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(54) Title: METHODS AND APPARATUS FOR INDICATING AND IMPLEMENTING OF NEW UE CATEGORY

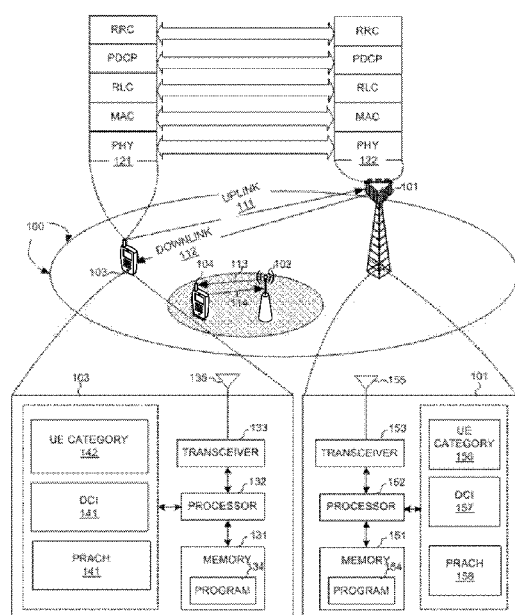


FIG. 1

(57) Abstract: Methods and apparatus for indicating and imple-
menting of new UE category are provided. In one novel aspect,
wherein the method comprising: reporting a UE capability to eNB
by a UE; and monitoring for a new DCI format corresponding to
the UE capability if eNB supports the reported UE capability, oth-
erwise, monitoring for a default DCI format. In the second novel
aspect, the method further comprising: determining if the eNB sup-
ports the reported UE capability by an indicator in system informa-
tion. UE monitors for the new DCI format in USS, monitors for
the default DCI format in CSS. The new DCI format including a
indicator for HARQ process number.

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METHODS AND APPARATUS FOR INDICATING AND IMPLEMENTING OF NEW UE CATEGORY

TECHNICAL FIELD

5 [0001] This disclosure relates generally to wireless communications and, more particularly, to methods and apparatus for DL control channel monitoring for new UE category.

BACKGROUND

10 [0002] Machine-Type Communication (MTC) is an important revenue stream for operators and has a huge potential from the operator perspective. Lowering the cost of MTC user equipment (UEs) / devices is an important enabler for the implementation of the concept of "Internet of Things" (IOT). Many MTC devices are targeting low-end (low average revenue per user, low data rate) applications that
15 can be handled adequately by GSM/GPRS. Owing to the low-cost of these devices and good coverage of GSM/GPRS, there is very little motivation for MTC UE suppliers to use modules supporting the LTE radio interface. In order to ensure that there is a clear business benefit to MTC UE vendors and operators for migrating low-end MTC devices from GSM/GPRS to LTE networks, a new type of terminal,
20 i.e. a low cost (LC) MTC UE, is introduced in Rel-11. The cost of the LC-MTC UEs is tailored for the low-end of the MTC market to be competitive with that of GSM/GPRS terminals. The LC-MTC UEs are characterized by: 1) One Rx antenna; 2) Downlink and uplink maximum TBS size of 1000 bits; 3) Bandwidth reduction (BR) – resources for each channel transmission are limited to contiguous 6 PRBs
25 (1.4MHz) for cost reduction, and 4) Coverage enhancement – some applications of LC-MTC UEs will require 15-20dB coverage extension and repeated transmission is a common technique to compensate penetration losses.

[0003] In LTE Rel. 12, it is shown that the implementation of half-duplex FDD (HD-FDD) MTC with single received antenna is cost-competitive. The bandwidth
30 reduction technique can offer further cost reduction. The UE with bandwidth reduction (BR-UE) can be implemented with lower cost by reducing the buffer size, clock rate for signal processing, and so on. In IoT/MTC traffic, there is a lot of infrequent small UL traffic data, e.g., up to 100~200 bytes uplink traffic periodically reported 1/ hour to 1/year.

35 [0004] Recently, a New UE category with larger TBS and/or more than one HARQ process and/or a larger bandwidth (BW) (e.g, a UE with larger RF bandwidth) are introduced. In order to support the new UE category, e.g., UE with more than one HARQ process, or a larger BW, there are some problems which need to be solved.

40 [0005] First, the current DCI format could not work for the new category UE, for example, UE with more than one HARQ process/a larger BW. So a new DCI format with HARQ process number indication is needed.

[0006] Second, during the procedure, UE and eNB need handshake to enable the new UE category e.g., support of more than one HARQ process and/or a resource allocation within larger BW. How to report UE category/capability and when to monitor for new DCI format needs to be solved.

5 [0007] Third, how to inform UE by the eNB that it can support new UE category/capability also needs to be solved.

[0008] In NB-IoT system, NPRACH resources for each coverage level can be partitioned into one or two groups for single/multi-tone MSG 3 transmission. Since there is no restriction on NPRACH resource configuration for multi-tone MSG 3
10 transmission. The configuration of that there is no NPRACH resource for single-tone or multi-tone MSG 3 transmission may happen. In this case, UEs who are capable of multi-tone MSG 3 transmission can only select NPRACH resource in coverage level 1 and set max transmission power. However, if those UEs are in normal coverage but transmit NPRACH with max power, it will impact on the UE in
15 extended/extreme coverage mode. Therefore, it is benefit to fix this problem.

SUMMARY

[0009] Methods and apparatus for indicating and implementing of new UE category are provided.

20 [00010] In one novel aspect, a method is provided, comprising: reporting a new UE capability to eNB by a UE in the wireless system; and implementing the new UE capability if eNB supports the reported UE capability, otherwise, implementing a default UE capability.

[00011] In one embodiment, determining if the eNB supports the reported UE
25 capability by configuration in system information.

[00012] In another embodiment, implementing the new UE capability by monitoring for a new DCI format and implementing the default UE capability by monitoring for a default DCI format. And implementing the new UE capability by UE monitoring for the new DCI format in UE specific search space and
30 implementing the default UE capability by monitoring for a default DCI format, or implementing the new UE capability by UE monitoring for the new DCI format in both UE specific search space and common search space, and implementing the default UE capability by monitoring for a default DCI format in both UE specific search space and common search space.

35 [00013] In yet another embodiment, determining if the eNB supports the reported UE capability by obtaining an indication in a dedicated RRC signaling, or the indication is implied by the present of a configuration of a DL control channel, or the indication is explicated indicated by an information element in RRC message.

[00014] In yet another embodiment, the dedicated RRC signaling is in MSG 4.

40 [00015] In another novel aspect, the UE capability is that UE support of more than one HARQ processes and/or a new UE category with larger buffer size and/or support of wide bandwidth and/or support of larger TBS.

[00016] In one embodiment, the new DCI format including a indicator for HARQ process number, and implementing the new UE capability by mapping the indicator in DCI to a new element and implementing the default UE capability by mapping the indicator in DCI to a default element.

5 [00017] In another embodiment, reporting a new UE capability to eNB in MSG 3.

BRIEF DESCRIPTION OF DRAWINGS

10 [00018] For a more complete understanding of the embodiments, and the advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings.

[00019] Figure 1 illustrates a wireless communication system in accordance with some embodiments.

15 [00020] Figure 2A illustrates the message procedure of UE reporting the new category and obtaining configuration of eNB support of the new category according to the first Embodiment of this invention.

[00021] Figure 2B illustrates examples of UE implementing the new capability and default capability.

[00022] Figure 3 illustrates the message procedure of UE obtaining the support of the new category according by eNB to the second Embodiment of this invention.

20 [00023] Figure 4A illustrates the message procedure of UE reporting the new category according to the third Embodiment of this invention.

[00024] Figure 4B illustrates a flow chart of UE reporting NPRACH according to the embodiments of this invention.

25 [00025] Figure 4C illustrates example of PRACH resource reserved for different capability. Figure 5 illustrates the message procedure of UE reporting the new category and obtaining confirmation from eNB according to the fourth Embodiment of this invention.

[00026] Figure 6 illustrates the flow chart of UE reporting the new category according to the fourth Embodiment of this invention.

30 [00027] Figure 7 illustrates the flow chart of UE reporting the new category according to the fourth Embodiment of this invention.

[00028] Figure 8 illustrates the flow chart of method 1 for PRACH power ramping according to the embodiment of this invention.

35 [00029] Figure 9 illustrates the flow chart of method 2 for PRACH power ramping according to the embodiment of this invention.

[00030] Corresponding numerals and symbols in the different figures generally refer to corresponding parts unless otherwise indicated. The figures are drawn to clearly illustrate the relevant aspects of the embodiments and are not necessarily drawn to scale.

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DETAILED DESCRIPTION

[00031] Certain terms are used throughout the description and following claims to refer to particular components. As one skilled in the art will appreciate,

manufacturers may refer to a component by different names. This document does not intend to distinguish between components that differ in name but not function. In the following description and in the claims, the terms "include" and "comprise" are used in an open-ended fashion, and thus should be interpreted to mean "include, but not limited to ...". Also, the term "couple" is intended to mean either an indirect or direct electrical connection. Accordingly, if one device is coupled to another device, that connection may be through a direct electrical connection, or through an indirect electrical connection via other devices and connections. The making and using of the embodiments of the disclosure are discussed in detail below. It should be appreciated, however, that the embodiments can be embodied in a wide variety of specific contexts. The specific embodiments discussed are merely illustrative, and do not limit the scope of the disclosure. Some variations of the embodiments are described. Throughout the various views and illustrative embodiments, like reference numbers are used to designate like elements.

[00032] In order to increase the bit rate, to reduce latency or to save UE power consumption, a new UE category or capability is introduced in a communication system. Some techniques can be used for a new UE category/capability, such as support of multiple HARQ process, larger BW, or increasing MAX TBS. In order to enable the feature, i.e., eNB can schedule multiple HARQ process, schedule a transport block onto radio resource spanning on a larger BW, and/or schedule a transport block with a large size, eNB needs to know the UE capability. In LTE system, UE will report category/capability after receiving the configuration from eNB, i.e., a RRC message UECapabilityEnquiry. UE reports its category/capability in UECapabilityInformation element. However, for NB-IoT UP solution, the data package is transmitted in Msg 5. Therefore, it is benefit to report UE category/capability in an early message.

[00033] In addition, the current DCI format could not work for the new category UE. For example, for UE with one HARQ process there is no field in DCI to indicate HARQ process number. However, to support more than one HARQ process, the field in DCI to indicate HARQ process number is needed, otherwise UE does not know which HARQ process the scheduled grant belongs to. In another example, a UE with larger BW, e.g, RF bandwidth may need more bit for resource allocation, which results in a different DCI format. UE and eNB need handshake to enable the new UE category/feature capability, e.g, to support more than one HARQ process and/or to schedule a larger resource allocation on a wider bandwidth and/or schedule a grant with a large TBS. After the handshake, UE monitors for a new DCI format for its higher category or new feature.

[00034] In one example, PRACH resource can be separated into two groups to report the new UE category/capability. For example, in NB-IoT system, each PRACH resource associated with a repetition level to extend the coverage. Within each PRACH resource, PRACH resource is partitioned into two groups for single/multi-tone Msg 3 transmission. However, since the transport size is limited, and there is no need to support multiple HARQ process, there is no need to report

UE category by partitioning PRACH resource, which may increase collision probability.

[00035] In addition, for the system with more than one PRACH coverage level, power ramping is supported for the lowest repetition level, which can overcome the near-far problem for NPRACH for NB-IoT UE in normal coverage. UE uses the max transmission power for other repetition levels for extend/extreme coverage. The method of power ramping in case of more than one PRACH resource groups needs to be studied. In this disclosure, methods for power ramping for PRACH are proposed to avoid near-far problem and increase system capacity.

[00036] In one novel aspect, UE could report the new category in MSG 3. And in this case, more HARQ process and/or larger TBS and/or wide BW can be enable after MSG 3. For example, for CP solution, the new feature/category can be used to improve the data rate. In another embodiment, UE could report the new category within the RRC message for UE category report.

[00037] Because some network may not be able to support UE with new category/feature, UE needs to know if the eNB can support the new category/feature so that UE can perform as a new category/feature UE, otherwise, UE performs as an old feature UE. In another novel aspect, the new UE category/feature is enabled by eNB, which is also called eNB enabler. For example, the follow features can be enabled: to support more than one HARQ process and/or to schedule a larger resource allocation on a wider bandwidth and/or schedule a grant with a large TBS.

[00038] In one embodiment, eNB broadcasts the configuration of support of the new category in SIB or dedicated RRC message or in MAC or in DCI. For example, in MSG 4. If UE receives the configuration from eNB, UE implements the new category/capability. For example, UE monitors a DL control channel in pre-defined rule to implement the new category/capability. In one example, the pre-defined rule is one or combination of the following options:

[00039] 1)Monitoring for a new DCI format:

[00040] In option 1), there are three cases, comprising:

- A. in UE specific search space (USS) only;
- B. in both USS and common search space (CSS);
- C. in CSS only, in case C, the CSS could be the CSS used for paging, or CSS for RAR Msg 3 retransmission and Msg 4.

[00041] 2)Monitoring for a new DCI format:

[00042] In option 2), there are three time occasions, comprising:

- A. Right after obtain the configuration from eNB;
- B. After UE capability reporting;
- C. In certain procedure, e.g., in connected mode, and/or in Idle mode, during RACH procedure.

[00043] Further details and embodiments and methods are described in the detailed description below. The accompanying drawings, where like numerals indicate like components, illustrate embodiments of the invention.

[00044] Figure 1 illustrates a wireless communication system in accordance with some embodiments. The wireless communication system 100 includes one or more fixed base infrastructure units forming a network distribution over a geographical region. The base unit may also be referred to as an access point, access terminal, base station, Node-B, eNode-B (eNB), or by other terminology used in the art. As shown in FIG. 1, the base units, e.g. eNB 101 and 102 serve a number of remote units, e.g. UE 103 and 104 within a serving area, for example, a cell, or within a cell sector. In some systems, one or more base units are communicably coupled to a controller to form an access network that is communicably coupled to one or more core networks. The disclosure however is not intended to be limited to any particular wireless communication system.

[00045] Generally, the eNB 101 and 102 respectively transmit downlink communication signals 112, 113 to UE 103, and 104 in the time and/or frequency and/or code domain. UE 103, and 104 communicate with one or more eNB 101 and 102 via uplink communication signals 113, and 114 respectively. The one or more eNB 101 and 102 may comprise one or more transmitters and one or more receivers that serve the UE 103 and 104. The UE 103, and 104 may be fixed or mobile user terminals. The UE may also be referred to as subscriber units, mobile stations, users, terminals, subscriber stations, user terminals, or by other terminology used in the art. The UE 103, and 104 may also comprise one or more transmitters and one or more receivers. The UE 103, and 104 may have half-duplex (HD) or full-duplex (FD) transceivers. Half-duplex transceivers do not transmit and receive simultaneously whereas full-duplex terminals transmit and receive simultaneously. In one embodiment, one eNB 101 can serve different kind of UEs. UE 103 and 104 may belong to different categories, such as having different RF bandwidth or different subcarrier spacing. UE belonging to different categories may be designed for different use cases or scenarios. For example, some use case such as Machine Type Communication (MTC) may require very low throughput, delay tolerant, the traffic packet size may be very small (e.g., 1000 bit per message), extension coverage. Some other use case, e.g. intelligent transportation system, may be very strict with latency, e.g. orders of 1ms of end to end latency. Different UE categories may be introduced for these diverse requirements. Different frame structures or system parameters may also be used in order to achieve some special requirement. For example, different UEs may have different RF bandwidths, subcarrier spacings, omitting some system functionalities (e.g., random access, CSI feedback), or use physical channels/signals for the same functionality (e.g., different reference signals).

[00046] Figure 1 also shows an exemplary diagram of protocol stacks for control-plane for UE 103 and eNB 101. UE 103 has a protocol stack 121, which includes the physical (PHY) layer, the medium access control (MAC) layer, the radio link control (RLC) layer, the pack data convergence protocol (PDCP) layer, and the radio resource control (RRC) layer. Similarly, base station eNB 101 has a protocol stack 122, which includes the PHY layer, the MAC layer, the RLC layer, the PDCP layer,

and the RRC layer, each of which connects with their corresponding protocol stack of UE protocol stack 121.

[00047] Figure 1 also includes a simplified block diagram of UE and eNB in accordance with novel aspects of the current invention, wherein, the UE could be UE 103, and the eNB could be eNB 101. UE comprises memory 131, a processor 132, a transceiver 133 coupled to an antenna 135. UE also comprises various function modules including UE category processing module 142, for processing UE category information; and DCI processing module 141, for processing operation for old or new DCI format, and PRACH processing module 143. And the above function module could be implemented by software, hardware, firmware of the combination of the above.

[00048] The eNB 101 comprises memory 151, a processor 152, a transceiver 153 coupled to an antenna 155. eNB also comprises various function modules including UE category processing module 156, for processing UE category information; and DCI processing 157, for processing operation for old or new DCI format, PRACH configuration module 158. The above apparatus may be implemented with a bus architecture. The bus may include any number of interconnecting buses and bridges depending on the specific application of the system structure and the overall design constraints. The bus links together various circuits including one or more processors and/or hardware modules, represented by the processor and different modules and the computer-readable medium. The bus may also link various other circuits such as timing sources, peripherals, voltage regulators, and power management circuits, which are well known in the art, and therefore, will not be described any further. It is understood that the specific order or hierarchy of steps in the processes disclosed is an illustration of exemplary approaches. Based upon design preferences, it is understood that the specific order or hierarchy of steps in the processes may be rearranged. Further, some steps may be combined or omitted. The accompanying method claims present elements of the various steps in a sample order, and are not meant to be limited to the specific order or hierarchy presented.

[00049] Figure 2A illustrates the message procedure of UE reporting the new category and obtaining configuration of eNB support of the new category according to the first Embodiment of this invention. In this solution, UE performs as the new category UE, for example, monitoring for new DCI format in USS if obtain the configuration in SIB. In one example, UE monitors for default DCI in common searching space (CSS) no matter UE implements as the new category or legacy/default category. For example, UE monitors the default DCI format in CSS, e.g., Type2-NPDCCH common search space for MSG 3 re-tx or MSG 4. UE monitors the default DCI format for paging, e.g., in Type 1-NPDCCH common search space. Some UE behaviors in IDLE mode or during RACH procedure do not require network/eNB to know the UE capability. For example, eNB treats all UEs as legacy UE before obtaining UE capability indication. This could avoid resource segmentation and improve system capacity. In another example, UE monitors the new DCI format in both USS and CSS. In one case, UE performs as the new

category/capability UE in order to support more HARQ processes and/or new UE category (e.g., large max TBS).

5 [00050] For UE which performs as new category/capability UE, UE monitors more DL control channel search space to improve data rate to reduce latency and save UE power consumption. For example, the search space between NPDCCH and scheduled NPDSCH or NPUSCH. In another example, the search space between NPDSCH to ACK/NACK. In addition, UE is busy with NPDSCH decoding within the offset, therefore, UE shall not be required to monitor NPDCCH between NPDSCH and its ACK/NACK. Moreover, since there is limited benefit for UE to support 2 HARQ process during RACH procedure, UE only needs to monitor additional NPDCCH search space in connected mode that is after RACH procedure.

10 [00051] In order to minimize eNB effort on scheduling, the same timing offset for both UL and DL is better to be kept. That is the same timing offset between NPDCCH and NPDSCH, NPDCCH and NPUSCH format 1 and NPDSCH and its ACK/NACK. In addition, the timing offset is calculated per HARQ process. Alternatively, UE performs as new UE category/capability, e.g. enable 2 HARQ process, different timing offset/scheduling delay may be used. More specifically, UE may map to different timing offset/scheduling delay table based on scheduling delay or HARQ/ACK resource field in DCI/RAR.

15 [00052] Because UE can expect two DCIs within one search space or an additional DCI between decoded DCI and its scheduled data channel, some "collision" may happen. However, eNB shall ensure there is no such error case and UE does not expect collision due to the two DCI. In addition, because of the two DCI, NPDSCH and NPUSCH may be scheduled overlapped, switching time from UL to DL needs to be reserved. Referencing eMTC, at least 1ms needs to be ensured by eNB. In another alternative, when collision happens, UE fully or partially drop one of the transport block or ACK/NACK. It can be based on a pre-defined rule or UE implementation.

20 [00053] Please refer to Figure 2A, first in step 210, eNB 202 broadcasts the support of new UE capability in SIB (e.g., by a configuration), and the new UE category, for example, is more than one HARQ process, and/or wide BW, and/or large max TBS. UE obtains configuration in SIB, by determining if an information element (IE) present in SIB or not. In step 220, UE transmits the PRACH/(NPRACH in Msg 1 to eNB 202. In step 230, UE monitors the type2-NPDCCH common search space for RAR. In one example, the DCI format in type2-NPDCCH CSS is common for legacy category and new category UE. In step 240, UE reports the new capability in MSG 3. For example, use one reserved bit in MAC. In one example, UE only reports the new capability in MSG 3 if UE obtains a configuration from eNB, for example, in SIB. In step 250, eNB transmits MSG 4 to UE 201. And then in step 260, after RACH procedure, the UE monitors USS for the new DCI format, if the cell supports the new UE category. Otherwise, UE monitors USS for legacy/default DCI format.

[00054] In this embodiment, if UE 201 is the new category, and eNB supports the characters of the new category, for example, more than one HARQ process, UE 201 could report this information in msg3 in step 240. And this information for example is element *twoHARQProcessSupport* (e.g., MAC control element or RRC element) included in MSG 3. In one example, this information is only in *RRCConnectionRequest* in the RRC Connection request message. In another case, this information is also in RRC connection resume request message or in RRC Connection Re-establishment message. In step 230, UE monitors the legacy DCI format in CSS for RAR. In step 240, UE may monitor the legacy DCI format in CSS for MSG 3 re-transmission. In step 250, UE monitors the legacy DCI format in CSS for MSG 4. And UE monitors the old DCI format for paging, e.g., in Type 1-NPDCCH common search space.

[00055] Figure 2B illustrates examples of UE implementing the new capability and default capability. In figure 2B, the above block shows a legacy DCI format, wherein block 2010 indicates a legacy resource assignment and/or modulation and coding scheme. The resource assignment indicates the number of subframes or resource units for DL or UL resource block. Moreover, with the resource assignment and modulation and coding scheme, UE can obtain a transport block size (TBS) based on a pre-defined TBS table. And in the below block, the block shows the new DCI format. And block 2020 shows the field for new resource assignment and/or modulation and coding scheme. UE implements as new capability/category by obtaining the TBS based on a new TBS table other than the legacy table, which UE uses to when implementing as legacy capability/category. In another example, UE implements as new capability/category by obtaining the TBS based on a legacy TBS table with more entries. Similarly, UE may obtain the number of subframes or resource unit based on a new table (Table used for mapping resource assignment, i.e., I_{SF} to N_{SF} for NB-IoT NPDSCH and/or I_{RU} to N_{RU} for NB-IoT NPUSCH) for new DCI format. In one example, the DCI field in new DCI format for resource assignment has the same size as in the legacy DCI format. In another example, the DCI field in new DCI format for resource assignment has the different size from the legacy DCI format. In the new DCI format, there is additional field 2030, which is the new field for HARQ process number. UE monitors a new DCI format as implementing the new capability. In one example, the DCI size of new DCI format is different from default format, as shown in figure 2B. In one case, a new field is used to indicate HARQ process number, for example, field 2030. In another example, UE interprets the DCI field to with a new table as implementing the new capability and with a default table as implementing the default capability. For example, different TBS and/or MCS table for different max TBS or bandwidth.

[00056] Figure 3 illustrates the message procedure of UE obtaining the support of the new category according by eNB to the second Embodiment of this invention. Please refer to figure 3, in step 310, eNB 302 transmits the dedicated signaling to the UE 301 to enable new implementation of the UE with new capability. UE 301 obtains the configuration. In one embodiment, eNB transmits the dedicated signaling

if obtain the new UE capability of UE 301, e.g. by obtaining the capability report in Msg 3 as in step 230 of in Figure 2A. The information element (RE) in the dedicated signaling is, e.g. Radio resource configuration in a RRC message, and the RRC message is for example one of the following messages, RRC connection reconfiguration, RRC connection reestablishment, RRC connection Resume, or RRC connection setup. More specifically, UE obtains the indication in MSG 4. And then in step 320, UE 301 implements the new capability. More specifically, the indication in an IE for dedicated physical configuration, e.g., *NPDCCH-ConfigDedicated* in *physicalConfigDedicated* or in *radioResourceConfigDedicated*.
 5 The indication of if eNB support capability is implied, so UE monitors NPDCCH for New DCI format (e.g., in USS) after obtaining an indicator for new DCI format in dedicated RRC signaling.

[00057] Figure 4A illustrates the message procedure of UE reporting the new category according to the third Embodiment of this invention. Please refer to figure 4A, in step 410, UE 401 transmits the NPRACH in MSG to eNB 402. In step 420, UE monitors the type2-NPDCCH common search space for RAR. In step 430, UE reports the new category in MSG 3 to eNB 402. In step 440, UE obtains the indication from eNB 402 to use the new DCI format. In one example, the indication is in MSG 4. And then in step 450, UE monitors USS for new DCI format for MSG
 15 5 and later receives the uni-cast channel from eNB 402.

[00058] In this embodiment, in step 430, If the UE is new category or support 2 HARQ process, the information about the new category or supporting for more than one HARQ process includes *twoHARQProcessSupport* in *RRCConnectionRequest* message. It could also be in RRC Connection resume request Message or RRC Connection Re-establishment message. In steps 420-440, the default DCI format is in CSS. In step 450, UE 401 monitors for new DCI format in USS if obtain indication, otherwise, UE 401 monitor for old DCI format in USS.
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[00059] Figure 4B illustrates a flow chart of UE reporting NPRACH according to the embodiments of this invention. In another example, please refer to figure 4B, UE 401 transmits the NPRACH in MSG to eNB 402 based on its capability, MSG is for example single/multi-tone MSG3. Wherein, in step 4010, UE decides a coverage level based on the RSRP. And in step 4020, UE selects and transmits PRACH within the PRACH resource associated with the coverage level. And further, UE selects and transmits PRACH within the PRACH resource reserved for its capability, i.e., single/multi-tone MSG 3 in step 4030. In step 4040, UE set the preamble received target power according to the coverage level and capability of UE to support of multi-tone Msg 3 transmission.
 30 35

[00060] Here are some power setting cases for PRACH. More specifically:

[00061] In case A, for multi-tone Msg 3 capable UE, for the lowest coverage level of PRACH with reserved resource for multi-tone Msg 3, setting
 40
 PREAMBLE_RECEIVED_TARGET_POWER to
 PREAMBLE_RECEIVED_TARGET_POWER - 10 *
 $\log_{10}(\text{numRepetitionPerPreambleAttempt})$.

[00062] In case B, For multi-tone Msg 3 non-capable UE, for the lowest coverage level of PRACH with reserved resource for single-tone Msg 3, setting PREAMBLE_RECEIVED_TARGET_POWER to PREAMBLE_RECEIVED_TARGET_POWER - 10 *

5 log10(numRepetitionPerPreambleAttempt).

[00063] Figure 4C illustrates example of PRACH resource reserved for different capability. Referring to Figure 4A. Where, the lowest coverage level of PRACH is the lowest coverage level have PRACH resource reserved for the correspond capability. UE obtains PRACH configuration with three coverage level, i.e.,
 10 coverage level 0, 1 and 2. All the PRACH resource in coverage level 0 are reserved for multi-tone MSG 3 and part of PARACH resource in coverage level 1 and 2 are reserved for multi-tone MSG3. In this example, the lowest coverage level for multi-tone MSG 3 capable UE is coverage level 0 and the lowest coverage level for single-tone only MSG 3 capable UE (i.e., non-multi-tone MSG 3 capable UE) is coverage
 15 level 1. And multi-tone MSG 3 capable UE performs power ramping (e.g., set PREAMBLE_RECEIVED_TARGET_POWER based on a configuration from eNB as preambleInitialReceivedTargetPower) if selects PRACH resource in coverage level 0. And non-multi-tone MSG 3 capable UE (single-tone MSG 3 only capable UE) performs power ramping if selects PRACH resource in coverage level 1, where
 20 is actual available lowest coverage level is not the lowest coverage level in PRACH configuration. Please refer to figure 4C, for coverage level 0, what is {1 1}, and the number for PRACH resources is reserved for multi-toen MSG 3 is the whole PRACH resource (i.e., $1 \times N_{SC}^{PRACH}$) For coverage level 1, the number for PRACH resources reserved for multi-tone MSG 3 is 1/3 of the whole PRACH resource (i.e., $1/3 \times N_{SC}^{PRACH}$) and the rest is for single-tone MSG 3. For coverage level 1, the
 25 number for PRACH resources reserved for multi-tone MSG 3 is 2/3 of the whole PRACH resource (i.e., $2/3 \times N_{SC}^{PRACH}$) and the rest is for single-tone MSG 3.

[00064] Figure 5 illustrates the message procedure of UE reporting the new category and obtaining confirmation from eNB according to the fourth Embodiment
 30 of this invention. In figure 5, in step 510, eNB 502 transmits the UE capability enquiry to UE 501 and UE obtains RRC message for UE capability enquiry. In step 520, UE reports the UE category/capability to eNB 502. In step 520, eNB obtains the UE capability/category from UE. In step 530, eNB 502 transmits the dedicated signaling to UE, and the dedicated signaling for example is RRC connection reconfiguration in the RRC message. For new eNB, it understands the new UE
 35 category/capability so that eNB can configures UE with corresponding configuration for the new UE capability/category, for example, a new IE can be inserted in a RRC message. For legacy eNB, it does not understand the new UE category/capability. So there is no new RRC IE in the RRC message. In step 540, UE performs
 40 implementation as new capability, e.g., monitors the DL control channel search space for the new DCI format after adopting the new configuration. In this embodiment, only the new UE capability/category is enough because the number of

HARQ process goes well with no matter what the UE category is. UE adopts new configuration if obtains the new IE in RRC message.

[00065] Figure 6 illustrates the flow chart of UE reporting the new category according to the fourth Embodiment of this invention. In step 610, UE reports a UE capability to eNB by a UE in the wireless system; and determines if the eNB supports the reported UE capability in step 620. If yes in step 620, goes to step 630, UE performs as the new UE capability UE, for example, UE monitors a new DCI format corresponding to the UE capability if eNB supports the reported UE capability, otherwise goes to step 640, UE performs as legacy/default UE capability UE, implements the legacy/default UE capability, e.g., monitors for a default DCI format.

[00066] Figure 7 illustrates the flow chart of UE reporting the new category according to the fourth Embodiment of this invention. In step 710, UE determines if eNB support a new capability. If yes in step 720, UE performs as new UE capability, e.g., reporting a new UE capability to eNB. for example, in MSG 3. If no in step 730, UE performs as legacy/default UE capability UE, implements the legacy legacy/default UE capability, e.g., not reporting a new UE capability to eNB (e.g., in MSG 3).

[00067] Figure 8 illustrates the flow chart of method 1 for PRACH power ramping according to the embodiment of this invention. Please refer to figure 8, in step 820, UE determines if the PRACH resource configuration is a valid configuration. If no in step 820, which means that, the PRACH resource configuration is not a valid configuration, so UE considers it is an access barring of the UE capability and goes to step 830 to perform cell resection. Or else goes to step 840 to perform RACH procedure. In step 820, UE supporting multi-tone MSG 3 determines that the PRACH resource configuration is invalid, if more than one enhanced coverage levels for NPRACH are configured, and at least one of the NPRACH resource has reserved resource for multi-tone MSG 3 but the resource of coverage level 0 has no reserved resource for multi-tone 3. For example, PRACH resource in other coverage level is partition into two groups. Before step 820, optional, UE may receive PRACH resource configuration from the eNB in step 810.

[00068] In step 820, the UE with single tone capability considers that, the PRACH source configuration is invalid, if the PRACH resource in the lowest coverage level (e.g, coverage level 0) has no resource for single tone MSG 3.

[00069] Figure 9 illustrates the flow chart of method 2 for PRACH power ramping according to the embodiment of this invention. Please refer to figure 9, in step 910, UE obtains configuration for PRACH, e.g., preamble initial received target power, RSRP threshold for each PRACH coverage level. In step 920, UE determines a PRACH coverage level based on its RSRP and RSRP threshold. Furthermore, UE determines a PRACH coverage level based on preamble transmission counter. In step 930, UE determines transmission power (e.g., by setting preamble received target power) of PRACH according to the coverage level and capability of UE to support of multi-tone Msg 3 transmission.

[00070] More specifically, for multi-tone Msg 3 capable UE, for the lowest coverage level of NPRACH with reserved resource for multi-tone Msg 3, setting PREAMBLE_RECEIVED_TARGET_POWER to PREAMBLE_RECEIVED_TARGET_POWER - 10 *

5

The random-access procedure shall be performed as follows:

- set PREAMBLE_RECEIVED_TARGET_POWER to $\text{preambleInitialReceivedTargetPower} + \text{DELTA\_PREAMBLE} + (\text{PREAMBLE\_TRANSMISSION\_COUNTER} - 1) * \text{powerRampingStep}$;

10

- if the UE is a BL UE or a UE in enhanced coverage:

15

- the PREAMBLE_RECEIVED_TARGET_POWER is set to:

$\text{PREAMBLE\_RECEIVED\_TARGET\_POWER} - 10 * \log_{10}(\text{numRepetitionPerPreambleAttempt})$;

20

- if NB-IoT:

- for the lowest repetition level and has PRACH resource reserved for single/multi-tone MSG 3, the PREAMBLE_RECEIVED_TARGET_POWER is set to:

$\text{PREAMBLE\_RECEIVED\_TARGET\_POWER} - 10 * \log_{10}(\text{numRepetitionPerPreambleAttempt})$

25

- for other repetition levels, the PREAMBLE_RECEIVED_TARGET_POWER is set

30 [00078] In one embodiment, the wireless communication system 100 utilizes an OFDMA or a multi-carrier based architecture including Adaptive Modulation and Coding (AMC) on the downlink and next generation single-carrier (SC) based FDMA architecture for uplink transmissions. SC based FDMA architectures include Interleaved FDMA (IFDMA), Localized FDMA (LFDMA), and DFT-spread OFDM (DFT-SOFDM) with IFDMA or LFDMA. In OFDMA based systems, UE 103 and 35 110 are served by assigning downlink or uplink radio resources that typically comprises a set of sub-carriers over one or more OFDM symbols. Exemplary OFDMA-based protocols include the developing Long Term Evolution (LTE) of the 3GPP UMTS standard and the IEEE 802.16 standard. The architecture may also 40 include the use of spreading techniques such as multi-carrier CDMA (MC-CDMA), multi-carrier direct sequence CDMA (MC-DS-CDMA), Orthogonal Frequency and Code Division Multiplexing (OFCDM) with one or two dimensional spreading. In other embodiments, the architecture may be based on simpler time and/or frequency

division multiplexing/multiple access techniques, or a combination of these various techniques. In alternate embodiments, the wireless communication system 100 may utilize other cellular communication system protocols including, but not limited to, TDMA or direct sequence CDMA.

5 [00079] For example, in the 3GPP LTE system based on SC-FDMA uplink, the radio resource is partitioned into subframes, and each of the subframes comprises 2 slots and each slot has 7 SC-FDMA symbols in the case of normal Cyclic Prefix (CP). For each user, each SC-FDMA symbol further comprises a number of subcarriers depending on the uplink assignment. The basic unit of the radio resource
10 grid is called Resource Element (RE) which spans an SC-FDMA subcarrier over one SC-FDMA symbol.

[00080] Each UE gets an assignment, i.e., a set of REs in a Physical Uplink Shared Channel (PUSCH), when an uplink packet is sent from a UE to an eNB. The UE gets the downlink and uplink assignment information and other control information
15 from its Physical Downlink Control Channel (PDCCH) or Enhanced Physical Downlink Control Channel (EPDCCH) whose content is dedicated to that UE. The uplink assignment is indicated in downlink control information (DCI) in PDCCH/EPDCCH. Usually, the uplink assignment indicated the resource allocation within one certain subframe, for example k+4 subframe if DCI is received in
20 subframe k for FDD and for TDD, the timing relationship is given in a table in TS 36.213. TTI bundling is used in uplink transmission in LTE system to improve uplink coverage. If TTI bundle is enabled, one uplink assignment indicates several subframes to transmit one transport block using different redundancy version (RV).

[00081] Uplink control information is transmitted in Physical Uplink Control
25 Channel (PUCCH) or transmitted with or without a transport block in PUSCH. UCI includes HARQ, scheduling request (SR), channel status information (CSI). PUCCH is allocated the border PRBs in uplink system bandwidth. Frequency diversity gain for PUCCH is obtained by frequency hopping between two slots in one subframe. Code Division Multiplexing (CDM) is used for PUCCH multiplexing between
30 different UEs on the same radio resource.

[00082] The embodiments of fig.2-9 could be used in embodiment of fig.1, which is not limitation.

[00083] The previous description is provided to enable any person skilled in the art to practice the various aspects described herein. Various modifications to these
35 aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects. Thus, the claims are not intended to be limited to the aspects shown herein, but is to be accorded the full scope consistent with the language claims, wherein reference to an element in the singular is not intended to mean "one and only one" unless specifically so stated, but rather "one or
40 more." Unless specifically stated otherwise, the term "some" refers to one or more. Combinations such as "at least one of A, B, or C," "at least one of A, B, and C," and "A, B, C, or any combination thereof" include any combination of A, B, and/or C, and may include multiples of A, multiples of B, or multiples of C. Specifically,

combinations such as "at least one of A, B, or C," "at least one of A, B, and C," and "A, B, C, or any combination thereof" may be A only, B only, C only, A and B, A and C, B and C, or A and B and C, where any such combinations may contain one or more member or members of A, B, or C. All structural and functional equivalents to the elements of the various aspects described throughout this disclosure that are known or later come to be known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the claims. Moreover, nothing disclosed herein is intended to be dedicated to the public regardless of whether such disclosure is explicitly recited in the claims. No claim element is to be construed as a means plus function unless the element is expressly recited using the phrase "means for."

[00084] The techniques described herein may be used for various wireless communication systems such as CDMA, TDMA, FDMA, OFDMA, SC-FDMA and other systems. The terms "system" and "network" are often used interchangeably. A CDMA system may implement a radio technology such as Universal Terrestrial Radio Access (UTRA), cdma2000, etc. UTRA includes Time Division Synchronous Code Division Multiple Access (TD-SCDMA), Wideband-CDMA (W-CDMA) and other variants of CDMA. Further, cdma2000 covers IS-2000, IS-95 and IS-856 standards. A TDMA system may implement a radio technology such as Global System for Mobile Communications (GSM). An OFDMA system may implement a radio technology such as Evolved UTRA (E-UTRA), Ultra Mobile Broadband (UMB), IEEE 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20, Flash-OFDM.RTM., etc. UTRA and E-UTRA are part of Universal Mobile Telecommunication System (UMTS). 3GPP Long Term Evolution (LTE) is a release of UMTS that uses E-UTRA, which employs OFDMA on the downlink and SC-FDMA on the uplink. UTRA, E-UTRA, UMTS, TD-SCDMA, LTE and GSM are described in documents from an organization named "3rd Generation Partnership Project" (3GPP). Additionally, cdma2000 and UMB are described in documents from an organization named "3rd Generation Partnership Project 2" (3GPP2). Further, such wireless communication systems may additionally include peer-to-peer (e.g., mobile-to-mobile) ad hoc network systems often using unpaired unlicensed spectrums, 802.xx wireless LAN, BLUETOOTH and any other short- or long-range, wireless communication techniques.

[00085] Although the embodiments and their advantages have been described in detail, it should be understood that various changes, substitutions, and alterations can be made herein without departing from the spirit and scope of the embodiments as defined by the appended claims. Moreover, the scope of the present application is not intended to be limited to the particular embodiments of the process, machine, manufacture, composition of matter, means, methods, and steps described in the specification. As one of ordinary skill in the art will readily appreciate from the disclosure, processes, machines, manufacture, compositions of matter, means, methods, or steps, presently existing or later to be developed, that perform substantially the same function or achieve substantially the same result as the

corresponding embodiments described herein may be utilized according to the disclosure. Accordingly, the appended claims are intended to include within their scope such processes, machines, manufacture, compositions of matter, means, methods, or steps. In addition, each claim constitutes a separate embodiment, and
5 the combination of various claims and embodiments are within the scope of the disclosure.

CLAIMS

1. A method, comprising:
reporting a new UE capability to eNB by a UE in the wireless system; and
implementing the new UE capability if eNB supports the reported UE
5 capability, otherwise, implementing a default UE capability.
2. The method of claim 1, further comprising:
determining if the eNB supports the reported UE capability by an configuration
in system information.
3. The method of claim 1, wherein implementing the new UE capability by
10 monitoring for a new DCI format and implementing the default UE capability by
monitoring for a default DCI format.
4. The method of claim 3, wherein implementing the new UE capability by UE
monitoring for the new DCI format in UE specific search space and implementing
the default UE capability by monitoring for a default DCI format.
- 15 5. The method of claim 4, wherein implementing the new UE capability by UE
monitoring for the new DCI format in both UE specific search space and common
search space, and implementing the default UE capability by monitoring for a
default DCI format in both UE specific search space and common search space.
6. The method of claim 1, further comprising:
20 determining if the eNB supports the reported UE capability by obtaining an
indication in a dedicated RRC signaling.
7. The method of claim 6, wherein the indication is implied by the present of a
configuration of a DL control channel.
8. The method of claim 6, wherein the indication is explicated indicated by an
25 information element in RRC message.
9. The method of claim 6, wherein the dedicated RRC signaling is in MSG 4.
10. The method of claim 1, wherein the UE capability is that UE support of
more than one HARQ processes and/or a new UE category with larger buffer size
and/or support of wide bandwidth and/or support of larger TBS.

11. The method of claim 1, wherein the new DCI format including a indicator for HARQ process number.

12. The method of claim 1, wherein reporting a new UE capability to eNB in MSG 3.

5 13. The method of claim 1, wherein implementing the new UE capability by mapping the indicator in DCI to a new element and implementing the default UE capability by mapping the indicator in DCI to a default element.

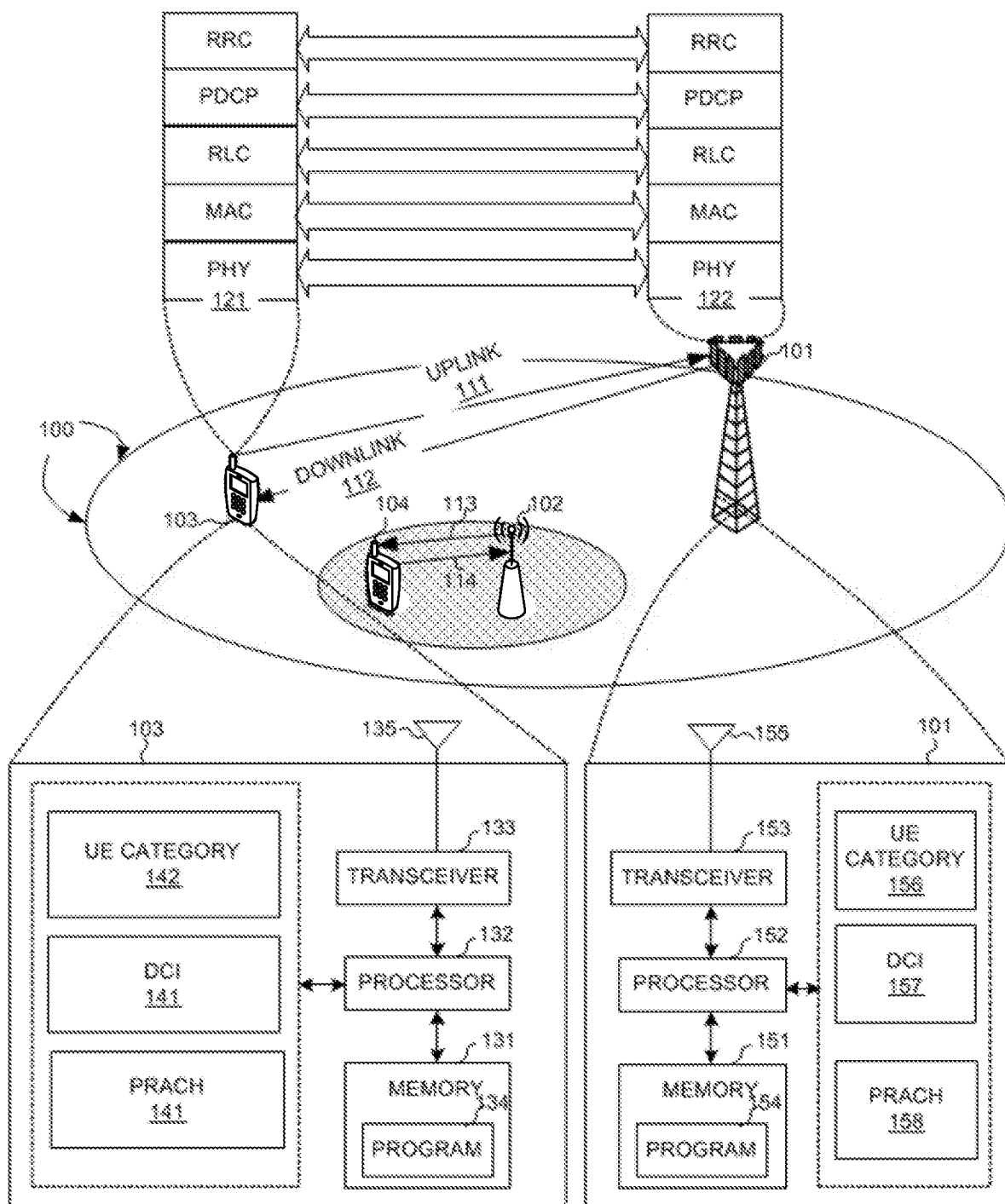


FIG. 1

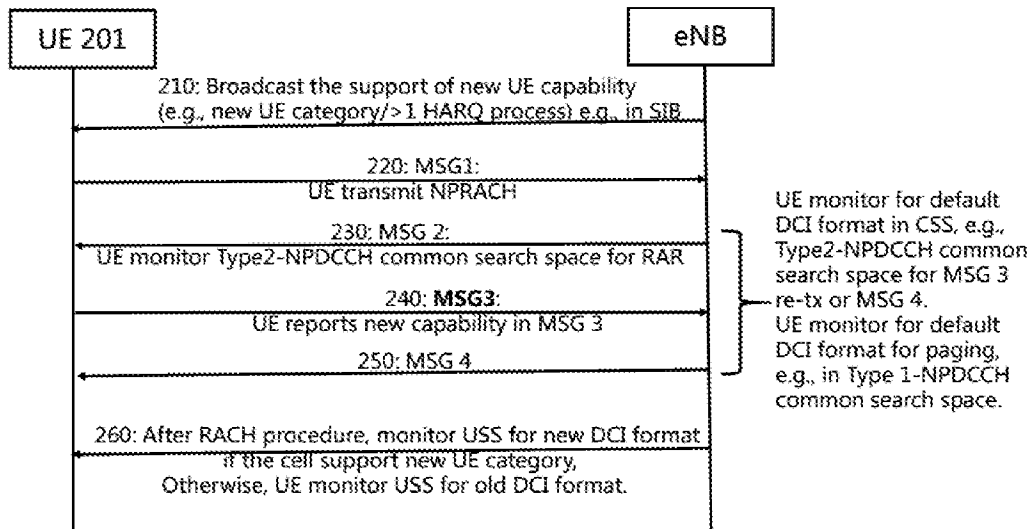


FIG. 2A

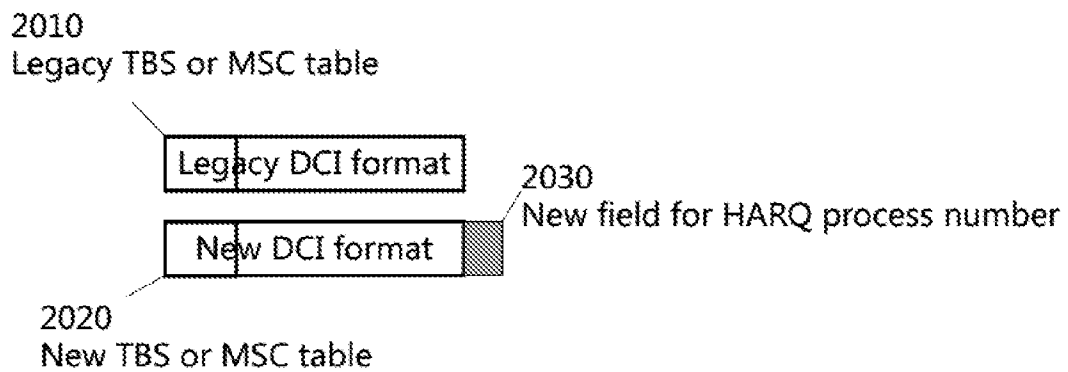
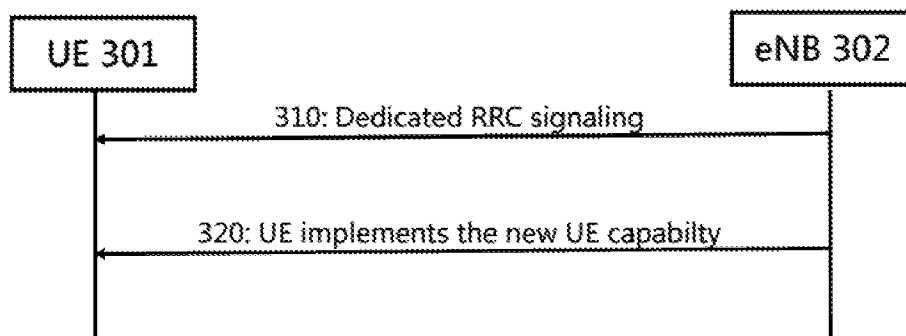
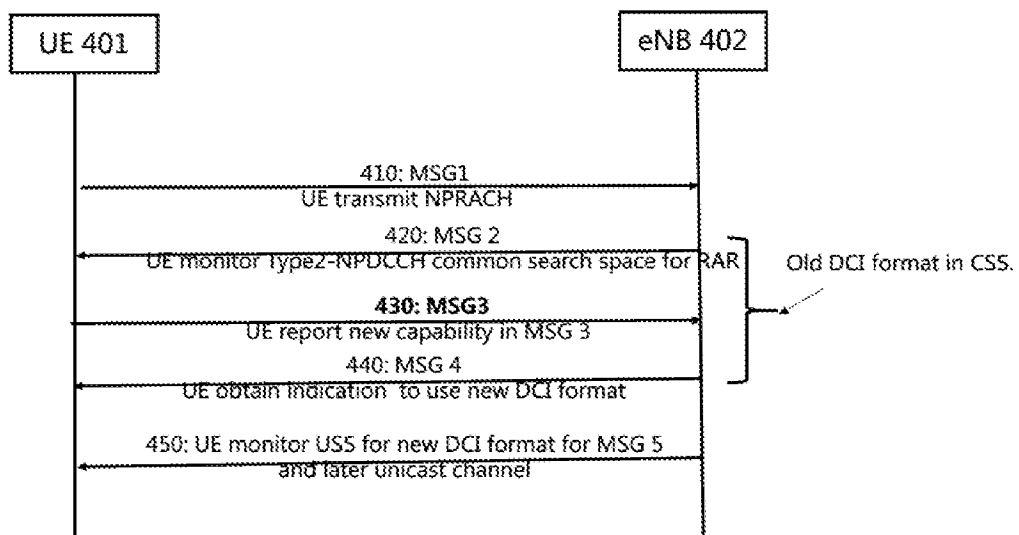


FIG. 2B

**FIG. 3****FIG. 4A**

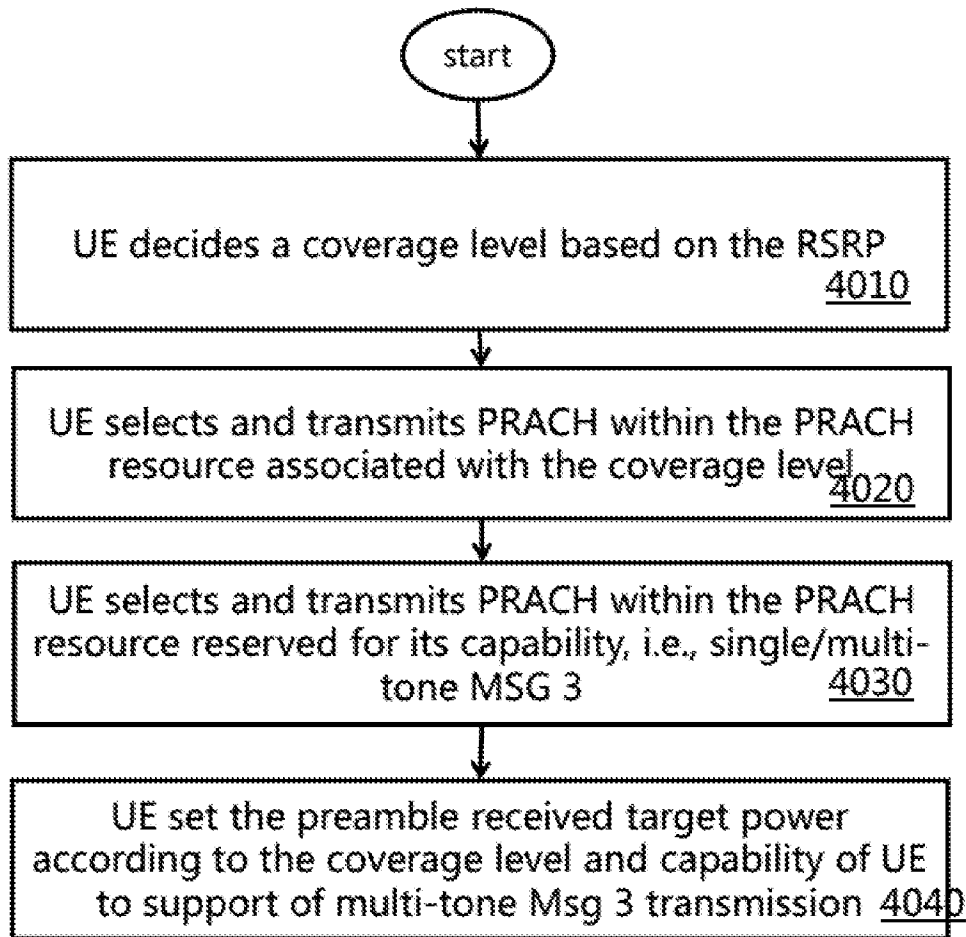


FIG. 4B

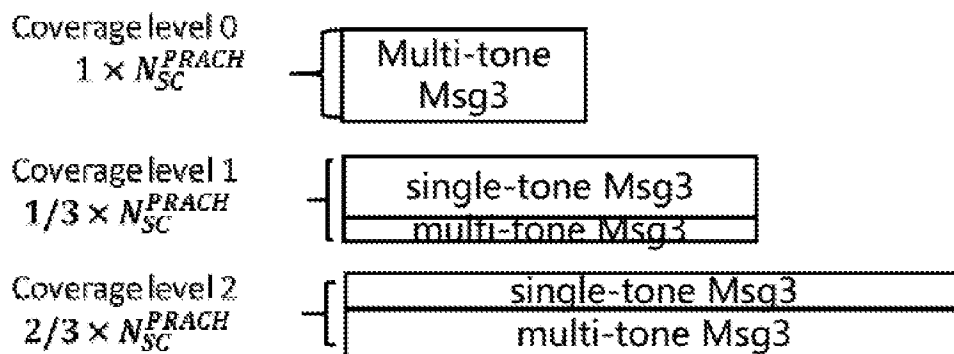
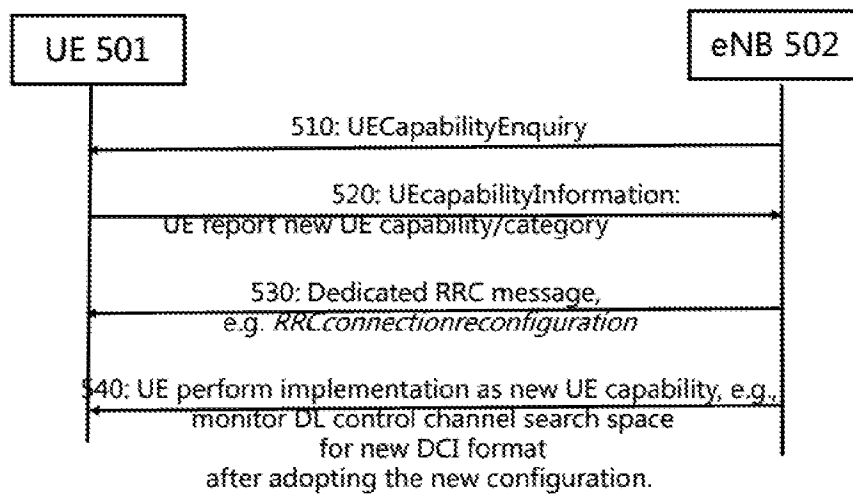
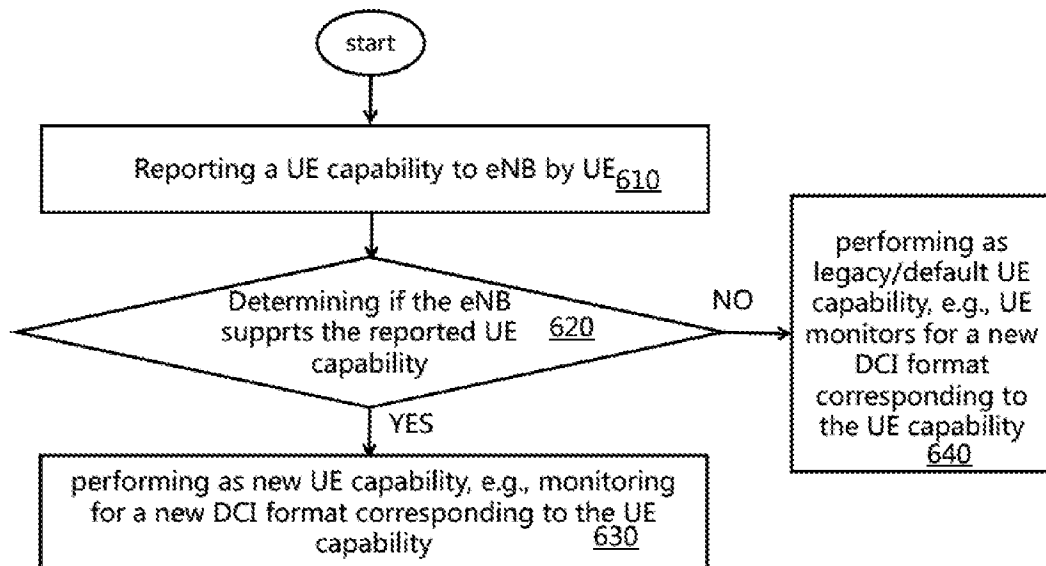


FIG. 4C

**FIG. 5****FIG. 6**

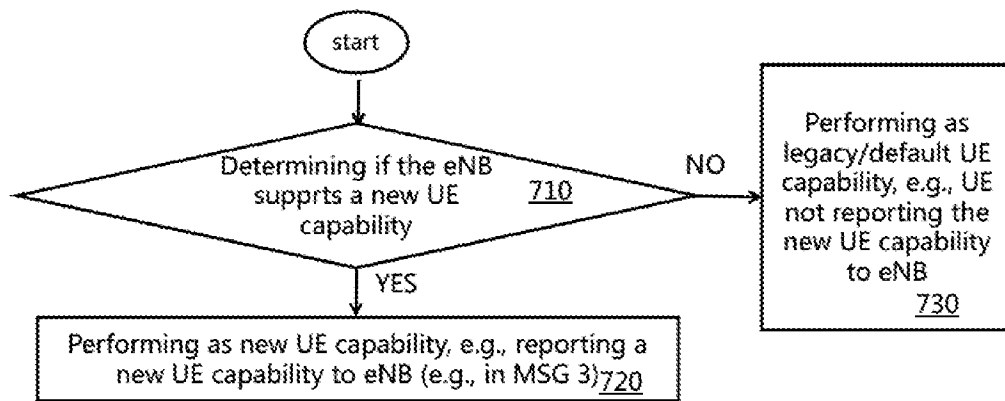


FIG. 7

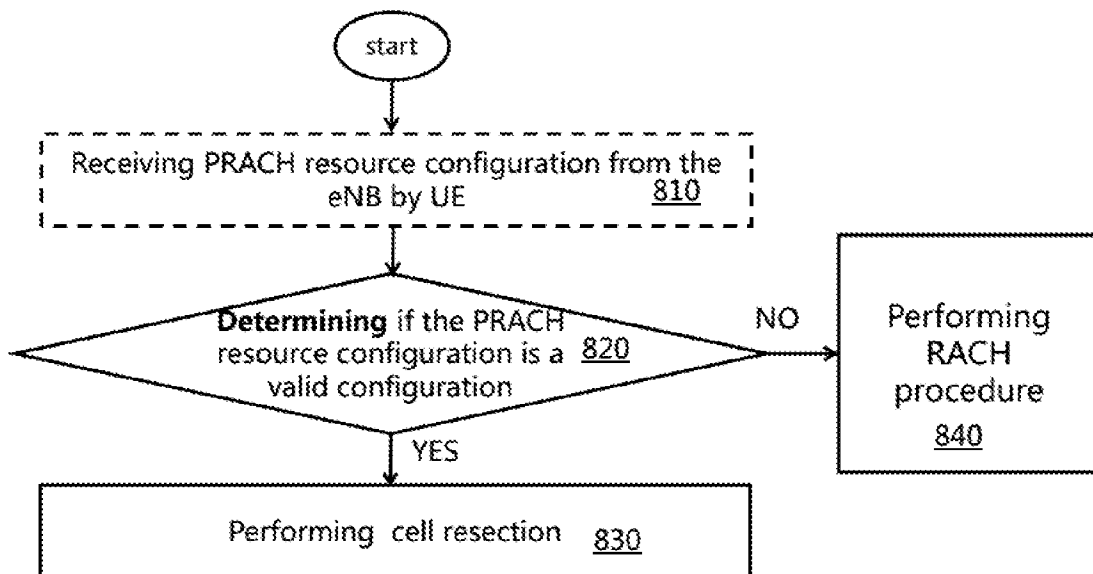
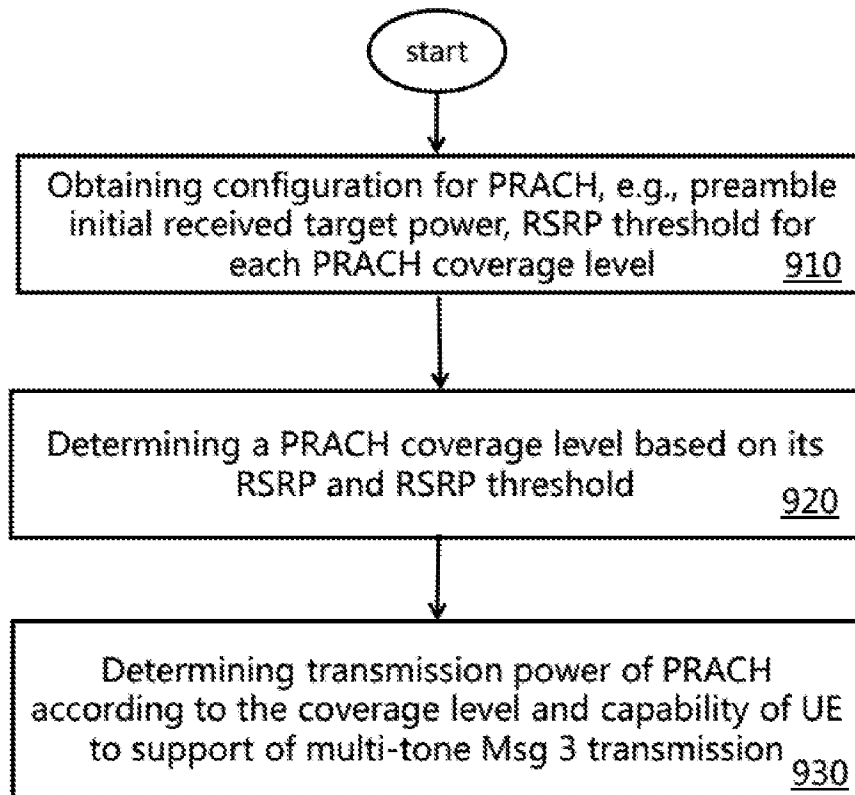


FIG. 8

**FIG. 9**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2016/101218

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/04(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: UE, capability, eNB, configuration, default, DCI, format, message, RRC, HARQ, TBS, support, monitor, CSS, downlink, DL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2016255628 A1 (INTEL CORPORATION) 01 September 2016 (2016-09-01) abstract, description, paragraphs [0026]-[0038], [0063], claims 4, 5, figures 9, 10	1-13
A	US 2012182896 A1 (SAMSUNG ELECTRONICS CO., LTD.) 19 July 2012 (2012-07-19) the whole document	1-13
A	US 2011188462 A1 (QUALCOMM INCORPORATED) 04 August 2011 (2011-08-04) the whole document	1-13
A	CN 104660544 A (HUAWEI TECHNOLOGIES CO., LTD.) 27 May 2015 (2015-05-27) the whole document	1-13

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

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

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

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

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

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

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

“&” document member of the same patent family

Date of the actual completion of the international search

17 March 2017

Date of mailing of the international search report

15 May 2017

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2016/101218

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
US	2016255628	A1	01 September 2016	CN	105229942	A	06 January 2016
				CN	105284059	A	27 January 2016
				CN	105247924	A	13 January 2016
				EP	3014788	A1	04 May 2016
				EP	3014791	A1	04 May 2016
				WO	2014210441	A1	31 December 2014
				EP	3014790	A1	04 May 2016
				CN	105229934	A	06 January 2016
				CN	105612769	A	25 May 2016
				EP	3014787	A1	04 May 2016
				US	2016113036	A1	21 April 2016
				WO	2014210493	A1	31 December 2014
				TW	201507391	A	16 February 2015
				US	2016119967	A1	28 April 2016
				WO	2014210212	A1	31 December 2014
				US	2015003301	A1	01 January 2015
				CN	105230053	A	06 January 2016
				KR	20160004355	A	12 January 2016
				WO	2014210477	A1	31 December 2014
				EP	3014909	A1	04 May 2016
				JP	2016530749	A	29 September 2016
				WO	2014210185	A1	31 December 2014
				EP	3014908	A1	04 May 2016
				US	2015004995	A1	01 January 2015
				EP	3014781	A1	04 May 2016
				US	2015003543	A1	01 January 2015
				CN	105264788	A	20 January 2016
				US	2015003326	A1	01 January 2015
				TW	201517660	A	01 May 2015
				JP	2016525305	A	22 August 2016
				US	2015003325	A1	01 January 2015
				WO	2014210500	A1	31 December 2014
				KR	20160003021	A	08 January 2016
				EP	3014923	A1	04 May 2016
				WO	2014210471	A1	31 December 2014
				WO	2014209451	A1	31 December 2014
				TW	201501515	A	01 January 2015
				TW	201509162	A	01 March 2015
				US	2015003338	A1	01 January 2015
				CA	2880588	A1	01 May 2014
				WO	2014066887	A1	01 May 2014
				WO	2014160882	A1	02 October 2014
				US	2014293982	A1	02 October 2014
				TW	201446040	A	01 December 2014
				CN	104254067	A	31 December 2014
				WO	2014210250	A1	31 December 2014
				US	2015004980	A1	01 January 2015
				EP	2827649	A1	21 January 2015
				AU	2013334019	A1	12 February 2015
				US	2015089074	A1	26 March 2015

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2016/101218

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
				TW	201515411	A	16 April 2015
				KR	20150048216	A	06 May 2015
				CN	104704844	A	10 June 2015
				EP	2912851	A1	02 September 2015
				KR	20150110690	A	02 October 2015
				CN	105027629	A	04 November 2015
				JP	2016500987	A	14 January 2016
				CN	105284166	A	27 January 2016
				EP	2979497	A1	03 February 2016
				HK	1207770	A1	05 February 2016
				US	2016050703	A1	18 February 2016
				US	2016081013	A1	17 February 2016
				US	2016088053	A1	24 March 2016
				TW	201615047	A	16 April 2016
				EP	3014934	A1	04 May 2016
				AU	2016200390	A1	11 February 2016
US	2012182896	A1	19 July 2012	KR	20120099568	A	11 September 2012
				US	2013286883	A1	31 October 2013
				EP	2667527	A2	27 November 2013
				CN	103380582	A	30 October 2013
				WO	2012099386	A2	26 July 2012
				WO	2012099389	A2	26 July 2012
				KR	20120083863	A	26 July 2012
				JP	2014503161	A	06 February 2014
				US	2012184281	A1	19 July 2012
				KR	20120083870	A	26 July 2012
				WO	2012099404	A2	26 July 2012
				CN	103329458	A	25 September 2013
				EP	2666248	A2	27 November 2013
				JP	2014506744	A	17 March 2014
				US	2014370905	A1	18 December 2014
US	2011188462	A1	04 August 2011	KR	20120123119	A	07 November 2012
				JP	2013518535	A	20 May 2013
				KR	20150007355	A	20 January 2015
				EP	2529501	A1	05 December 2012
				CN	102725989	A	10 October 2012
				TW	201145889	A	16 December 2011
				WO	2011094650	A1	04 August 2011
CN	104660544	A	27 May 2015	JP	2015159566	A	03 September 2015
				WO	2015074592	A1	28 May 2015
				US	2016269218	A1	15 September 2016
				EP	3073696	A1	28 September 2016
				KR	20160089458	A	27 July 2016