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(54) **PAGING MESSAGE COVERAGE ENHANCEMENT**

FUNKRUFNACHRICHTABDECKUNGSVERBESSERUNG

AMÉLIORATION DE COUVERTURE DE MESSAGE DE RADIOMESSAGERIE

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(73) Proprietor: **Nokia Solutions and Networks Oy**
02610 Espoo (FI)

(72) Inventors:
- **Du, Lei**
  Haidian District, Beijing 100085 (CN)
- **Ratasuk, Rapeepat**
  Inverness, IL 60010 (US)
- **Zhang, Yan Ji**
  Chaoyang, Beijing 10029 (CN)

(74) Representative: **Nokia EPO representatives**
Nokia Technologies Oy
Karakaari 7
02610 Espoo (FI)

(56) References cited:
EP-A1- 3 032 897
EP-A1- 3 157 297
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Description

BACKGROUND:

Field:

[0001] The invention relates to a method and to a MME for paging in enhanced coverage.

[0002] Various communication systems may benefit from the proper use of control channel resources. For example, certain communication systems associated with the long term evolution of the third generation partnership project may benefit from physical downlink control channel transmission improvement for paging message coverage enhancement.

Description of the Related Art:

[0003] Third generation partnership project (3GPP) RP-130848, which is hereby incorporated by reference in its entirety, describes allowance of a new machine type communication (MTC) operation in long term evolution (LTE) that also allows for enhanced coverage compared to existing LTE networks. Such new MTC operation may aim to provide a relative LTE coverage improvement corresponding to 15dB for frequency division duplex (FDD) for low complexity user equipment (UEs) and other UEs operating delay tolerant MTC applications with respect to their respective nominal coverage. Repetition may be specified as a method to improve coverage.

[0004] With existing paging procedure, the evolved node B (eNB) must be able to schedule the paging message transmission in the appropriate transmission time interval (TTI) and indicate the scheduled physical downlink shared channel (PDSCH) resource in physical downlink control channel (PDCCH) with a paging radio network temporary identifier (P-RNTI). In order to get 15dB coverage improvement, the PDCCH needs a number of repetitions. As a result there may be PDCCH collision for different UEs in the same subframe.

[0005] Figure 1 illustrates PDCCH repetition to reach coverage enhanced user equipment. As shown in Figure 1, the PDCCH may need to be retransmitted 20 times to reach the coverage enhanced UEs (CE-UEs). There are three UEs illustrated in this example: UE #1, which needs coverage enhancement and monitors subframe #4 for PDCCH with P-RNTI; UE #2, which does not need coverage enhancement nor PDCCH repetition and which monitors subframe #5 for PDCCH with P-RNTI; and UE #3, which needs coverage enhancement and which monitors subframe #9 for PDCCH with P-RNTI.

[0006] The first PDCCH with P-RNTI for UE #1 is transmitted at subframe #4 in frame # 1, and it is repeated 20 times in the subsequent subframes, marked in grey. The PDCCH for UE #2 is transmitted at subframe# 5 of frame # 1. The first PDCCH with P-RNTI for UE #3 is transmitted at subframe #9 in frame #1, and it is repeated 20 times in the subsequent subframes marked in grey.

[0007] In this case, there will be two PDCCH indications in subframe #5 of frame #1, and in all the subframes filled with slashed lines, for example subframe #5 of frame #1 where there will be a collision between PDCCH repetition of UE #1 and original PDCCH transmission of UE #2, subframe #9 of frame #1 where there will be a collision between PDCCH repetition of UE #1 and original PDCCH transmission of UE #3; and subframe #0 of frame #2 where there will be a collision of PDCCH repetition between UE #1 and UE#3.

[0008] In these subframes, the UE would detect more than one PDCCH and, if each PDCCH is successfully decoded, the UE would have to further receive the respective PDSCH, even though the PDSCH may not be destined to that UE. This brings confusion to the UE and costs the UE power and processing efforts. Document WO 2014/055878 A1 (INTERDIGITAL PATENT HOLDINGS [US]) 10 April 2014 (2014-04-10) discloses a possible implementation of paging in coverage enhancement case wherein the repetition level is communicated by the WTRU to the eNB.

SUMMARY:

[0009] Technical features of the invention are included in the independent claims. According to certain embodiments, a method can include obtaining a coverage enhancement paging parameter at a user equipment. The method can also include calculating, by the user equipment, a paging frame or paging occasion according to the paging parameter.

[0010] A method, according to certain embodiments, can include receiving, at a user equipment, a coverage enhancement paging radio network temporary identifier for use in coverage enhancement mode. The method can also include decoding a physical downlink control channel based on the coverage enhancement paging radio network temporary identifier.

[0011] In certain embodiments, a method can include determining whether a paging is for user equipment in coverage enhancement mode. The method can also include indicating in a paging message that the paging is for user equipment in coverage enhancement mode, based on the determining.

[0012] An apparatus, according to certain embodiments, can include at least one processor and at least one memory including computer program code. The at least one memory and the computer program code can be configured to, with the at least one processor, cause the apparatus at least to obtain a coverage enhancement paging parameter at a user equipment. The at least one memory and the computer program code can also be configured to, with the at least one processor, cause the apparatus at least to calculate, by the user equipment, a paging frame or paging occasion according to the paging parameter.

[0013] In certain embodiments, an apparatus can include at least one processor and at least one memory

including computer program code. The at least one memory and the computer program code can be configured to, with the at least one processor, cause the apparatus at least to receive, at a user equipment, a coverage enhancement paging radio network temporary identifier for use in coverage enhancement mode. The at least one memory and the computer program code can also be configured to, with the at least one processor, cause the apparatus at least to decode a physical downlink control channel based on the coverage enhancement paging radio network temporary identifier.

[0014] An apparatus, in certain embodiments, can include at least one processor and at least one memory including computer program code. The at least one memory and the computer program code can be configured to, with the at least one processor, cause the apparatus at least to determine whether a paging is for user equipment in coverage enhancement mode. The at least one memory and the computer program code can also be configured to, with the at least one processor, cause the apparatus at least to indicate in a paging message that the paging is for user equipment in coverage enhancement mode, based on the determining.

[0015] According to certain embodiments, a non-transitory computer-readable medium can be encoded with instructions that, when executed in hardware, perform a process. The process can include obtaining a coverage enhancement paging parameter at a user equipment. The process can also include calculating, by the user equipment, a paging frame or paging occasion according to the paging parameter.

[0016] In certain embodiments, a non-transitory computer-readable medium encoded with instructions that, when executed in hardware, perform a process. The process can include determining whether a paging is for user equipment in coverage enhancement mode. The process can also include indicating in a paging message that the paging is for user equipment in coverage enhancement mode, based on the determining.

[0017] A computer program product, according to certain embodiments, can encode instructions for performing a process. The process can include obtaining a coverage enhancement paging parameter at a user equipment. The process can also include calculating, by the user equipment, a paging frame or paging occasion according to the paging parameter.

[0018] A computer program product, in certain embodiments, can encode instructions for performing a process. The process can include determining whether a paging is for user equipment in coverage enhancement mode. The process can also include indicating in a paging message that the paging is for user equipment in coverage enhancement mode, based on the determining.

BRIEF DESCRIPTION OF THE DRAWINGS:

[0019] For proper understanding of the invention, reference should be made to the accompanying drawings, wherein:

Figure 1 illustrates PDCCH repetition to reach coverage enhanced user equipment.

Figure 2 illustrates PCCH-Config according to 3GPP TS 36.331.

Figure 3 illustrates a procedure of the PDCCH transmission according to certain embodiments.

Figure 4 illustrates the possibility of multiple repetition levels in one cell, according to certain embodiments.

Figure 5 illustrates a method according to certain embodiments.

Figure 6 illustrates a system according to certain embodiments.

DETAILED DESCRIPTION:

[0020] The claimed invention corresponds to fig. 5 and to the related text in the description. The remaining figures and the text of the description are intended to better explain the invention.

[0021] It is planned that for machine type communications (MTC), an enhanced coverage mode for UEs will provide a 15-20dB improvement. In order to achieve this 15-20dB improvement, a number of repetitions of the scheduled resources in the PDCCH may be performed, which may lead to collisions. Certain embodiments provide a mechanism whereby for those UEs that are in a coverage enhancement mode, a separate coverage enhancement nB is defined from which these UEs can calculate their paging occasions. Certain embodiments may also provide a separate coverage enhancement P-RNTI to address the PDCCH for enhanced coverage mode UEs. In case of a PDCCH overlap with UEs that are not in a coverage enhancement mode, the coverage enhancement mode nB can be used in order to, for example, keep a low density of paging occasions, so that there may be no collisions on the PDCCH.

[0022] Certain embodiments may define a separate CE-nB for a UE in coverage enhancement mode, which could be decided based on a required repetition number. Furthermore, in certain embodiments a coverage enhanced UE can calculate the UE's paging frame/paging occasion according to a CE-nB instead of the nB advertised in current specification. According to certain embodiments, an MME can indicate in a paging message to the eNB whether the paging is for UEs in CE mode.

[0023] If available, a repetition level for the UE could be also indicated. This information might be available, for example, for stationary UE. The repetition level of the UE can be conveyed to the MME when the UE moves to idle mode. The paging records in the paging message can address UEs in CE mode with the same repetition level.

[0024] In certain embodiments a separate coverage enhancement paging radio network temporary identifier (CE-P-RNTI) is defined for UE in coverage enhancement

mode. Multiple CE-P-RNTIs could be defined for each repetition level, for example if a repetition level for each UE is known by the MME.

[0025] The eNB can dynamically derive the CE-P-RNTI based on the repetition level in paging message to transmit PDCCH. The UE can decode the PDCCH by the CE-P-RNTI corresponding to the UE's repetition level.

[0026] Any desired paging occasion (PO)/paging frame (PF) calculation can be applied for UE in coverage enhancement mode. If there is PDCCH overlapping with current nB, a separate coverage enhanced nB (CE-nB) can be applied for the CE-UE in order to keep a low density of PO for UE in coverage enhancement mode and thereby, for example, to make sure there is no collision of the PDCCH (re)-transmission within a single subframe. The value of CE-nB can, for example, be decided based on the repetition number of PDCCH, for example how many times the PDCCH is to be transmitted. For example, if the required repetition number is *N,* and the paging cycle is *T,* CE-nB can be set to one of the available values smaller than (*T**10/*N*), if nB > (*T**10/*N*), based on the PCCH-Config defined in 3GPP 36.331 as shown in Figure 2.

[0027] For example, if the repetition number for PDCCH is 120, then the CE-nB for UE in coverage enhancement can be set to *oneSixteenthT* or *oneThirtySecondT,* while for normal UEs, the nB used for PO derivation can remain unchanged. In certain embodiments, the nearest value satisfying *CE-nB* < *T**10/*N* can be selected.

[0028] In addition, the Ns parameter can be updated for UE in coverage enhancement from the equation below based on CE-nB: Ns = max (1, *CE-nB*/*T*)

[0029] Thus value of Ns may always be 1 for a UE in coverage enhancement mode, because the required repetition number of PDCCH transmission may be larger than 10. Thus, there may only be one subframe available for paging in the paging frame. The subframe may be subframe #9 for FDD and subframe #0 for TDD, based on the subframe pattern defined in 3GPP technical specification (TS) 36.204 v12.0.0, "User Equipment (UE) procedures in idle mode," which is hereby incorporated herein by reference in its entirety.

[0030] The UE in coverage enhancement mode can still wake up every discontinuous reception (DRX) cycle in the original PO, as derived for example from the formulae in 3GPP TS 36.304, to monitor the PDCCH channel with CE-P-RNTI and continue to receive the PDCCH repetition marked with CE-P-RNTI from the consecutive subframes until it receives all the required number of PDCCH transmission or could decode the PDCCH successfully. The CE-P-RNTI can be a new type of RNTI for differentiating PDCCH transmission between the normal UE and UE in CE mode.

[0031] Figure 3 illustrates a procedure of the PDCCH transmission according to certain embodiments. In this particular example, the required repetition number can be 20, based on the CE-nB calculation equation: CE-nB = T/2. There are three UEs in this example: UE #1, which needs coverage enhancement and monitors the subframe #9 for PDCCH with CE-P-RNTI using CE-nB; UE #2, which does not need coverage enhancement, has no PDCCH repetition, and monitors the subframe #4 for PDCCH with P-RNTI using normal nB; and UE #3 needs coverage enhancement and monitors the subframe #9 for PDCCH with CE-P-RNTI (using CE-nB).

[0032] The first PDCCH with CE-P-RNTI for UE #1 is, in this example, transmitted at subframe #9 in frame #1, and it is repeated 19 times marked with CE-P-RNTI in the subsequent subframes, marked in grey. The PDCCH for UE #2 is, in this example, transmitted at subframe# 4 of frame #2. The first PDCCH with CE-P-RNTI for UE #3 is, in this example, transmitted at subframe #9 in frame #3, and the PDCCH is repeated 19 times marked with CE-P-RNTI in the subsequent subframes, marked in grey.

[0033] In this example, there is only a single PDCCH marked either with P-RNTI or CE-P-RNTI in one subframe. For example, in subframe #4 of frame #2 there is a PDCCH repetition marked with CE-P-RNTI for UE #1 and PDCCH transmission with P-RNTI for UE #2. There would not, in this example, be any repetition collision for PDCCH repetition marked with CE-P-RNTI in any subframe.

[0034] Figure 4 illustrates the possibility of multiple repetition levels in one cell, according to certain embodiments. As shown in Figure 4, there can be multiple repetition levels in one cell and that overlapping of PDCCH may occur in this case. For example, for UE #1 a repetition number is 20, CE-nB = ½T and in this example for UE #2 a repetition number is 10, CE-nB = T. Thus, in this example, there is still overlap for PDCCH repetition in frame #3.

[0035] One approach that avoids such an outcome is to assign a different value for CE-P-RNTI based on the repetition level of the UE. The repetition level could be transferred, for example by the UE, to the MME when the UE moves from connected mode to idle mode and can then be indicated from the MME to the eNB in a paging message. Alternatively, the repetition level could be transferred from the eNB to the MME when the UE moves from connected mode to idle mode and then be indicated from the MME to the eNB in a paging message. The eNB can derive the CE-P-RNTI of the UE for transmitting PDCCH for paging.

[0036] With the same example as shown in Figure 4, even in frame #3 when there are two PDCCHs the UE could find the correct PDCCH by its dedicated CE-P-RNTI because they have a different repetition level. Thus, this approach can ensure that each UE could get a dedicated PDCCH within a single subframe.

[0037] Figure 5 illustrates a method according to certain embodiments. The method can include, at 510, obtaining a coverage enhancement paging parameter, CE-nB, at a user equipment. CE-nB may be configured for use only when the user equipment is in coverage en-

hancement mode.

[0038] The method can also include, at 520, calculating, by the user equipment, a paging frame or paging occasion according to the CE-nB.

[0039] The method includes, at 505, indicating a repetition level for the user equipment to a mobility management entity for later use. The obtained CE-nB can be based on the repetition level stored at the UE. The repetition level of the user equipment is conveyed to the mobility management entity when the user equipment moves to idle mode.

[0040] The user equipment can derive a CE-P-RNTI for use in coverage enhancement mode. The method can additionally include, at 530, decoding a physical downlink control channel based on the CE-P-RNTI. The CE-P-RNTI can be one of a plurality of CE-P-RNTI and can be derived based on the stored repetition level.

[0041] Although blocks 505, 510, and 520 have been described above in terms that may be applicable to a UE, the blocks can also refer to eNB behavior. For example, the method can include, at 505, indicating repetition level from eNB to MME. The method can also include, at 560, receiving paging message including repetition level from MME. The method can further include, at 510, obtaining CE-nB based on the repetition level. The method can additionally include, at 520, calculating PF/PO based on CE-nB. Moreover, at 535 the method can include sending paging message addressed by CE-P-RNTI on the calculated PF/PO based on respective CE-nB. The CE-P-RNTI can be one of a plurality of CE-P-RNTI and can be derived based on the stored repetition level.

[0042] The method includes, at 540, determining, by an MME, whether a paging is for user equipment in coverage enhancement mode. The method also includes, at 550, indicating in a paging message that the paging is for user equipment in coverage enhancement mode, based on the determining.

[0043] The method includes, at 560, receiving by an eNB from an MME, as described above, or , optionally, by an MME) an indication of a repetition level for the user equipment, wherein the determining and/or obtaining is based on the repetition level. The repetition level of the user equipment is conveyed to a mobility management entity when the user equipment moves to idle mode, as mentioned above. Thus, the method also includes, at 570, sending the indication of the repetition level from the MME to the eNB.

[0044] Figure 6 illustrates a system according to certain embodiments of the invention. In one embodiment, a system may include multiple devices, such as, for example, at least one UE 610, at least one eNB 620 or other base station or access point, and at least one MME 630. In certain systems, UE 610, eNB 620, MME 630, and a plurality of other user equipment and MMEs may be present. Other configurations are also possible, including those with multiple base stations, such as eNBs. The UE 610 may be equipped for both cellular and D2D communication.

[0045] Each of these devices may include at least one processor, respectively indicated as 614, 624, and 634. At least one memory may be provided in each device, as indicated at 615, 625, and 635, respectively. The memory may include computer program instructions or computer code contained therein. The processors 614, 624, and 634 and memories 615, 625, and 635, or a subset thereof, may be configured to provide means corresponding to the various blocks of Figures 3-5. Although not shown, the devices may also include positioning hardware, such as global positioning system (GPS) or micro electrical mechanical system (MEMS) hardware, which may be used to determine a location of the device. Other sensors are also permitted and may be included to determine location, elevation, orientation, and so forth, such as barometers, compasses, and the like.

[0046] As shown in Figure 6, transceivers 616, 626, and 636 may be provided, and each device may also include at least one antenna, respectively illustrated as 617, 627, and 637. The device may have many antennas, such as an array of antennas configured for multiple input multiple output (MIMO) communications, or multiple antennas for multiple radio access technologies. Other configurations of these devices, for example, may be provided. For example, eNB 620 and MME 630 may additionally or solely be configured for wired communication, and in such a case antennas 627, 637 would also illustrate any form of communication hardware, without requiring a conventional antenna.

[0047] Transceivers 616, 626, and 636 may each, independently, be a transmitter, a receiver, or both a transmitter and a receiver, or a unit or device that is configured both for transmission and reception.

[0048] Processors 614, 624, and 634 may be embodied by any computational or data processing device, such as a central processing unit (CPU), application specific integrated circuit (ASIC), or comparable device. The processors may be implemented as a single controller, or a plurality of controllers or processors.

[0049] Memories 615, 625, and 635 may independently be any suitable storage device, such as a non-transitory computer-readable medium. A hard disk drive (HDD), random access memory (RAM), flash memory, or other suitable memory may be used. The memories may be combined on a single integrated circuit as the processor, or may be separate from the one or more processors. Furthermore, the computer program instructions stored in the memory and which may be processed by the processors may be any suitable form of computer program code, for example, a compiled or interpreted computer program written in any suitable programming language.

[0050] The memory and the computer program instructions may be configured, with the processor for the particular device, to cause a hardware apparatus such as UE 610, eNB 620, and MME 630, to perform any of the processes described above (see, for example, Figures 3-5). Therefore, in certain embodiments, a non-transitory

computer-readable medium may be encoded with computer instructions that, when executed in hardware, perform a process such as one of the processes described herein. Alternatively, certain embodiments may be performed entirely in hardware.

[0051] Furthermore, although Figure 6 illustrates a system including a UE, eNB, and MME, embodiments of the invention may be applicable to other configurations, and configurations involving additional elements.

[0052] One having ordinary skill in the art will readily understand that the invention as discussed above may be practiced with steps in a different order, and/or with hardware elements in configurations which are different than those which are disclosed. Therefore, although the disclosure has been described based upon these preferred embodiments, it would be apparent to those of skill in the art that certain modifications, variations, and alternative constructions would be apparent, while remaining within the scope of the invention. In order to determine the metes and bounds of the invention, therefore, reference should be made to the appended claims.

Partial Glossary

[0053]

AS - Access Stratum
CN - Core Network
DL - Down Link
MME - Mobility Management Entity
MO - Mobile Originating
MTC - Machine Type Communication
NAS - Non Access Stratum
RAN - Radio Access Network
RRC - Radio Resource Control
UE - User Equipment
UL - Up Link
TAU - Tracking Area Update

Claims

1. A method, **characterized in**:

receiving (560), at a mobility management entity, an indication of a repetition level for a user equipment;
determining (540), by the mobility management entity, based on the received repetition level, whether a paging is for user equipment in coverage enhancement mode;
indicating (550), by the mobility management entity in a paging message, that the paging is for user equipment in coverage enhancement mode, based on the determining; and sending (570), by the mobility management entity, the received repetition level to an evolved Node B, wherein the repetition level is indicative of a number of repetitions of a physical downlink control channel for paging message transmission to the user equipment,
wherein the repetition level of the user equipment is conveyed to the mobility management entity when the user equipment moves to idle mode.

2. A mobility management entity, comprising:

at least one processor; and
at least one memory including computer program code,
characterized in that the at least one memory including the computer program code are configured to, with the at least one processor, cause the mobility management entity to
receive (560), at the mobility management entity, an indication of a repetition level for a user equipment;
determine (540), by the mobility management entity, based on the received repetition level, whether a paging is for user equipment in coverage enhancement mode;
indicate (550), by the mobility management entity in a paging message, that the paging is for user equipment in coverage enhancement mode, based on the determining; and
send (570), by the mobility management entity, the received repetition level to an evolved Node B, wherein the repetition level is indicative of a number of repetitions of a physical downlink control channel for paging message transmission to the user equipment,
wherein the repetition level of the user equipment is conveyed to the mobility management entity when the user equipment moves to idle mode.

Patentansprüche

1. Verfahren, das durch Folgendes gekennzeichnet ist:

Empfangen (560) einer Anzeige eines Wiederholungsmaßes für eine Teilnehmereinrichtung an einer Mobilitätsverwaltungsentität;
Bestimmen (540) auf Basis des empfangenen Wiederholungsmaßes durch die Mobilitätsverwaltungsentität, ob ein Paging für eine Teilnehmereinrichtung in einem Abdeckungsverbesserungmodus bestimmt ist;
Anzeigen (550) in einer Pagingnachricht, dass das Paging für eine Teilnehmereinrichtung in einem Abdeckungsverbesserungmodus ist, durch die Mobilitätsverwaltungsentität auf Basis des Bestimmens und
Senden (570) des empfangenen Wiederho-

lungsmaßes durch die Mobilitätsverwaltungsentität an einen Evolved Node B, wobei das Wiederholungsmaß eine Anzahl von Wiederholungen eines physischen Downlinksteuerkanals für eine Pagingnachrichtenübertragung zur Teilnehmereinrichtung anzeigt,
wobei das Wiederholungsmaß der Teilnehmereinrichtung zur Mobilitätsverwaltungsentität übermittelt wird, wenn die Teilnehmereinrichtung in einen Ruhemodus geht.

2. Mobilitätsverwaltungsentität die Folgendes umfasst:

mindestens einen Prozessor und
mindestens einen Speicher, der Computerprogrammcode beinhaltet,
dadurch gekennzeichnet, dass der mindestens eine Speicher, der den Computerprogrammcode beinhaltet, dazu ausgelegt sind, mit dem mindestens einen Prozessor die Mobilitätsverwaltungsentität zu Folgendem zu veranlassen
Empfangen (560) einer Anzeige eines Wiederholungsmaßes für eine Teilnehmereinrichtung an der Mobilitätsverwaltungsentität;
Bestimmen (540) auf Basis des empfangenen Wiederholungsmaßes durch die Mobilitätsverwaltungsentität, ob ein Paging für eine Teilnehmereinrichtung in einem Abdeckungsverbesserungmodus bestimmt ist;
Anzeigen (550) in einer Pagingnachricht, dass das Paging für eine Teilnehmereinrichtung in einem Abdeckungsverbesserungmodus ist, durch die Mobilitätsverwaltungsentität auf Basis des Bestimmens und
Senden (570) des empfangenen Wiederholungsmaßes durch die Mobilitätsverwaltungsentität an einen Evolved Node B, wobei das Wiederholungsmaß eine Anzahl von Wiederholungen eines physischen Downlinksteuerkanals für eine Pagingnachrichtrnübertragung zur Teilnehmereinrichtung anzeigt,
wobei das Wiederholungsmaß der Teilnehmereinrichtung zur Mobilitätsverwaltungsentität übermittelt wird, wenn die Teilnehmereinrichtung in einen Ruhemodus geht.

Revendications

1. Procédé **caractérisé par** :

la réception (560), au niveau d'une entité de gestion de la mobilité, d'une indication d'un niveau de répétition pour un équipement utilisateur ;
la détermination (540), par l'entité de gestion de la mobilité, sur la base du niveau de répétition reçu, précisant si une radiomessagerie est destinée à l'équipement utilisateur en mode d'amélioration de couverture ;
l'indication (550), par l'entité de gestion de la mobilité dans un message de radiomessagerie, que la radiomessagerie est destinée à l'équipement utilisateur en mode d'amélioration de couverture, sur la base de la détermination ; et
l'envoi (570), par l'entité de gestion de la mobilité, du niveau de répétition reçu à un noeud B évolué, dans lequel le niveau de répétition indique un nombre de répétitions d'un canal physique de contrôle de liaison descendante pour une transmission de message de radiomessagerie à l'équipement utilisateur,
dans lequel le niveau de répétition de l'équipement utilisateur est converti vers l'entité de gestion de la mobilité lorsque l'équipement utilisateur passe en mode veille.

2. Entité de gestion de la mobilité, comprenant :

au moins un processeur ; et
au moins une mémoire comportant un code de programme informatique,
caractérisée en ce que l'au moins une mémoire comportant le code de programme informatique sont configurée pour, avec l'au moins un processeur, amener l'entité de gestion de la mobilité à
recevoir (560), au niveau de l'entité de gestion de la mobilité, une indication d'un niveau de répétition pour un équipement utilisateur ;
déterminer (540), par l'entité de gestion de la mobilité, sur la base du niveau de répétition reçu, si une radiomessagerie est destinée à l'équipement utilisateur en mode d'amélioration de couverture ;
indiquer (550), par l'entité de gestion de la mobilité dans un message de radiomessagerie, que la radiomessagerie est destinée à l'équipement utilisateur en mode d'amélioration de couverture, sur la base de la détermination ; et
envoyer (570), par l'entité de gestion de la mobilité, le niveau de répétition reçu à un noeud B évolué, dans laquelle le niveau de répétition indique un nombre de répétitions d'un canal physique de contrôle de liaison descendante pour une transmission de message de radiomessagerie à l'équipement utilisateur,
dans laquelle le niveau de répétition de l'équipement utilisateur est converti vers l'entité de gestion de la mobilité lorsque l'équipement utilisateur passe en mode veille.

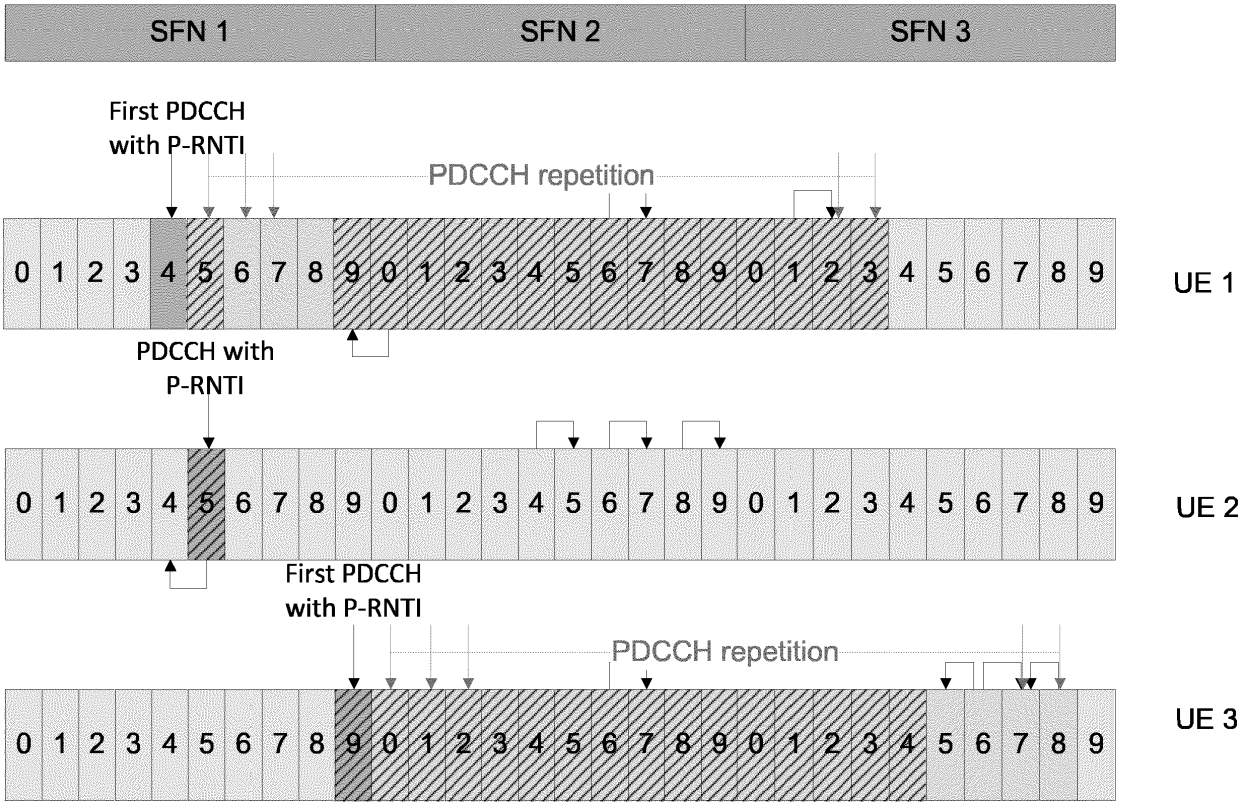
SFN 1
SFN 2
SFN 3
First PDCCH with P-RNTI
PDCCH repetition
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9
UE 1
PDCCH with P-RNTI
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9
UE 2
First PDCCH with P-RNTI
PDCCH repetition
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9
UE 3

Figure 1

```
PCCH-Config ::=                         SEQUENCE {
    defaultPagingCycle                      ENUMERATED {
                                                rf32, rf64, rf128, rf256},
    nB                                      ENUMERATED {
                                                fourT, twoT, oneT, halfT, quarterT, oneEighthT,
                                                oneSixteenthT, oneThirtySecondT}
}
```

Figure 2

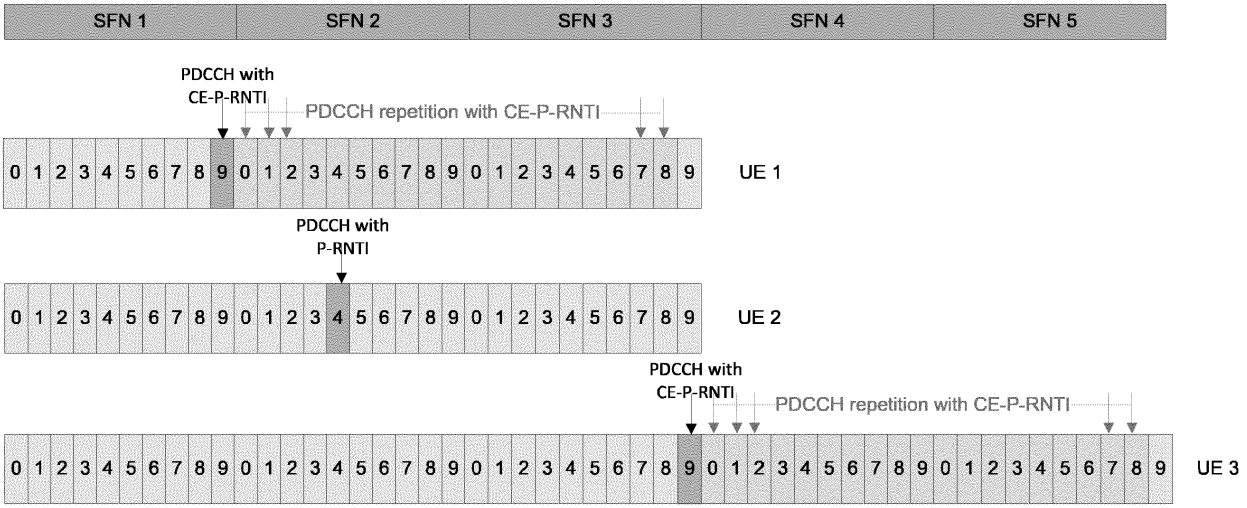
SFN 1
SFN 2
SFN 3
SFN 4
SFN 5
PDCCH with CE-P-RNTI
PDCCH repetition with CE-P-RNTI
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9
UE 1
PDCCH with P-RNTI
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9
UE 2
PDCCH with CE-P-RNTI
PDCCH repetition with CE-P-RNTI
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9
UE 3

Figure 3

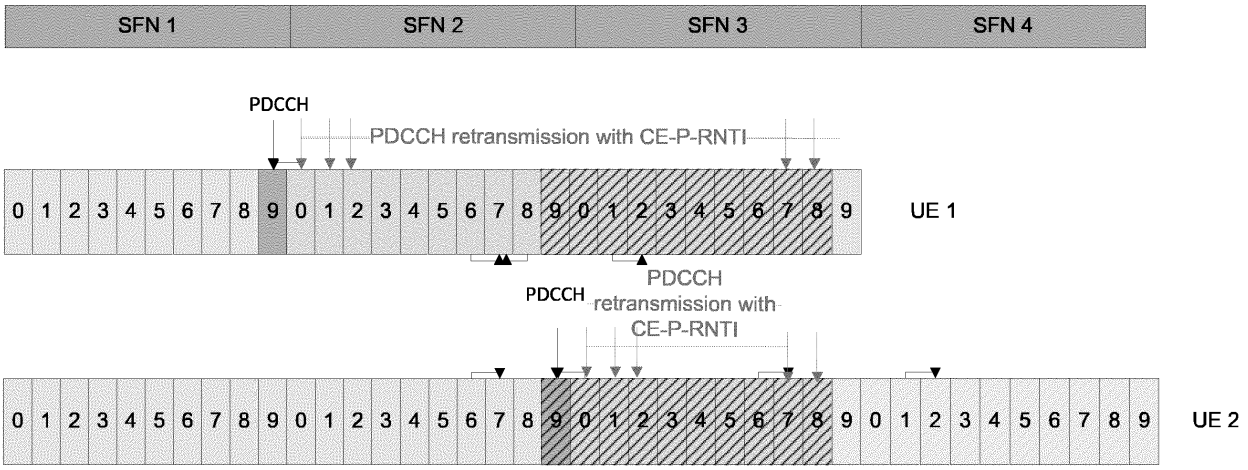
SFN 1
SFN 2
SFN 3
SFN 4
PDCCH
PDCCH retransmission with CE-P-RNTI
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9
UE 1
PDCCH
PDCCH retransmission with CE-P-RNTI
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9
UE 2

Figure 4

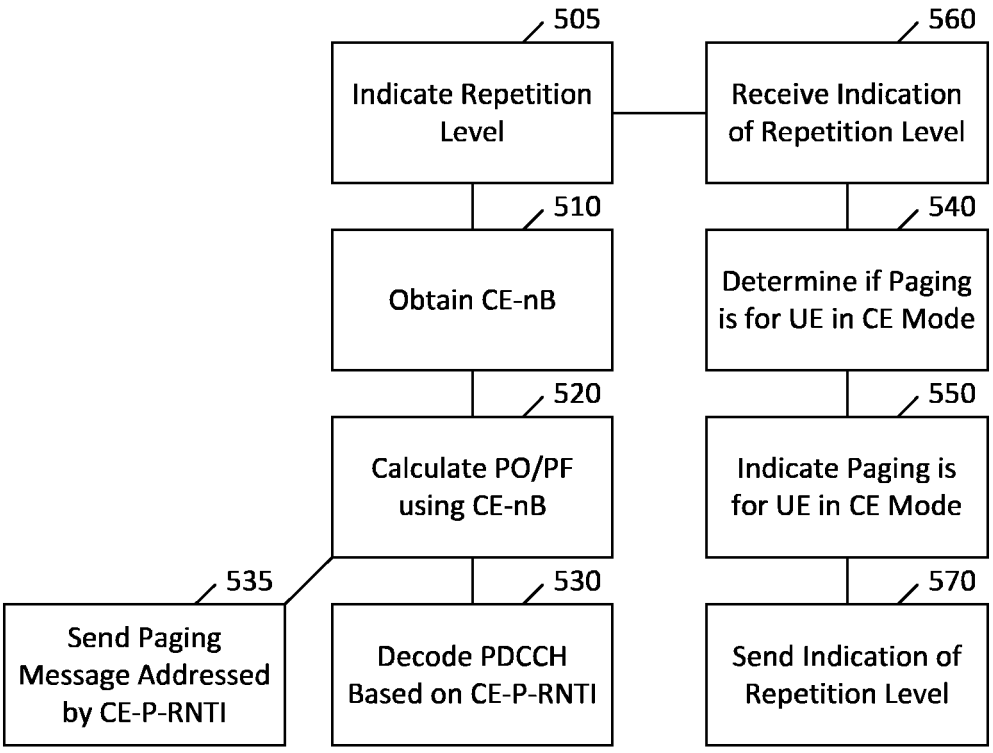
505
Indicate Repetition Level
510
Obtain CE-nB
520
Calculate PO/PF using CE-nB
535
Send Paging Message Addressed by CE-P-RNTI
530
Decode PDCCH Based on CE-P-RNTI
560
Receive Indication of Repetition Level
540
Determine if Paging is for UE in CE Mode
550
Indicate Paging is for UE in CE Mode
570
Send Indication of Repetition Level

Figure 5

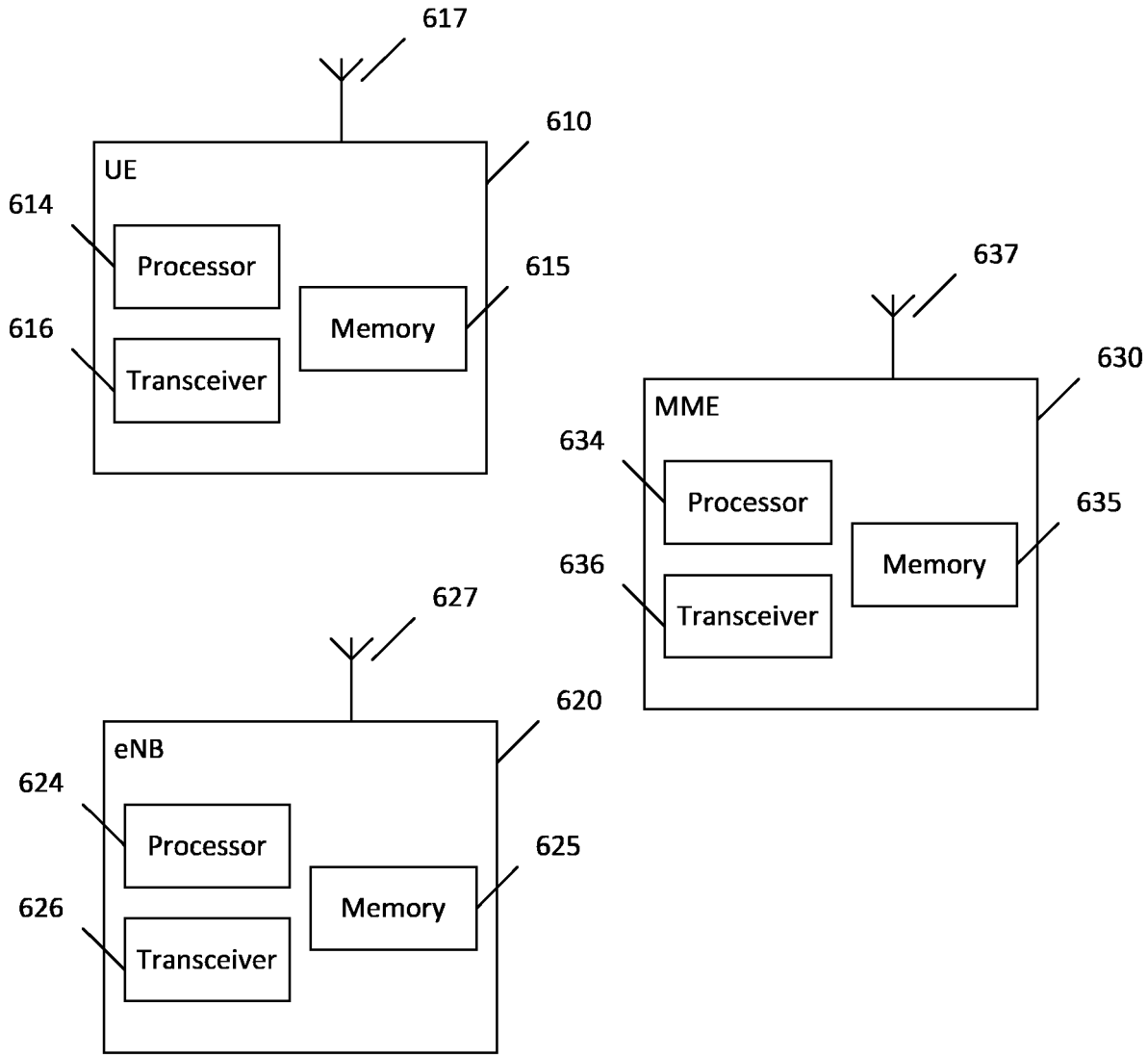
617
610
UE
614
Processor
615
Memory
616
Transceiver
637
630
MME
634
Processor
635
Memory
636
Transceiver
627
620
eNB
624
Processor
625
Memory
626
Transceiver

Figure 6

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2014055878 A1 **[0008]**
- WO 20140410 A **[0008]**