the invention

5 The present invention generally relates to improvements on handling carrier types in wired or wireless communication systems. More particularly, the present invention addresses apparatuses, methods and computer program product for enhanced system information transmissions and/or handover command for new carrier type mobility.

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Background

Standalone new carrier type (SA-NCT) is considered to be one of the main topics for Long Term Evolution LTE in 3GPP Release 12 (Rel-12) enhancement.

15

The 3GPP Release 11 brings changes to a number of features defined in earlier releases with a non-standalone new carrier type (R11 NCT). The features, such as enhanced physical downlink control channel (ePDCCH) replacing physical downlink control channel PDCCH, where the control channels are no longer fixed to certain time-frequency resources, but more flexibly allocated, and cell-specific (common) reference signals CRS, are at least significantly reduced, if not completely removed. Besides, the system operation on the NCT is now mostly based on channel state information reference signals CSI-RS and demodulation reference signals DM-RS instead of cell-specific reference signals CRS.

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With those changes brought by 3GPP Release 11, enabling a new standalone carrier type without CRS and legacy control channels would not require many changes. Such changes mainly include initial access and mobility measurements.

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References:

[1] Ericsson, "Views on TD-LTE for Rel-12", presentation on CMCC TD-LTE workshop, Apr. 2012

[2] China Mobile, "TD-LTE Evolution and Sharing of TD-LTE Trial" presentation on CMCC TD-LTE workshop, Apr. 2012

5 [3] 3GPP RAN1 #68bis, meeting report

[4] 3GPP RAN1 #69, meeting report

[5] 3GPP RAN2 #78, meeting report

10 According to the new work item WI description for 3GPP Release 12 (Rel-12) new carrier type, new features may give a NCT cell some new flexibility, such as:

- flexible CSI-RS configuration, no or very low CRS, energy saving mode, also NCT may operate with standalone (SA), CA, or macro
- 15 assisted modes; and
- may mix deployed with legacy carrier during migration period.

20 According to enhanced inter-cell interference coordination eICIC topic, some solutions for enhanced system information transmissions have been discussed. For example, in [3] the following possibility was mentioned;

- if signaling is needed, examples of possible eNB signaling solution to enable significantly improved detection of physical broadcast channel PBCH and/or system information block 1 SIB1 in the presence of
- 25 dominant interferers with 9dB bias; and
- the victim cell may send its system information to the user equipment UE using higher layer signaling in the protected subframes.

In [4], the following was agreed as working assumption:

30

- eNB signaling solution to aid detection of PBCH in the presence of dominant interferers with 9dB bias;

- related master information block MIB information from the victim cell may also be supplied by aggressor cell during handover from aggressor to victim cells; and
- single frequency network SFN offset between victim and aggressor cell.

However, the main point with these solutions is to provide system information in protected resource to avoid interference, and these system information or handover command are not related to any information regarding new carrier type.

In [5], the CSI-RS resource configuration for coordinated multi-point CoMP measurement was discussed, with the following agreements:

- CSI-RS resources on which the UE is supposed to measure are configured explicitly by the network NW, i.e., blind detection of CSI-RS resources in the UE is not required; and
- CSI-RS resource specific configurations are configured as part of the MeasurementObject (for further study how to associate them with measurement configuration and how to refer to them in measurement reports).

These configurations apply for UE which is configured with CoMP transmission mode and not related to system information acquisition, nor handover to new carrier type.

However, these new features may result in confusion in UE detection, handover and measurement. For example, an UE may need to blind detect many possibilities before identify presence of a Rel-12 carrier or legacy carrier, or even blind if certain CSI-RS is used in certain neighbor cell. This complicates UE implementation, and may introduce very unnecessary big power consumption, and may also make the delay of measurement longer. Moreover, in Rel-12, the system may handle a huge number of neighbor cells (dense small cells), which may make this issue even worse.

Therefore, there is the need for optimizing fast access and handover in terms of the RRC connection and handover procedure.

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Summary of the Invention

It is an object of the present invention to address the above problems. In particular, it is an object of the present invention to provide apparatuses,
10 methods and a computer program product for enabling enhancement of the support of SA-NCT mobility, in particular for initial access, tracking and possible measurement.

According to a first aspect of the present invention, an apparatus comprises
15 at least one processor and at least one memory including computer program code, the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to perform determining whether the carrier type to be used for communication is a legacy carrier or a new carrier type which supports at
20 least one of a standalone, macro-assisted and non-standalone configuration, in case of a determining the new carrier type, composing assistant information comprising at least one of: reference signal type information indicating support of at least one of reference signal type information indicating support of at least one of a primary/secondary synchronization
25 signal configuration, cell-specific reference signal configuration, channel state information reference signal configuration and physical discovery channel configuration for the new carrier type; sleep/active mode type information; cell deployment type information indicating a macro/pico/small cell deployment; and information indicating enhanced physical download
30 control channel's common search space resource; and causing transmission of the composed assistant information to a user equipment.

According to a second aspect of the present invention, a method comprises the steps of determining whether the carrier type to be used for

communication is a legacy carrier or a new carrier type which supports at least one of a standalone, macro-assisted and non-standalone configuration, in case of a determining the new carrier type, composing assistant information comprising at least one of: reference signal type information
5 indicating support of at least one of a primary/secondary synchronization signal configuration, cell-specific reference signal configuration, channel state information reference signal configuration and physical discovery channel configuration for the new carrier type; sleep/active mode type information; cell deployment type information indicating a macro/pico/small
10 cell deployment; and information indicating enhanced physical downlink control channel common search space resource; and causing transmission of the composed assistant information to a network element.

According to a third aspect of the present invention, an apparatus
15 comprises at least one processor and at least one memory including computer program code, the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to perform receiving transmission of composed assistant information from a base station, and processing the received assistant
20 information, wherein the assistant information is composed by: determining whether the carrier type to be used for communication is a legacy carrier or a new carrier type which supports at least one of a standalone, macro-assisted and non-standalone configuration, in case of a determining the new carrier type, composing assistant information comprising at least one of:
25 reference signal type information indicating support of at least one of reference signal type information indicating support of at least one of a primary/secondary synchronization signal configuration, cell-specific reference signal configuration, channel state information reference signal configuration and physical discovery channel configuration for the new
30 carrier type; sleep/active mode type information; cell deployment type information indicating a macro/pico/small cell deployment; and information indicating enhanced physical downlink control channel's common search space resource.

According to a fourth aspect of the present invention, a method comprises the steps of receiving transmission of composed assistant information from a base station, and processing the received assistant information, wherein the assistant information is composed by: determining whether the carrier type to be used for communication is a legacy carrier or a new carrier type which supports at least one of a standalone, macro-assisted and non-standalone configuration, in case of a determining the new carrier type, composing assistant information comprising at least one of: reference signal type information indicating support of at least one of a primary/secondary synchronization signal configuration, cell-specific reference signal configuration, channel state information reference signal configuration and physical discovery channel configuration for the new carrier type; sleep/active mode type information; cell deployment type information indicating a macro/pico/small cell deployment; and information indicating enhanced physical download control channel common search space resource.

According to a fifth aspect of the present invention, there is provided a computer program product comprising computer-executable components which, when the program is run on a computer, are configured to carry out the method according to the second aspect and/or the method according to the fourth aspect.

According to a sixth aspect of the present invention, an apparatus, comprises determination means for determining whether the carrier type to be used for communication is a legacy carrier or a new carrier type which supports at least one of a standalone, macro-assisted and non-standalone configuration, composition means for composing assistant information comprising at least one of: reference signal type information indicating support of at least one of a primary/secondary synchronization signal configuration, cell-specific reference signal configuration, channel state information reference signal configuration and physical discovery channel configuration for the new carrier type; sleep/active mode type information; cell deployment type information indicating a macro/pico/small cell deployment; and information indicating enhanced physical download control

channel common search space resource; and transmission means for causing transmission of the composed assistant information to a network element.

- 5 According to a seventh aspect of the present invention, an apparatus, comprises reception means for receiving transmission of composed assistant information from a base station, and processing means for processing the received assistant information, wherein the assistant information is composed by: determination means for determining whether
10 the carrier type to be used for communication is a legacy carrier or a new carrier type which supports at least one of a standalone, macro-assisted and non-standalone configuration, composition means for composing assistant information comprising at least one of: reference signal type information indicating support of at least one of a primary/secondary
15 synchronization signal configuration, cell-specific reference signal configuration, channel state information reference signal configuration and physical discovery channel configuration for the new carrier type; sleep/active mode type information; cell deployment type information indicating a macro/pico/small cell deployment; and information indicating
20 enhanced physical downlink control channel common search space resource; and transmission means for causing transmission of the composed assistant information to a network element.

Advantageous further developments or modifications of the aforementioned
25 exemplary aspects of the present invention are set out in the dependent claims.

Brief description of drawings

- 30 For a more complete understanding of example embodiments of the present invention, reference is now made to the following descriptions taken in connection with the accompanying drawings in which:

Fig. 1 shows a target standalone NCT scenario according to [1];

Fig. 2 shows a principle configuration of an example for an apparatus according to certain embodiments of the present invention;

- 5 Fig. 3 shows a principle flowchart of an example for a method according to certain embodiments of the present invention;

Fig. 4 shows a principle configuration of an example for an apparatus according to certain embodiments of the present invention;

10

Fig. 5 shows a principle flowchart of an example for a method according to certain embodiments of the present invention;

- 15 Fig. 6 shows an example of the master information block MIB information element according to certain embodiments of the present invention for initial access assistance;

Fig. 7 shows an example of the system information block SIB according to certain embodiments of the present invention for initial access assistance;

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Figs. 8a and 8b show an example of *SystemInformationBlockType4* and *SystemInformationBlockType 5* information elements for cell measurement assistance according to certain embodiments of the present invention;

- 25 Fig. 9 shows an example of the *MobilityControlInfo* information element for handover assistance according to certain embodiments of the present invention; and

30 Figs. 10a and 10b show an example of the *RRConnectionRequest* message as well as some example of the signaling design of the *RRConnectionReject* according to certain embodiments of the present invention for re-direction using *RRConnectionReject*.

It is to be noted that the changes in the exemplary information elements shown in Figs. 6 to 10 are indicated in bold letters.

5 **Description of exemplary embodiments**

Exemplary aspects of the present invention will be described herein below. More specifically, exemplary aspects of the present are described hereinafter with reference to particular non-limiting examples and to what
10 are presently considered to be conceivable embodiments of the present invention. A person skilled in the art will appreciate that the invention is by no means limited to these examples, and may be more broadly applied.

It is to be noted that the following description of the present invention and
15 its embodiments mainly refers to specifications being used as non-limiting examples for certain exemplary network configurations and deployments. Namely, the present invention and its embodiments are mainly described in relation to 3GPP specifications being used as non-limiting examples for certain exemplary network configurations and deployments. In particular, a
20 LTETM/LTE-Advanced communication system is used as a non-limiting example for the applicability of thus described exemplary embodiments. As such, the description of exemplary embodiments given herein specifically refers to terminology which is directly related thereto. Such terminology is only used in the context of the presented non-limiting examples, and does
25 naturally not limit the invention in any way. Rather, any other network configuration or system deployment, etc. may also be utilized as long as compliant with the features described herein.

Hereinafter, various embodiments and implementations of the present
30 invention and its aspects or embodiments are described using several alternatives. It is generally noted that, according to certain needs and constraints, all of the described alternatives may be provided alone or in any conceivable combination (also including combinations of individual features of the various alternatives).

Fig. 1 shows a targeted scenario according to [1] and [2], wherein standalone non-backwards compatible carriers are provided to further enhance the spectrum efficiency and to improve cell deployment flexibilities.

5

According to certain embodiments of the present invention in a first aspect, new assistant information in system information and/or handover command for new carrier type mobility is provided.

- 10 In particular, the new assistant information comprises cell type information which indicates that the cell applies a Rel-8-Rel-10 compatible carrier or a standalone SA/macro-assisted/non-standalone new carrier type.

Further, RS type information is contained for indicating the possible
15 primary/secondary synchronization signal PSS/SSS, cell-specific reference signals CRS, channel state information reference signals CSI-RS, physical discovery channel PDCH, etc. configurations for the new carrier type NCT. Thereby, one carrier type may implicitly link to one reference signal RS configuration or/and PSS/SSS/PDCH configuration, so that only cell type
20 need to be indicated.

Alternatively, an eNB may explicitly send such RS/PSS/SSS/PDCH configuration RS configuration or/and cell discovery signal configuration for serving cell and all/some cells in the neighbor list.

25

Further, the new assistant information may also indicate which RS is used for certain procedures/purpose, for example, PDCH for inter-frequency detection or PSS/SSS/CSI-RS for normal initial access and tracking.

- 30 The assistant information may comprise sleep/active mode type/configuration. Hence, multiple level sleeping mode may be supported.

Furthermore, cell deployment type information may be provided so as to indicate a Macro/Pico/Small cell deployment, by which UE may have different preference on cell to reselect.

- 5 According to certain embodiments, the new assistant information comprises ePDCCH common search space (CSS) resource indication.

In handover HO command, besides above information, according to certain embodiments of the present invention, it could further include extra
10 dedicated RS configuration, such as CSI-RS to certain UEs to enable fast HO measurement.

According to still further embodiments of the present invention in a second aspect, an eNB may re-direct an UE to small cell during the RRC connection
15 establishment procedure based on demand.

Thereby, the UE may report its rough establishment cause in *RRCconnectionRequest* IE (information element).

- 20 Further, the eNB could include new assistant info in *RRCconnectionReject* to re-direct UE to small cell.

The rejection cause information is mainly used to let Rel-12 UE re-select the current cell without any waiting time if no small cell is discovered.
25

Fig. 2 shows a principle configuration of an example for an apparatus according to certain embodiments of the present invention. The apparatus
20 comprises at least one processor 42 and at least one memory 22 including computer program code, which are connected by a bus 24 or the like. As indicated with a dashed line in Fig. 2, an interface 23 may optionally
30 be connected to the bus 22 or the like, which may enable communication e.g. to/from a network entity, a base station, a UE, a vehicle gateway or the like. The at least one memory and the computer program code are arranged to, with the at least one processor, cause the apparatus at least to perform

determining whether the carrier type to be used for communication is a legacy carrier or a new carrier type which supports at least one of a standalone, macro-assisted and non-standalone configuration, in case of a determining the new carrier type, composing assistant information comprising at least one of: reference signal type information indicating support of at least one of reference signal type information indicating support of at least one of a primary/secondary synchronization signal configuration; cell-specific reference signal configuration; channel state information reference signal configuration and physical discovery channel configuration for the new carrier type; sleep/active mode type information; cell deployment type information indicating a macro/pico/small cell deployment; and information indicating enhanced physical download control channel common search space resource; and causing transmission of the composed assistant information to a network element.

Fig. 3 shows a principle flowchart of an example for a method according to certain embodiments of the present invention.

In Step S31, it is determined whether the carrier type to be used for communication is a legacy carrier or a new carrier type which supports at least one of a standalone, macro-assisted and non-standalone configuration.

In Step S32, assistant information are composed, the assistant information comprising at least one of reference signal type information indicating support of at least one of a primary/secondary synchronization signal configuration, cell-specific reference signal configuration, channel state information reference signal configuration and physical discovery channel configuration for the new carrier type; sleep/active mode type information; cell deployment type information indicating a macro/pico/small cell deployment; and information indicating enhanced physical download control channel common search space resource.

In Step S33, transmission of the composed assistant information to a network element is caused.

Fig. 4 shows a principle configuration of an example for an apparatus according to certain embodiments of the present invention. The apparatus 40 comprises at least one processor 41 and at least one memory 42 including computer program code, which are connected by a bus 44 or the like. As indicated with a dashed line in Fig. 4, an interface 43 may optionally be connected to the bus 42 or the like, which may enable communication e.g. to/from a network entity, a base station, a UE, a vehicle gateway or the like. The at least one memory and the computer program code are arranged to, with the at least one processor, cause the apparatus at least to perform receiving transmission of composed assistant information from a base station, and processing the received assistant information, wherein the assistant information is composed by: determining whether the carrier type to be used for communication is a legacy carrier or a new carrier type which supports at least one of a standalone, macro-assisted and non-standalone configuration, in case of a determining the new carrier type, composing assistant information comprising at least one of: reference signal type information indicating support of at least one of reference signal type information indicating support of at least one of a primary/secondary synchronization signal configuration; cell-specific reference signal configuration; channel state information reference signal configuration and physical discovery channel configuration for the new carrier type; sleep/active mode type information; cell deployment type information indicating a macro/pico/small cell deployment; and information indicating enhanced physical downlink control channel common search space resource; and causing transmission of the composed assistant information to a network element.

Fig. 5 shows a principle flowchart of an example for a method according to certain embodiments of the present invention.

In Step S51, transmission of composed assistant information from a base station is received, the assistant information is composed by: determining whether the carrier type to be used for communication is a legacy carrier or

a new carrier type which supports at least one of a standalone, macro-assisted and non-standalone configuration, in case of a determining the new carrier type, composing assistant information comprising at least one of: reference signal type information indicating support of at least one of:
5 reference signal type information indicating support of at least one of a primary/secondary synchronization signal configuration; cell-specific reference signal configuration; channel state information reference signal configuration and physical discovery channel configuration for the new carrier type; sleep/active mode type information; cell deployment type
10 information indicating a macro/pico/small cell deployment; and information indicating enhanced physical download control channel common search space resource; and causing transmission of the composed assistant information to a network element.

15 In Step S52, the received assistant information is processed in operation of the apparatus.

According to certain embodiments of the present invention, the reference signal type information further comprises allocation information of the reference signal to a certain purpose, wherein the certain purpose may be
20 one of tracking, demodulation or measurements.

According to certain embodiments of the present invention, presence of a demand for re-directing the network element during radio resource control connection establishment procedure is determined; and further assistant
25 information indicating at least one of a rejection cause and a suggested re-direct target cell is composed.

According to certain embodiments of the present invention, information indicating an establishment cause is received from the network element,
30 wherein the cause may be one of offloading purpose and ICIC purpose.

According to certain embodiments of the present invention, the assistant information further comprises cell measurement information about at least one neighbor cell.

All the mentioned embodiments can be formed in several alternatives as illustrated but not limited to the implementation examples shown below.

- 5 Fig. 6 shows an example of the master information block MIB information element according to certain embodiments of the present invention for initial access assistance. Fig. 7 shows an example of the system information block SIB according to certain embodiments of the present invention for initial access assistance.

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The modified master information block MIB/ system information block SIB can be used to indicate the assistant information such as carrier type, RS type, sleep mode status. Further, the UE can make use of the info and reduce blind detection and enable faster detection and power efficient for
15 UE during initial access. One example is shown here for MIB/SIB1. Note that these new IEs are just for illustration purpose; maybe only part of them is used.

The possible cell type and RS are:

- 20 - R8-R10 type (PSS/SSS+CRS); if the cell type is Rel8-Rel10 carrier, then the RS will be known;
- R12 NCT type
- o PSS/SSS+CSI-RS configuration/density/position (CSI-RS for tracking, for measurement);
- 25 o PDCH+CSI-RS (if use PDCH for initial access).

Figs. 8a and 8b show an example of *SystemInformationBlockType4* and *SystemInformationBlockType 5* information elements for cell measurement assistance according to certain embodiments of the present invention.

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For neighbor cell detection which aims for cell reselection or handover, those info of neighbor cells can be indicated in *NeighCellInfo* in SIB4/5 to help reduce UE power consumptions, and reduce delay. One example is

shown here for intra- frequency neighbor cell, and inter-frequency neighbor cells.

5 Especially since the neighbor can be large for small cells which is likely to be deployed with for high frequency carriers, blind detection can be large, and those info can help reduce blind detection greatly.

10 Fig. 9 shows an example of the *MobilityControlInfo* information element for handover assistance according to certain embodiments of the present invention.

Within handover command, UE can be informed those info of the target to assist on fast and reliable handover.

15 Besides, certain CSI-RS can be configured temporarily dedicatedly for certain UE to facilitate fast handover. And this handover-assistant CSI-RS should be included in handover command. This dedicated handover CSI-RS can help reduce delay of handover. One example is shown here (in green).

20 The IE *MobilityControlInfo* includes parameters relevant for network controlled mobility to/within E-UTRA.

25 Figs. 10a and 10b show an example of the *RRCConnectionRequest* message as well as some example of the signaling design of the *RRCconnectionReject* according to certain embodiments of the present invention for re-direction using *RRCconnectionReject*.

30 To re-direct UE to small cell during the RRC connection establishment procedure, eNB needs to insert some new signaling in the *RRCconnectionReject* in Msg4, and also before that, eNB needs to have some rough knowledge about the UE information, e.g. establishment cause, UE release, etc. This could leave to eNB implementation to handle the offloading / re-direct, and it is possible to also take UE speed into account,

and it is possible to report some initial measurement result to eNB to help the re-direct in Msg3.

Some of the advantages of the present invention are as follows:

- 5 - for the first aspect:
 - o for dense deployment (number of neighboring cell is large) or mixed deployment (hypothesis are more often than pure new carrier or legacy carrier deployment), the proposal can help UE simplify its blind detection, save power and reduce handover
 - 10 delay.
- for the second aspect, compared to first establish the connection in macro cell and then do HO procedure, it could
 - o avoid traffic interruption due to the possibility that there maybe no X2 interface between macro and small cell (easy to deploy→
 - 15 S1 interface might be used)
 - o if UE is in the coverage of the small cell, the HO procedure could be seen as overhead and not necessary
 - o eNB has better flexibility on controlling initial access of UEs, by considering UE request reason, traffic delay sensitivity, load
 - 20 status, legacy and new UE number, etc.

In the foregoing exemplary description of the apparatus, only the units that are relevant for understanding the principles of the invention have been described using functional blocks. The apparatuses may comprise further

25 units that are necessary for its respective function. However, a description of these units is omitted in this specification. The arrangement of the functional blocks of the apparatuses is not construed to limit the invention, and the functions may be performed by one block or further split into sub-blocks.

30 According to exemplarily embodiments of the present invention, a system may comprise any conceivable combination of the thus depicted devices/apparatuses and other network elements, which are arranged to cooperate as described above.

Embodiments of the present invention may be implemented in software, hardware, application logic or a combination of software, hardware and application logic. The software, application logic and/or hardware generally, but not exclusively, may reside on the devices' modem module. In an example embodiment, the application logic, software or an instruction set is maintained on any one of various conventional computer-readable media. In the context of this document, a "computer-readable medium" may be any media or means that can contain, store, communicate, propagate or transport the instructions for use by or in connection with an instruction execution system, apparatus, or device, such as a computer or smart phone, or user equipment.

As used in this application, the term "circuitry" refers to all of the following:

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

The present invention relates in particular but without limitation to mobile communications, for example to environments under LTETM, LTE-A, WCDMA, WIMAX and WLAN and can advantageously be implemented in user equipments or smart phones, or personal computers connectable to such networks. That is, it can be implemented as/in chipsets to connected devices, and/or modems thereof.

According to the present invention, user equipment may refer to a portable computing device. Such computing devices include wireless mobile communication devices operating with or without a subscriber identification module (SIM), including, but not limited to, the following types of devices: mobile phone, smartphone, personal digital assistant (PDA), handset, laptop computer.

If desired, the different functions discussed herein may be performed in a different order and/or concurrently with each other. Furthermore, if desired, one or more of the above-described functions may be optional or may be combined.

Although various aspects of the invention are set out in the independent claims, other aspects of the invention comprise other combinations of features from the described embodiments and/or the dependent claims with the features of the independent claims, and not solely the combinations explicitly set out in the claims.

It is also noted herein that while the above describes example embodiments of the invention, these descriptions should not be viewed in a limiting sense. Rather, there are several variations and modifications which may be made without departing from the scope of the present invention as defined in the appended claims.

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

35	CC	Component Carrier
----	----	-------------------

	DL	Downlink
	eNB	Enhanced Node B (name for Node B in LTE)
	HARQ	Hybrid Acknowledge ReQuest
	LTE	Long Term Evolution
5	LTE-A	Long Term Evolution Advanced
	PCC	Primary Cell Carrier
	PS	Power Saving
	RRC	Radio Resource Control
	SCC	Secondary Cell Carrier
10	UE	User Equipment
	UL	Uplink
	SA	Stand Alone
	NCT	New Carrier Type
	PSS	Primary Synchronisation Signal
15	SSS	Secondary Synchronisation Signal
	CRS	Cell-Specific Reference Signal
	CSI-RS	Channel State Information Reference Signal
	PDCH	Physical Discovery Channel
	ePDCCH	enhanced Physical Downlink Control Channel
20	CSS	Common Search Space

WHAT IS CLAIMED IS:

1. An apparatus comprising
at least one processor; and
5 at least one memory including computer program code;
the at least one memory and the computer program code configured
to, with the at least one processor, cause the apparatus at least to perform
determining whether the carrier type to be used for communication is
a legacy carrier or a new carrier type which supports at least one of a
10 standalone, macro-assisted and non-standalone configuration;
in case of a determining the new carrier type, composing assistant
information comprising at least one of:
reference signal type information indicating support of at least
one of a primary/secondary synchronization signal configuration, cell-
15 specific reference signal configuration, channel state information reference
signal configuration and physical discovery channel configuration for the
new carrier type;
sleep/active mode type information;
cell deployment type information indicating a macro/pico/small
20 cell deployment; and
information indicating enhanced physical downlink control
channel common search space resource; and
causing transmission of the composed assistant information to a
network element.
25
2. The apparatus according to claim 1, wherein the reference signal type
information further comprises allocation information of certain configuration
of reference signal to a certain purpose.
- 30 3. The apparatus according to claim 2, wherein the certain purpose is one of
tracking, demodulation or measurements.
4. The apparatus according to any of claims 1 to 3, wherein the apparatus is
further caused to perform determining presence of a demand for re-

directing the network element during radio resource control connection establishment procedure; and composing further assistant information indicating at least one of a rejection cause and a suggested re-direct target cell.

5

5. The apparatus according to claim 4, wherein the apparatus is further caused to perform receiving information indicating an establishment cause from the network element.

10 6. The apparatus according to claim 5, wherein the cause is one of offloading purpose and ICIC purpose.

7. The apparatus according to any of claims 1 to 6, wherein the assistant information further comprising cell measurement information about at least
15 one neighbor cell.

8. The apparatus according to any of claims 1 to 7, wherein the apparatus is a base station.

20 9. The apparatus according to any of claims 1 to 8, wherein the network element is a user equipment.

10. The apparatus according to any of claims 1 to 9, wherein the apparatus and/or the network element is operating according to the long-term
25 evolution or according to the long-term evolution advanced.

11. A method, comprising:

determining whether the carrier type to be used for communication is a legacy carrier or a new carrier type which supports at least one of a standalone, macro-assisted and non-standalone configuration;

30 in case of a determining the new carrier type, composing assistant information comprising at least one of:

reference signal type information indicating support of at least one of a primary/secondary synchronization signal configuration, cell-specific reference signal configuration, channel state information reference

signal configuration and physical discovery channel configuration for the new carrier type;

sleep/active mode type information;

cell deployment type information indicating a macro/pico/small cell deployment; and

information indicating enhanced physical download control channel common search space resource; and

receiving transmission of the composed assistant information to a network element.

12. An apparatus comprising

at least one processor; and

at least one memory including computer program code;

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

receiving transmission of composed assistant information from a base station; and

processing the received assistant information,

wherein the assistant information is composed by:

determining whether the carrier type to be used for communication is a legacy carrier or a new carrier type which supports at least one of a standalone, macro-assisted and non-standalone configuration;

in case of a determining the new carrier type, composing assistant information comprising at least one of:

reference signal type information indicating support of at least one of a primary/secondary synchronization signal configuration, cell-specific reference signal configuration, channel state information reference signal configuration and physical discovery channel configuration for the new carrier type;

sleep/active mode type information;

cell deployment type information indicating a macro/pico/small cell deployment; and

information indicating enhanced physical download control channel common search space resource.

13. The apparatus according to claim 12, wherein receiving the reference signal type information further comprises allocation information of certain configuration of the reference signal to a certain purpose.

5

14. The apparatus according to claim 13, wherein the certain purpose is one of tracking, demodulation or measurements.

15. The apparatus according to any of claims 11 to 14, wherein the apparatus is further caused to receiving further assistant information indicating at least one of a rejection cause and a suggested re-direct target cell.

16. The apparatus according to claim 15, wherein the apparatus is further adapted to cause transmission of information indicating an establishment cause from the base station.

17. The apparatus according to claim 16, wherein the cause is one of offloading purpose and ICIC purpose.

20

18. The apparatus according to any of claims 11 to 17, wherein receiving the assistant information further comprising cell measurement information about at least one neighbor cell.

19. The apparatus according to any of claims 11 to 18, wherein the apparatus is a user equipment.

20. The apparatus according to any of claims 9 to 15, wherein the apparatus is operating according to the long-term evolution or according to the long-term evolution advanced.

21. A method, comprising:

receiving transmission of composed assistant information from a base station; and

processing the received assistant information,

wherein the assistant information is composed by:

determining whether the carrier type to be used for communication is
a legacy carrier or a new carrier type which supports at least one of a
standalone, macro-assisted and non-standalone configuration;

in case of a determining the new carrier type, composing assistant
information comprising at least one of:

reference signal type information indicating support of at least
one of a primary/secondary synchronization signal configuration, cell-
specific reference signal configuration, channel state information reference
signal configuration and physical discovery channel configuration for the
new carrier type;

sleep/active mode type information;

cell deployment type information indicating a macro/pico/small
cell deployment; and

information indicating enhanced physical downlink control
channel common search space resource.

22. A computer program including a program for a processing device,
comprising software code portions for performing the steps according claim
11 or 21 when the program is run on the processing device.

23. The computer program product according to claim 22, wherein the
computer program product comprises a computer-readable medium on
which the software code portions are stored.

24. The computer program product according to claim 22, wherein the
program is directly loadable into an internal memory of the processing
device.

25. An apparatus, comprising

determination means for determining whether the carrier type to be
used for communication is a legacy carrier or a new carrier type which

supports at least one of a standalone, macro-assisted and non-standalone configuration;

composition means for composing assistant information comprising at least one of:

- 5 reference signal type information indicating support of at least one of a primary/secondary synchronization signal configuration, cell-specific reference signal configuration, channel state information reference signal configuration and physical discovery channel configuration for the new carrier type;
- 10 sleep/active mode type information;
- cell deployment type information indicating a macro/pico/small cell deployment; and
- information indicating enhanced physical download control channel common search space resource; and
- 15 transmission means for causing transmission of the composed assistant information to a network element.

26. An apparatus, comprising

- reception means for receiving transmission of composed assistant
- 20 information from a base station; and
- processing means for processing the received assistant information, wherein the assistant information is composed by:
 - determining whether the carrier type to be used for communication is a legacy carrier or a new carrier type which supports at least one of a
 - 25 standalone, macro-assisted and non-standalone configuration;
 - in case of a determining the new carrier type, composing assistant information comprising at least one of:
 - reference signal type information indicating support of at least
 - one of a primary/secondary synchronization signal configuration, cell-
 - 30 specific reference signal configuration, channel state information reference signal configuration and physical discovery channel configuration for the new carrier type;
 - sleep/active mode type information;

cell deployment type information indicating a macro/pico/small cell deployment; and

information indicating enhanced physical download control channel common search space resource.

Fig. 1

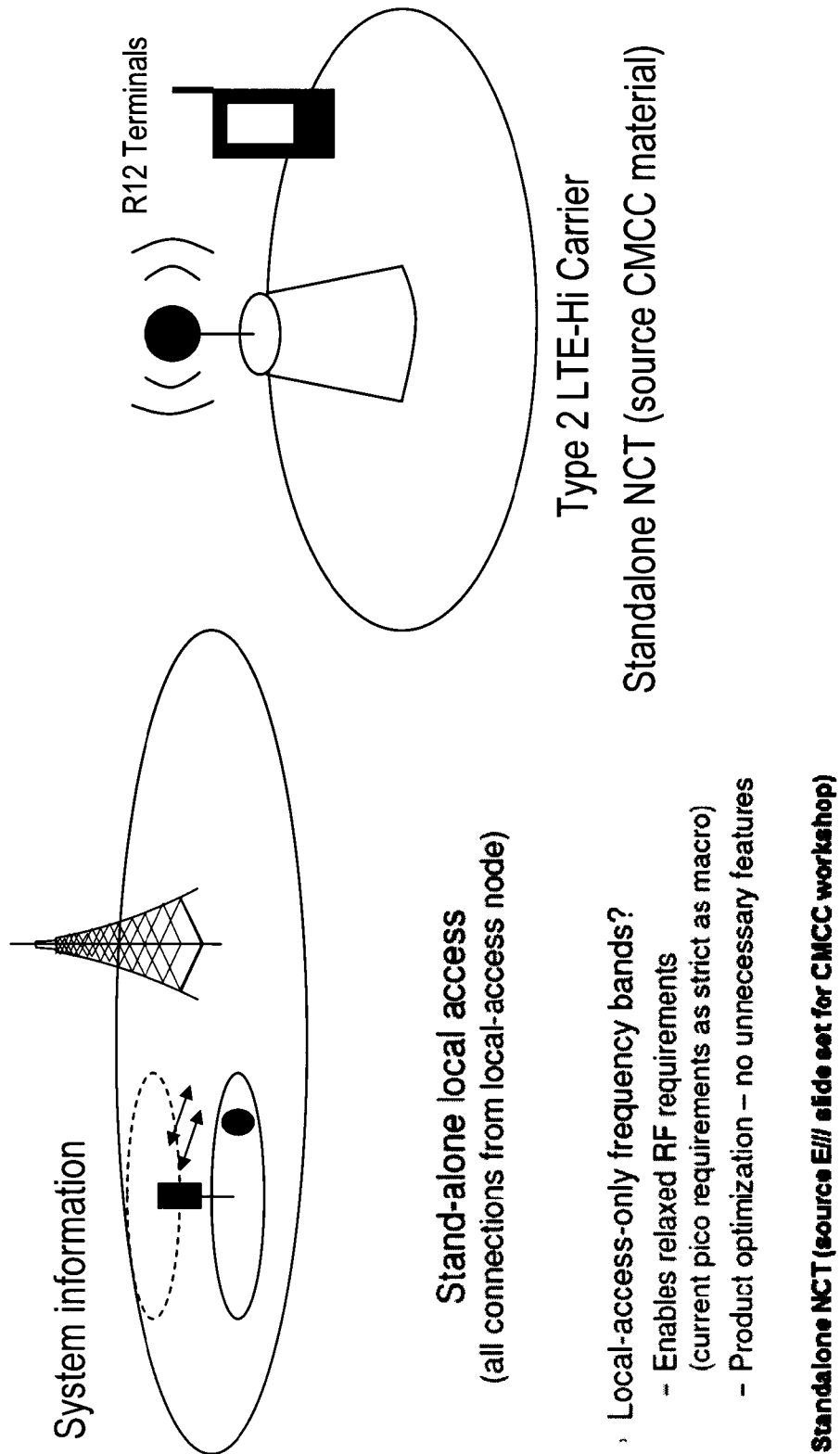


Fig. 2

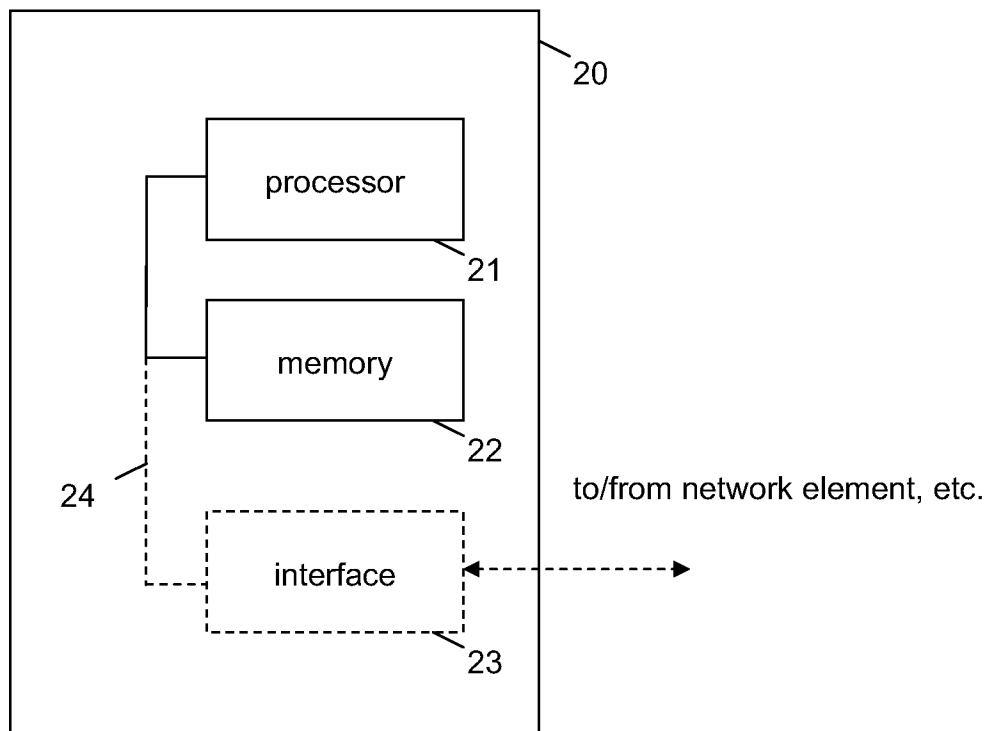


Fig. 3

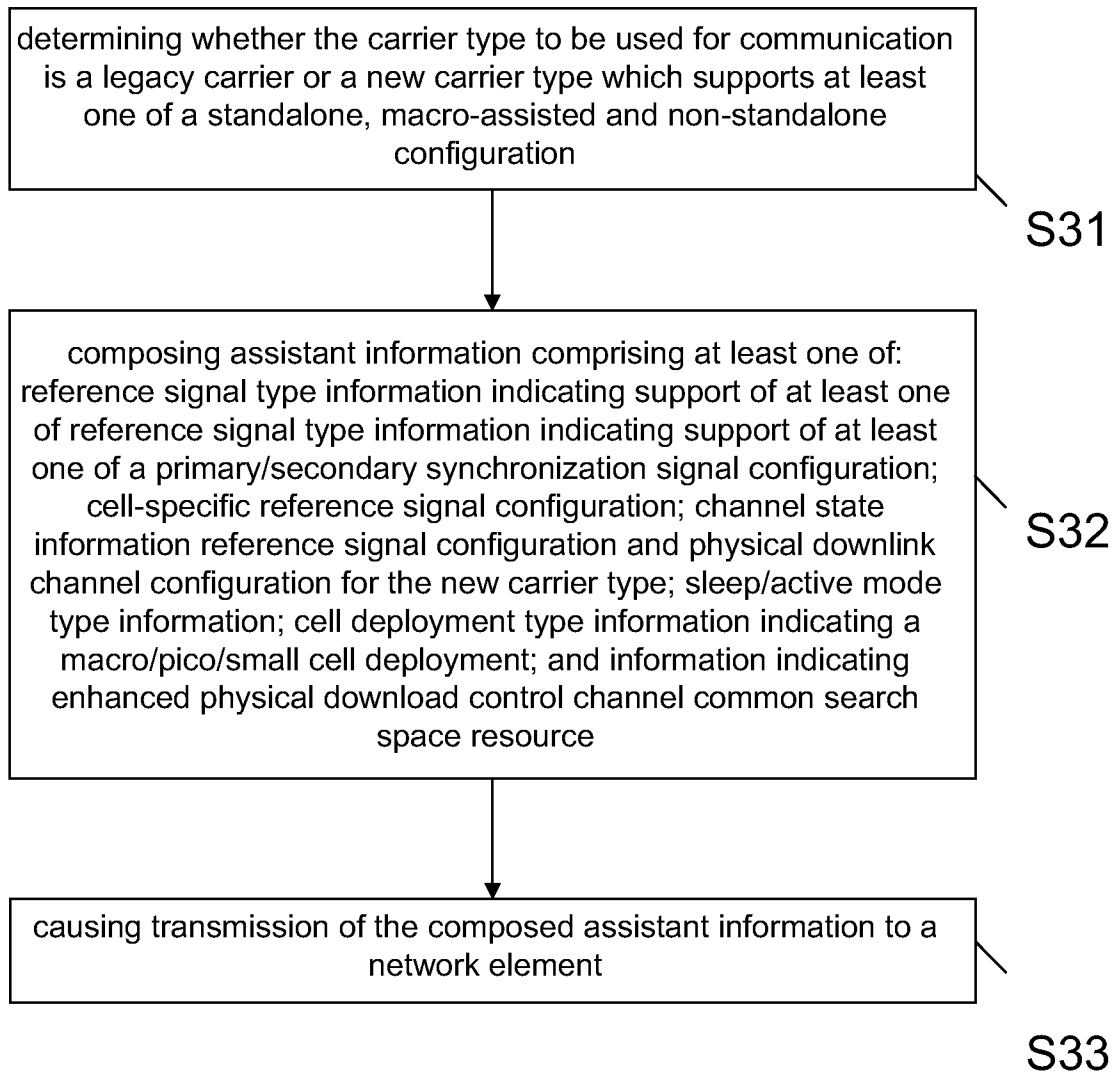


Fig. 4

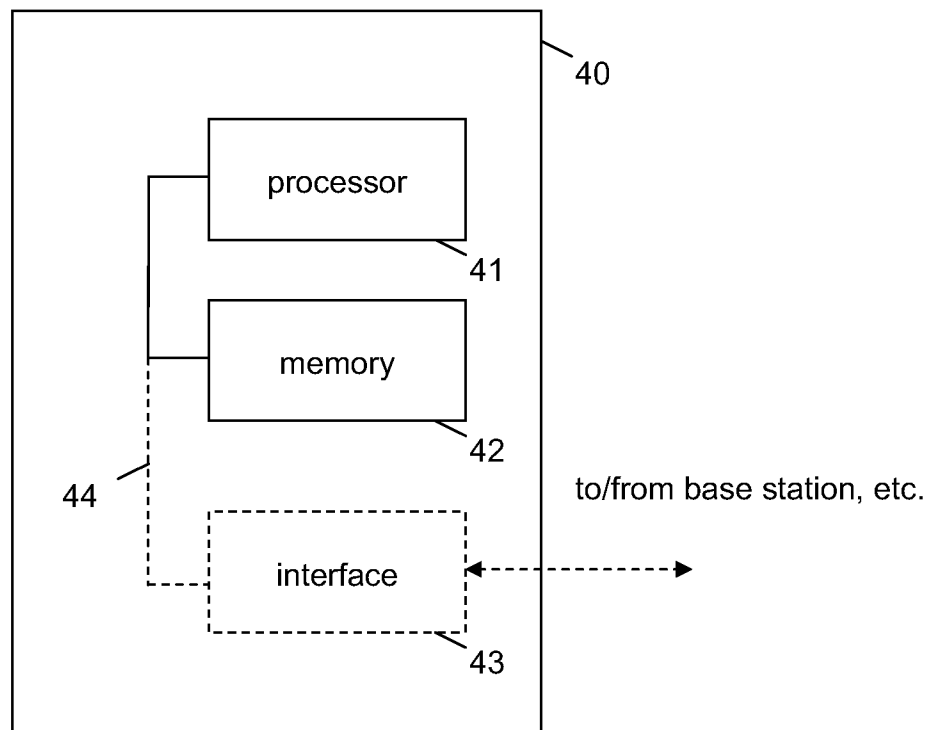


Fig. 5

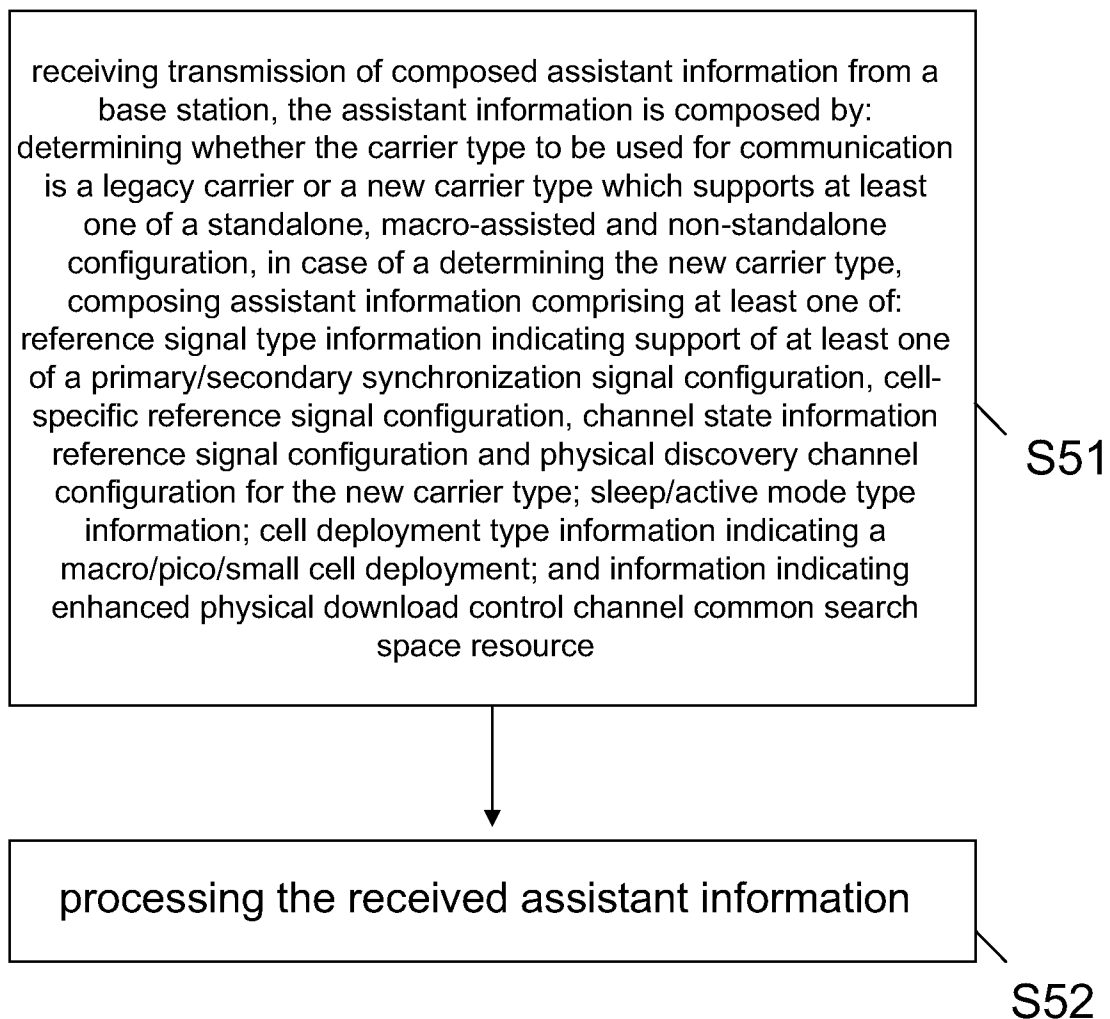


Fig. 6

```

-- ASN1START
MasterInformationBlock ::=
  dl-Bandwidth
  phich-Config
  systemFrameNumber
  carrierType
  sleepmodeIndicator
  ePDCCH-CSS
  spare
}

-- ASN1STOP

```

MasterInformationBlock

```

SEQUENCE {
  ENUMERATED {
    n6, n15, n25, n50, n75, n100,
  }
  PHICH-Config,
  BIT STRING (SIZE (8)),
  ENUMERATED {legacy carrier, new carrier}
  ENUMERATED {active mode, energy saving mode}
  INTEGER (1..4)
  BIT STRING (SIZE (406))
}

```


Fig. 8

```

-- ASN1START

SystemInformationBlockType4 ::= SEQUENCE {
    intraFreqNeighCellList      OPTIONAL, -- Need OR
    intraFreqBlackCellList     OPTIONAL, -- Need OR
    csg-PhysCellIdRange        OPTIONAL, -- Cond CSG
    ...,
    lateNonCriticalExtension    OCTET STRING      OPTIONAL      -- Need OP
}

IntraFreqNeighCellList ::= SEQUENCE (SIZE (1..maxCellIntra)) OF IntraFreqNeighCellInfo

IntraFreqNeighCellInfo ::= SEQUENCE {
    physCellId                PhysCellId,
    q-OffsetCell              Q-OffsetRange,
    carrierType                ENUMERATED {legacy carrier, new carrier}      OPTIONAL,
    sleepmodeIndicator         ENUMERATED {active mode, energy saving mode}  OPTIONAL,
    ePDCCH-CSS                INTEGER (1..4)
    RSconfig                   RSconfig      OPTIONAL
    PDCHconfig                 PDCHconfig    OPTIONAL
    deploymentType             ENUMERATED {macro, pico}      OPTIONAL
    sleepmodeconfig            sleepmodeconfig OPTIONAL
    ...
}

IntraFreqBlackCellList ::= SEQUENCE (SIZE (1..maxCellBlack)) OF PhysCellIdRange

-- ASN1STOP

```

Fig. 9

[illegible]

Fig. 11

RRCConnectionRequest message

```

-- ASN1START
RRCConnectionRequest ::=
    criticalExtensions
        rrcConnectionRequest-r8
        criticalExtensionsFuture
    }
}
RRCConnectionRequest-r8-IEs ::=
    ue-Identity
    establishmentCause
    spare
}
InitialUE-Identity ::=
    s-TMSI
    randomValue
}
EstablishmentCause ::=
    CHOICE {
        emergency, highPriorityAccess, mt-Access, mo-Signalling,
        mo-Data, delayTolerantAccess-v1020, delayTolerantAccess-v1200, spare1
    }
-- ASN1STOP

```

Fig. 12

RRCConnectionReject message

```

-- ASN1START
RRCConnectionReject ::=
  criticalExtensions
    CHOICE {
      c1
        rrcConnectionReject-r8
          spare3 NULL, spare2 NULL, spare1 NULL
        },
      criticalExtensionsFuture
        SEQUENCE {}
    }
}

RRCConnectionReject-r8-IEs ::=
  SEQUENCE {
    waitTime
      INTEGER (1..16),
    nonCriticalExtension
      RRCConnectionReject-v8a0-IEs
    } OPTIONAL
}

RRCConnectionReject-v8a0-IEs ::= SEQUENCE {
  lateNonCriticalExtension
    OCTET STRING
    RRCConnectionReject-v1020-IEs
  } OPTIONAL, -- Need OP
  nonCriticalExtension
    OPTIONAL
}

RRCConnectionReject-v1020-IEs ::= SEQUENCE {
  extendedWaitTime-r10
    INTEGER (1..1800)
    SEQUENCE {}
  nonCriticalExtension
    OPTIONAL, -- Need ON
    SEQUENCE {}
    OPTIONAL, -- Need OP
}

RRCConnectionReject-v1200-IE ::= SEQUENCE {
  rejectCause ::=
    ENUMERATED (Offloading, ICIC, spare, spare)
  rsConfigNewCarrierType
}
-- ASN1STOP

```

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2012/085075

A. CLASSIFICATION OF SUBJECT MATTER

H04W 48/08 (2009.01) i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H04W, H04L, H04Q, H04B

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)

CNABS, CNTXT, VEN, USTXT, WOTXT, EPTXT, 3GPP FTP, CNKI: legacy carrier, new carrier type, assistant information, reference signal, mode

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	TSG RAN WG1. Attachment. 3GPP TSG-RAN1 Meeting #70, R1-124026 attachment: Att_UpdInfoRev1M2012rev_2_editorials.doc. 26 August 2012 URL: http://isearch.3gpp.org/isysquery/6583f293-fd20-4ed2-9291-32d6c1e7f373/1/doc/ page 10, lines 33-35 and page 13, line 31 to page 14, line 9	1-26
A	ZTE Corporation. Discussion on New Carrier Type. 3GPP TSG-RAN WG2 Meeting #78, R2-122241. 15 May 2012 the whole document	1-26
A	China Unicom. Discussion on UE assistant information. 3GPP TSG-RAN WG2 Meeting #78, R2-122437. 11 May 2012 the whole document	1-26
A	CN 102685795 A (New Post Communication Equipment Co., Ltd.) 19 September 2012 (19.09.2012) the whole document	1-26

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

* Special categories of cited documents:	“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
“A” document defining the general state of the art which is not considered to be of particular relevance	
“E” earlier application or patent but published on or after the international filing date	“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	
“P” document published prior to the international filing date but later than the priority date claimed	“&” document member of the same patent family

Date of the actual completion of the international search 08 Aug. 2013 (08.08.2013)	Date of mailing of the international search report 29 Aug. 2013 (29.08.2013)
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer DU, Yongyan Telephone No. (86-10)62089451

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2012/085075

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 102685795 A	19.09.2012	None	